Original Article

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A study on factors determining dose of topical lignocaine during broncho-alveolar lavage by spray-as-you-go technique: A single centre observational study

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Summary **Basic bronchoscopic diagnostic procedures like Broncho-alveolar lavage (BAL) are often performed without sedation, using lignocaine administered *via* the working channel of bronchoscope (spray-as-you-go technique) and other routes. Our aim was to evaluate the factors responsible for variation in the total dose of lignocaine administered in individual subjects. We prospectively included consecutive subjects undergoing BAL in an outpatient setting from August 2016 to November 2017 at our centre. The subjects were administered lignocaine *via* nebulization, nasal gel, oropharyngeal spray before and during bronchoscopy ("spray-as-you-go") as per a predefined protocol. The demographic details, high resolution computerized tomography (HRCT) characteristics, procedural details, doses of lignocaine administered and a visual analogue scale (VAS) for satisfaction with the procedure were recorded. Using lignocaine dose as outcome, variables were assessed for effect by univariate and multivariate regression analysis. 96 subjects were included with a mean age of 40 years and male predominance (60.4%). Cough was the most common presenting symptom (64.6%). Predisposing factors included tuberculosis (47.9%) and smoking (23.2%). Maximum variation in lignocaine dose occurred prior to intubating vocal cords using "spray-as-you-go", which was significantly related to history of past tuberculosis ($p = 0.031$), obstructive airway disease ($p = 0.009$), fibrotic sequelae ($p = 0.011$) and bronchiectasis ($p = 0.049$). Obstructive airway disease and fibrotic sequelae were also significant on multivariate analysis ($p = 0.01$ and 0.005 respectively). Obstructive airway disease and architectural distortion due to fibrotic sequelae leads to higher dose requirement for lignocaine during BAL by fibre-optic bronchoscopy. Caution must be maintained during bronchoscopic procedures to avoid exceeding recommended maximum doses in such patients.**

Keywords: Bronchoscopy, broncho-alveolar lavage, lignocaine dose

1. Introduction

Flexible fibre-opticbronchoscopy (FFB) is one of the most commonly used tools in the diagnosis and treatment of broncho-pulmonary diseases throughout the world. It is generally believed to be an extremely safe procedure with low rates of major complications and extremely low mortality (0-0.04% in 68,000 procedures) (*1*). Minor procedure related complications are common, of which cough is often reported by most patients to be particularly distressing (*2*). A number of regimens have been suggested for optimal patient comfort during the procedure, ranging from conscious sedation combined with anticholinergic agents and topical lignocaine to topical lignocaine alone (*3*). While sedatives are often recommended in patients in whom there are no contraindications, actual practice scan vary based on the settings (office, intensive care units, or operating room), complexity and duration of the procedure (advanced diagnostic or therapeutic bronchoscopy) (*4*). In most cases, basic bronchoscopic diagnostic procedures like broncho-alveolar lavage (BAL) can be performed without sedatives while minimizing patient discomfort if adequate topical lignocaine is provided (*5*).

Lignocaine is the most commonly used topical

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anaesthetic for flexible bronchoscopy because of its efficacy in suppressing cough, short half-life, wide safety margin and minimal tissue toxicity (*6*). It can be administered as soaked cotton pledgets, dropper instillation, aerosol spray, nebulization, trans-cricoid or trans-tracheal injection, local nerve block, or "spray-as-you-go" (through the working channel of the bronchoscope) (*4*). Although believed to be safe, systemic absorption of a fraction of administered dose is known, and dose related cardiac (arrhythmias) and neurologic (circum-oral paraesthesia, seizures) side effects can occur if the total topical dose exceeds 8.2 mg/kg or serum lidocaine level exceeds 5 mg/L (*3*). The total dose of lignocaine administered, therefore, needs to be carefully tracked and meticulously recorded throughout the procedure. Studies on lignocaine kinetics have identified subjects with advanced age, impaired liver function, or congestive heart failure at particular risk of toxicity (*7*). However, clinical experience suggests that the dose of lignocaine administered is highly variable among patients irrespective of the presence of aforementioned factors. The objective of this study was to identify patients in whom such high doses could be anticipated and thus could be pre-emptively supplemented with sedatives prior to the procedure to limit total lignocaine used.

