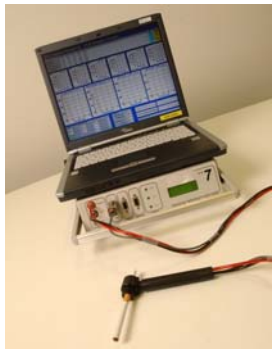
A COMPARISON OF THE PLOWSHARE CRESSMICRO™ SMOKING TOPOGRAPHY ANALYSER WITH A PROPRIETARY SMOKING ANALYSER

INTRODUCTION

- Smoke toxicant exposure influenced by cigarette design and human smoking behaviour[1,2]
- Smoking behaviour changed by modifying puffing behaviour (topography) or cigarette consumption
- Smoking behaviour normally assessed by measurement of differential pressures across an orifice in a cigarette holder to determine the volumetric flow through the holder[3]
- Apparatus / laboratory setting impacts 'normal' smoking behaviour[4]

British American Tobacco Smoking Analyser



- Comprises cigarette holder, data acquisition and transfer unit (DAT) and laptop PC
- Pressure and flow calibrated using a motorised syringe driver
- SA7 is transportable rather than truly portable by the smoker
- Studies generally involve a balanced, randomised design at a 'central location'

Plowshare CReSSmicro™

- Portable and lightweight
- Smoking behaviour recorded in any location
- Calibration using a 50mL syringe to draw a known volume of air through the device
- 'Device Scale Factor' enables adjustment of indicated volume to drawn volume
- 4 weeks measurement capacity, data downloaded to PC

OBJECTIVES

1. To compare puffing topography data from the CReSSmicro™ with the SA7 using machine and human smoking
2. To compare CReSSmicro™ data from smokers' normal smoking situation (home, work or leisure) with central location
3. To compare smoke exposure estimates from different analysers/locations using filter analysis

METHOD - LABORATORY

The CReSSmicro™ and SA7 units were set up in series connected to a Borgwaldt A14 single channel smoking machine to enable puffs to be drawn through a cigarette and both devices simultaneously. The order of the two devices was reversed during data collection.

Puffs were drawn through both units under various puffing parameters, measuring topography with the cigarettes both lit and unlit.

Volume: 20 – 80mL **Duration: 1.0 – 2.5s** **Profile: Sine and Square Wave**

METHOD - FIELDWORK

Product :	Commercial UK 5mg ISO tar cigarette
Subjects :	25 male : 25 female smokers aged ≥ 21 years Normal consumption ≥10 cigs per day of the test cigarette as their normal brand for ≥6 months Subjects were paid £80 to cover travel costs and inconvenience on completion of the study.
Locations :	Rented commercial premises in Romford, UK (Central Location) Smokers' home, work, leisure ('Home')

Table 1: Summary of Fieldwork

Central Location 1	SA7 (1 cig)	≥ 20 mins	CReSSmicro™ (1 cig)
'Home' 1 2 days	Collect filters from ≥ 15 cigs ± CReSSmicro™		
Central Location 2	SA7 (1 cig)	≥ 20 mins	CReSSmicro™ (1 cig)
'Home' 2 2 days	Collect filters from ≥ 15 cigs ± CReSSmicro™		
Central Location 3	SA7 (1 cig)	≥ 20 mins	CReSSmicro™ (1 cig)

(order randomised / balanced)

FILTER ANALYSIS

- Estimates the maximum mouth-level exposure of smoke constituents, reported as Tar or Nicotine In-Use (TIU / NIU), collectively Yield In-Use (YIU)
- Uses actual cigarettes smoked regardless of location
- Minimally invasive
- Enables sample collection from large numbers of subjects

- Subjects collect a 10mm section of the mouth end from at least 15 filters using a special filter cutter/collector
- Tar content of 3 replicates of 5 filter sections determined using HPLC with UV detection (310nm) after methanol extraction
- Nicotine content determined using GC with FID detection
- Mouth-level exposure estimated using calibrations from cigarettes machine smoked using puffing parameters that encompass the normal volumes and flows generated by smokers[5]

REFERENCES

1. Benowitz NL Compensatory smoking of low yield cigarettes. In: Shopland DR, Burns DM, Benowitz NL, Amacher RH, eds, Risks associated with smoking cigarettes with low machine-measured yields of tar and nicotine. NCI Smoking and Tobacco Control Monograph No. 13 Bethesda (MD): US. NIH, National Cancer Institute, NIH Publication no 02-5074; 2001 Oct p39-64
2. Benowitz, NL, Jacob P, III, Bernert JT, Wilson M, Wang L, Allen F and Dempsey D Carcinogen exposure during short-term switching from regular to "light" cigarettes. Cancer Epidemiol. Biomarkers Prev., *14:* 1376-1383, 2005.
3. Creighton DE, Noble MJ and Whewell RT Instruments to measure, record and duplicate human smoking patterns In: Thornton RE, ed, Smoking behaviour: physiological and psychological influences. Churchill Livingstone, London, 1978 p277-28
4. Ossip-Klein DJ, Martin JE, Lomax BD, Prue DM, Davis CJ Assessment of smoking topography generalization across laboratory, clinical, and naturalistic settings. Addict Behav, 8, 11-7, 1983
5. Shepperd CJ, St.Charles, FK, Lien M and Dixon M Validation of Methods for Determining Consumer Smoked Cigarette Yields from Cigarette Filter Analysis. Beit. Tabakforsch. Int., *22:* 176-184, 200

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RESULTS

Table 2: Puffing Topography Comparison – Unlit Cigarette

		CReSSmicro™	SA7	P (paired t test)
Puff Duration (s)	Mean	1.7	1.8	0.307
	sd	0.6	0.6	
Puff Volume (mL)	Mean	60.4	53.0	0.032
	sd	23.6	20.8	
Average Puff Flow (mL/s)	Mean	36.6	30.8	0.003
	sd	12.8	12.1	

Table 