2. Materials and Methods

2.1. *Study setting*

The current study was conducted in the bronchoscopy suite of the department of Medicine, All India Institute of Medical Sciences, New Delhi, a tertiary care academic centre in India. We included consecutive subjects undergoing FFB for BAL from August 2016 to November 2017 through a prospectively acquired database. The study protocol was approved by the Ethics Review Committee (Ref. No. IECPG/499/29.8.2016), and written informed consent was obtained from all the subjects.

2.2. *Patient characterization*

The demographic details of the subjects were recorded, including age, sex, education, weight, height, body mass index (BMI), smoking status, and clinical features of underlying broncho-pulmonary disease (shortness of breath, haemoptysis, cough, fever, history of past or present anti-tubercular therapy (ATT) and inhaler use). All the subjects in the study had a recent High-Resolution Computed Tomography (HRCT) chest done, and pertinent findings of the scan were also recorded.

2.3. *Study protocol*

As mentioned previously, the subjects undergoing BAL were not routinely sedated, and bronchoscopy was performed under topical anaesthesia with lignocaine. All subjects were kept fasting overnight prior to the procedure. BAL was done by a single operator (A.R) who has more than 5 years of experience using Pentax EB-1970K with a 6.2 mm distal tube diameter, 2.8 mm working channel and 120° angle of view. BAL was done using standard protocol and 80-100 mL of lignocaine was instilled in a "wedged" segment followed by application of suction through a wall-mounted apparatus keeping the pressure below 100 mm of Hg at all times. The subjects received lignocaine through 4 routes according to a predefined protocol: nebulization, nasal gel, oropharyngeal spray before and "spray-as-you-go" during bronchoscopy. Nebulization: 2.5 mL of 4% lignocaine for 15 minutes. Oropharyngeal spray: Lignocaine spray (10%) was sprayed twice (10 mg/puff) over the oropharynx. Nasal Gel: Approximately 3 mL of lignocaine gel (2%), equivalent to 60 mg of lignocaine, was administered in the nasal cavity prior to the introduction of the bronchoscope. "Spray-as-you-go": Subjects thereafter received 1-mL aliquots of 2% lignocaine solution delivered through the bronchoscope as a rescue therapy to suppress cough, at the discretion of the operator. In general, four aliquots of 1 mL of lignocaine were administered: one each at the vocal cord, tracheal carina, and in the right and left main bronchus.

The sum of the administered dose (2.5 mL of 4% nebulized lignocaine [100 mg] plus 3 mL of 2% lignocaine gel [60 mg] plus two puff s of 10% lignocaine spray [20 mg] plus 20 mg for every additional aliquot of 2% lignocaine during "spray-as-you-go") made up the total dose of lignocaine used. For ease of calculations, the dose administered was recorded as milligrams of lignocaine. The amount of lignocaine administered before and after passing through the vocal cords and the total dose of lignocaine administered per kg body weight were also recorded. The subjects in whom technical difficulty prevented completion of procedure received additional intravenous sedation and were excluded from this study.

Vital parameters, namely pulse rate, respiratory rate, blood pressure (BP), and oxygen saturation (by pulse oximetry) were monitored throughout the procedure. Subjects were also monitored for any adverse effects related to lignocaine use (like arrhythmia, involuntary movements, anaphylaxis, and bronchospasm).

Along with the dose of lignocaine, the amount of normal saline (NS) administered, number of BAL sites and time taken for the procedure was also recorded. A Visual Analogue Scale (VAS) was used to objectively assess satisfaction with the procedure as reported by the patient and bronchoscopist independently. The scale consisted of a 100 mm line, wherein the rating was given by marking a point along this line, where 0 represented complete satisfaction with the procedure and 100 represented no satisfaction at all.

The satisfaction rating thus obtained was assessed for agreement between bronchoscopist and the patient. The dose of lignocaine used across different quartiles of patient satisfaction groups was also analysed.

2.4. *Sample size estimation*

The primary objective of this study was to identify independent factors that affect dosing of lignocaine among patients. For the purpose of sample size estimation, it was assumed that analysing up to 5 variables for independent effect by multivariate analysis would be sufficient. Assuming an alpha of 0.05, power of 0.80, number of predictors to be 5 with moderate effect size ($f^2 = 0.15$), the number of subjects required for analysis was estimated to be 92 (*8*). An additional 8 cases were added to account for requirement of IV sedation and withdrawal of consent.

2.5. *Statistical analysis*

The continuous variables are presented as means with standard deviations or medians with interquartile range depending upon underlying distribution. The categorical variables are presented as percentages for each category. The statistical association of each of the variables with lignocaine dose administered throughout the procedure, prior to passing through vocal cords and thereafter, along with lignocaine dose by body weight was assessed by Student's *t* tests, Mann Whitney *U* tests and chi square tests as appropriate. One-way ANOVA was used for comparing intergroup differences in patient and bronchoscopist reported satisfaction as there were more than 2 groups. Appropriate subsets of the determinant variables were assessed for independent effect on outcome by multivariate linear regression analysis. All analyses were performed using IBM SPSS Statistics Version 20 and Microsoft Excel 2011.

3. Results

A total of 99 consecutive subjects who underwent BAL over the 1-year period gave consent for inclusion in this study. In 3 subjects the procedure couldn't be completed on topical lignocaine alone and required intravenous sedation. They were therefore excluded and the remaining 96 subjects were included in the study. The study population had a mean age of 40 years with male predominance (59.4%) and a relatively high proportion of present or past tuberculosis (8.3% and 39.6%) (Table 1). Cough was the most common presenting symptom (64.6%), although shortness of breath, fever and haemoptysis were fairly common as well (34.4%, 35.8% and 22.9% respectively). The most common computerized tomography (CT) findings included bronchiectasis, centri-lobular nodules, consolidation, cavitation and fibrotic sequelae (26.0%, 28.1%, 27.1%, 21.9% and 28.1% respectively). However almost all CTs had some demonstrable abnormality, and only 2 subjects had near normal CT scans (Table 2).

The mean doses of lignocaine administered to various subgroups of categorical clinical findings were compared by Student's *t* test (Table 3). The maximum variation in lignocaine administered occurred during "spray-as-you-go" prior to intubating vocal cords (VC), with same doses used for nebulization, nasal gel, oropharyngeal spray and nearly similar doses after intubating vocal cords. The time needed for reaching vocal cords during the procedure was also dependent only on the dose of lignocaine needed prior to reaching VC (Spearman's rho: 0.725, $p < 0.001$) (Figure 1).

The total dose of lignocaine was similar irrespective of sex, however, females received significantly lesser lignocaine dose when compared based on dose administered per kg body weight (6.5 mg/kg *vs*. 7.76 mg/kg for males, $p < 0.01$) (Figure 2). No association was noted for history of smoking, inhaler use, shortness of breath, haemoptysis or cough, although there was a trend towards significance for cough when compared for lignocaine needed prior to intubating vocal cords. (66.9 mg *vs*. 55.8 mg, $p = 0.062$). Subjects with history of past ATT (anti-tubercular therapy) intake also required significantly more lignocaine doses prior to vocal cords (70.5 mg *vs*. 58.1 mg, $p = 0.031$). In addition, subjects with fever (53.8 mg *vs*. 68.1 mg, $p = 0.015$) and present ATT use (42.5 mg *vs*. 64.8 mg, $p = 0.028$) appeared to require lesser lignocaine doses than others. The effect of history of fever was also evident on total lignocaine dose

Table 1. Demographic and clinical characteristics of study population

Age (yrs) mean ± SD	40.0 ± 14.8
Females, *n* (%)	39 (40.6%)
Weight (kg) mean ± SD	47.7 ± 11.5
Height (m) mean ± SD	1.61 ± 0.10
BMI (kg/m^2) mean ± SD	18.23 ± 3.83
Smokers, *n* (%)	22 (23.2%)
History of shortness of breath, *n* (%)	33 (34.4%)
History of fever, *n* (%)	34 (35.8%)
History of hemoptysis, n (%)	22 (22.9%)
History of cough, *n* (%)	62 (64.6%)
Presently taking ATT, *n* (%)	8 (8.3%)
Past history of ATT use, *n* (%)	38 (39.6%)
History of inhaler use, *n* (%)	21 (21.9%)

Table 2. High Resolution Computerized Tomography characteristics of study population

Bronchiectasis, *n* (%)	25 (26.0%)
Mass lesion, *n* (%)	9 (9.4%)
Miliary nodules, *n* (%)	3 (3.1%)
Centrilobular nodules, *n* (%)	27 (28.1%)
Consolidation, *n* (%)	26 (27.1%)
Cavitation, *n* (%)	21 (21.9%)
Fibrotic sequelae, *n* (%)	27 (28.1%)
Collapse, *n* (%)	7 (7.3%)
Air trapping, *n* (%)	11 (11.5%)
Normal CT scan	2 (2.1%)

Table 3. Mean lignocaine dose administered across clinical subgroups[$]

Items		Total lignocaine administered*	Sig.[#]	Lignocaine administered prior to VC*	Sig.[#]	Lignocaine administered after VC*	Sig.[#]	Total lignocaine/ Body weight*	Sig.[#]	Total "spray-as-you-go" lignocaine	Sig.[#]
Females	Y	320.7 ± 39.8	NS	64 ± 27.5	NS	76.8 ± 22.2	NS	6.5 ± 1.58	< 0.01	133.2 ± 34	NS
	N	313.3 ± 34.7		61.5 ± 28.4		71.7 ± 18.7		7.76 ± 1.71		140.8 ± 35.3	
Smokers	Y	319 ± 32.9	NS	63.6 ± 25.9	NS	75.4 ± 19.4	NS	6.81 ± 2.06	NS	139.1 ± 32.9	NS
	N	316.9 ± 39.5		62.3 ± 28.3		74.7 ± 21.6		7.04 ± 1.64		137.1 ± 39.4	
History of shortness of breath	Y	326 ± 40.1	NS	69.3 ± 31.4	NS	76.9 ± 22.4	NS	7.28 ± 1.74	NS	146.4 ± 39.7	NS
	N	313.3 ± 36.1		59.6 ± 25.2		73.6 ± 20.2		6.87 ± 1.74		133.3 ± 36.1	
History of fever	Y	307 ± 32.6	0.041	53.8 ± 20.0	0.015	73.5 ± 20.7	NS	6.48 ± 1.78	0.021	127.4 ± 32.2	0.034
	N	323.6 ± 39.7		68.1 ± 30.4		75.4 ± 21.4		7.34 ± 1.66		143.6 ± 39.8	
History of hemoptysis	Y	320 ± 39	NS	63.6 ± 32.4	NS	76.3 ± 19.1	NS	6.79 ± 1.6	NS	140 ± 39.04	NS
	N	317 ± 37.6		62.8 ± 26.4		74.3 ± 21.5		7.08 ± 1.78		137.2 ± 37.5	
History of cough	Y	322.2 ± 38.1	NS	66.9 ± 28.8	0.062	75.4 ± 21.2	NS	7.17 ± 1.76	NS	142.4 ± 37.9	NS
	N	309.4 ± 36.2		55.8 ± 24.5		73.5 ± 20.7		6.74 ± 1.68		129.4 ± 36.3	
Presently taking ATT	Y	295 ± 39.6	0.076	42.5 ± 16.6	0.028	72.5 ± 26	NS	6.04 ± 1.12	NS	115 ± 39.6	NS
	N	319.7 ± 37.2		64.8 ± 27.8		75 ± 20.6		7.09 ± 1.76		139.9 ± 37	
Past history of ATT use	Y	326.8 ± 40.3	0.055	70.5 ± 29.6	0.031	76.3 ± 20.7	NS	7.39 ± 1.75	0.089	146.8 ± 40.3	0.066
	N	311.7 ± 35.1		58.1 ± 25.5		73.7 ± 21.2		6.76 ± 1.7		131.9 ± 34.9	
History of inhaler use	Y	327.6 ± 43.5	NS	70.9 ± 33.4	NS	77.1 ± 23	NS	7.22 ± 1.64	NS	148.1 ± 42.9	NS
	N	314.9 ± 35.8		60.8 ± 25.7		74.1 ± 20.4		6.95 ± 1.77		134.9 ± 35.9	

*: Lignocaine doses are reported as equivalents of milligrams of lignocaine. [#]: Significance is reported for Student's *t* test as *p* values. Only values < 0.10 are reported. Values < 0.05 are accepted as statistically significant. [$]: All Values are reported as means ± Standard deviation in mg, unless stated otherwise.

Table 4. Mean lignocaine dose administered across computerized tomography subgroups[$]

Items		Total lignocaine administered*	Sig.[#]	Lignocaine administered prior to VC*	Sig.[#]	Lignocaine administered after VC*	Sig.[#]	Total lignocaine/ Body weight*	Sig.[#]	Total "spray-as-you-go" lignocaine	Sig.[#]
Bronchiectasis	Y	320.8 ± 37.6	NS	72.4 ± 30.7	0.049	68.8 ± 16.4	NS	7.15 ± 1.42	NS	141.2 ± 37	NS
	N	316.6 ± 38		59.7 ± 26		76.9 ± 22		6.96 ± 1.85		136.6 ± 38.1	
Mass lesion	Y	302.2 ± 25.3	NS	53.3 ± 14.1	NS	68.8 ± 22.6	NS	6.87 ± 2.57	NS	122.2 ± 25.4	NS
	N	319.3 ± 38.6		64 ± 28.6		75.4 ± 20.8		7.03 ± 1.65		139.4 ± 38.5	
Miliary nodules	Y	280 ± 40	0.079	33.3 ± 11.5	0.059	66.6 ± 30.5	NS	6.42 ± 2.13	NS	100 ± 40	0.079
	N	318.9 ± 37.3		63.9 ± 27.6		75 ± 20.7		7.03 ± 1.74		139 ± 37.2	
Centrilobular nodules	Y	322.9 ± 41.7	NS	62.2 ± 27.3	NS	80.7 ± 22.5	0.082	7.04 ± 1.97	NS	143 ± 41.8	NS
	N	315.6 ± 36.2		63.3 ± 28.1		72.4 ± 20		7 ± 1.66		135.8 ± 36.1	
Consolidation	Y	315.3 ± 35.4	NS	58.4 ± 25.2	NS	76.9 ± 21.6	NS	6.75 ± 1.47	NS	135.4 ± 35.5	NS
	N	318.5 ± 38.8		64.7 ± 28.6		74 ± 20.8		7.11 ± 1.83		138.7 ± 38.7	
Cavitation	Y	318 ± 43.7	NS	63.8 ± 33.8	NS	74.2 ± 22.9	NS	7.04 ± 1.76	NS	138.1 ± 43.8	NS
	N	317.6 ± 36.3		62.8 ± 26		74.9 ± 20.5		7 ± 1.74		137.7 ± 36.1	
Fibrotic sequelae	Y	337.7 ± 44.8	0.005	77.7 ± 36.5	0.011	80 ± 19.2	NS	7.41 ± 1.85	NS	157.8 ± 44.8	0.005
	N	309.8 ± 31.7		57.2 ± 21.1		72.7 ± 21.4		6.86 ± 1.68		130 ± 31.5	
Collapse	Y	314.2 ± 37.7	NS	57.1 ± 24.2	NS	77.1 ± 21.3	NS	6.64 ± 2.39	NS	134.3 ± 37.8	NS
	N	317.9 ± 38		63.4 ± 28		74.6 ± 21		7.04 ± 1.69		138.1 ± 37.9	
Air trapping	Y	329 ± 32.6	NS	67.2 ± 16.1	NS	81.8 ± 24.4	NS	7.41 ± 1.77	NS	149.1 ± 32.7	NS
	N	316.2 ± 38.3		62.4 ± 28.9		73.8 ± 20.4		6.96 ± 1.74		136.4 ± 38.2	
Obstructive Airway Disease**	Y	327.3 ± 39.6	0.031	71.4 ± 30.1	0.009	76 ± 21	NS	7.14 ± 1.55	NS	147.6 ± 39.3	0.031
	N	310.5 ± 35		56.7 ± 24.2		73.8 ± 21		6.91 ± 1.88		130.5 ± 35	

*: Lignocaine doses are reported as equivalents of milligrams of lignocaine. [#]: Significance is reported for Student's *t* test as *p* values. Only values < 0.10 are reported. Values < 0.05 are accepted as statistically significant. [$]: All Values are reported as means ± Standard deviation in mg, unless stated otherwise. **: Obstructive airway disease is a composite of bronchiectasis, air trapping and history of inhaler use.

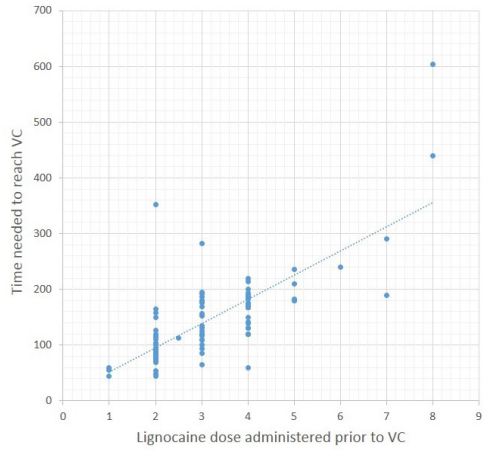

Figure 1. Subjects requiring higher lignocaine dose prior to VC intubation also required longer time for intubating VC.

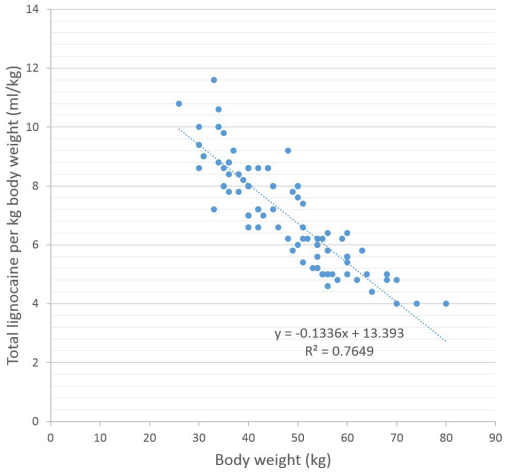

Figure 2. Subjects with higher body weights received significantly lower doses of total lignocaine when assessed based on per kg body weight.

Table 5. Procedural characteristics of subjects undergoing Broncho-alveolar lavage

Total lignocaine dose (mg) mean ± SD	317.71 ± 37.82
Lignocaine administered prior to vocal cords(VC) (mg), mean ± SD	63.02 ± 27.76
Lignocaine administered after vocal cords(VC) (mg), mean ± SD	74.79 ± 20.98
Total lignocaine dose/kg body weight (mg/kg), mean ± SD	7.02 ± 1.74
Time (seconds) needed to reach VC, median(IQR)	130 (93-180)
Time (seconds) needed after passing VC, median(IQR)	245 (195-285)
Lignocaine 4-6 mg/kg	35 (36.5%)
Lignocaine between 6 and 8.2 mg/kg	35 (36.5%)
Lignocaine > 8.2mg/kg	26 (27.1%)
Satisfaction (as assessed by the patient)	50 (20-80)
Satisfaction (as assessed by the bronchoscopist)	30 (20-60)

Table 6. Multivariate linear regression analysis to identify independent predictors of lignocaine dose administered prior to reaching VC

Variable	B (95% Confidence Interval)	Beta	Sig.
(Constant)	46.72 (35.37-58.08)		0.000
History of cough	9.96 (–0.99-20.92)	0.172	0.074
Present ATT use	– 12.79 (–31.77-6.18)	– 0.128	0.184
Past ATT use	– 0.521 (–12.85-11.81)	– 0.009	0.933
Miliary nodules	– 9.128 (–40.11- 21.85)	– 0.058	0.560
Fibrotic sequelae	19.03 (5.83-32.23)	0.310	0.005
Obstructive airway disease	14.21 (3.48-24.93)	0.254	0.010

and lignocaine per kg body weight.

The doses required for subjects with different CT findings were similarly compared (Table 4). Subjects with fibrotic sequelae (77.7 mg *vs*. 57.2 mg, $p = 0.011$) and bronchiectasis (72.4 mg *vs*. 59.7 mg, $p = 0.049$) on CT required significantly higher dose of lignocaine prior to intubating VC. None of the other findings on CT were associated with lignocaine dose.

The continuous variables were assessed across various lignocaine doses by calculating Pearson's correlation coefficients. Statistically significant but overall poor correlation was noted between subjects' age and lignocaine administered after passing VC ($r = 0.202$, $p = 0.048$) (Table 5).

To better explain the variability in lignocaine administered prior to reaching VC, multivariate linear regression analysis was conducted, using lignocaine dose administered prior to reaching VC as dependent variable. To control the degrees of freedom for small sample size, a composite variable of obstructive airway disease was calculated, using past inhaler use for obstructive airway disease, CT features of bronchiectasis or air trapping. The predictors assessed therefore included history of cough, present or past ATT use, miliary nodules on CT, fibrotic sequelae on CT and obstructive airway disease. Multivariate analysis identified presence of obstructive airway disease and fibrotic sequelae as the only independent predictors of lignocaine dose required (Table 6). Together, the presence of these 2 variables explained nearly one

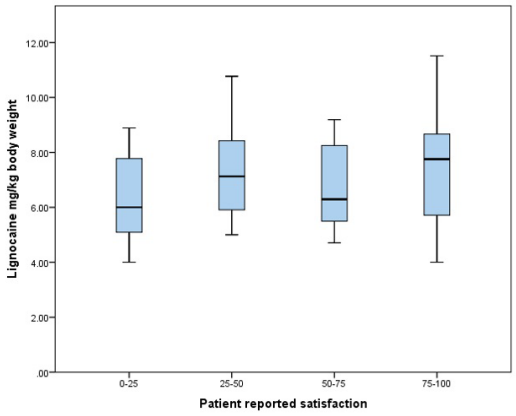

Figure 3. Boxplots of dose of lignocaine used across quartiles of patient reported outcomes.

fourth of variations in lignocaine dose needed (adjusted $R^2 = 0.241$).

Most of the subjects were only partly satisfied with the procedure, with a median self-rated satisfaction of 50% (IQR 20-80). The self-rated index of dissatisfaction was consistently higher when assessed by the subjects compared with that of bronchoscopist (median of 30) (Table 4). There was a significant but only moderate correlation between patient and bronchoscopist assessed outcomes for satisfaction (Spearman's rho = 0.464). While bronchoscopist reported satisfaction was related to the dose of lignocaine ($p = 0.002$, One-way ANOVA), no similar association could be identified for patient reported satisfaction. No definite trend was identified in dose of lignocaine across quartiles of satisfaction (Figure 3).

4. Discussion

To the best of our knowledge this the first study on the possible factors governing the dose of lignocaine during FBB. It is known that different patients require different doses of topical lignocaine during bronchoscopy – but little is known about the factors dictating increased doses of lignocaine.

Our study demonstrated that the presence of obstructive airway disease (history of prior inhaler use for physician diagnosed obstructive airway disease, features of airway trapping or bronchiectasis on CT scan) and fibrosis on CT scan were the only two independent predictors of lignocaine dose. It is known that obstructive airway disease, in the form of both asthma and non-asthmatic conditions can be associated with a heightened cough response which can explain the increased cough and need for increased dose of topical lignocaine in the group of presumed obstructive airway disease as seen in our study (*9*).

Tuberculosis is often associated with architectural compromise of the airways (*10*) and lung parenchyma leading to a gamut of restrictive and obstructive defects in pulmonary function (*11,12*). Badivuku *et al*. have demonstrated increased bronchial reactivity in patients with treated tuberculosis (*13*). The architectural distortion coupled with ongoing inflammation as a result of inter-current infections may predispose these individuals to increased cough reactivity – leading to increased requirement of topical lignocaine.

Also, the maximum variation in lignocaine dose occurred before intubation of vocal cord and the doses were not much different after intubation. The possible reason for the same was that the lignocaine used above the vocal cord also trickled down to the tracheo-bronchial tree producing topical anaesthesia, thus reducing further dose requirement. This is further demonstrated by the fact that the total doses of lignocaine used as "spray-as-you-go" (total lignocaine above and below the vocal cord) showed similar predictors as those for above the vocal cord.

The weight of the patient was not a potential factor dictating the requirement of lignocaine dose. A fixed amount of lignocaine (nebulisation and nasal) was given to the subjects and the "spray-as-you-go" were given according to the cough response of the patient - which did not vary according to weight – signifying that other factors and not the weight determine the dose of lignocaine. Thus, patients with lesser weight are more likely to be administered higher doses when compared on a per kg basis, and appropriate caution must be exercised in such patients.

Morice, *et al*. (*14*) had reported increased cough in females in response to inhalation cough challenge (with 10% citric acid) which suggested that there may be a sex-related difference in cough reflex sensitivity. No such difference was noted on our study. It may however be reasoned, that the smaller diameter of trachea-bronchial tree in females (*15*) may lead to greater deposition of topical lignocaine, protecting against the tussive effect of the bronchoscope in the airway.

There is no standard validated technique for assessing adequacy of anaesthetic dose administered during the procedure, although a number of tools have been used in the past with inconsistent results. The VAS is a simple and easily administered tool that can be used to gain insight to both the doctor's and patients' opinion of the procedure on a common scale. In our study, the bronchoscopist assessed outcomes were similar to that of others (*16*) for non-sedated patients, for satisfaction (Table 4). As reported previously, however, the patient assessed outcomes were only moderately correlated with that of bronchoscopist and were usually higher and more variable. The patient related outcomes also did not show a statistical association with the dose of lignocaine administered, indicating that there would be additional factors responsible for dissatisfaction, which cannot be accounted by the dose of lignocaine used alone. More studies are needed in this particular field for providing better patient comfort and procedure

results.

The limitations of this study are that it was conducted in a single centre (making it less generalizable), cross-sectional design and lack of blinding of the operator to patients' past medical history as well as dose of lignocaine given raising the possibility of bias. As the study was conducted in a tuberculosis endemic region around 40% patients had past history of tuberculosis. The strengths of the study, apart from its novelty, is the uniformity of the study protocol applied to all patients because of the fact that it was done by a single bronchoscopist following a pre-determined protocol.

In conclusion, the topical dose of lignocaine in patients undergoing FFB in a tuberculosis-endemic region is linked to patient factors like existence of obstructive airway disease and fibrotic sequelae. Such patients may require a combination of intravenous sedation and topical anaesthesia rather than topical lignocaine alone.

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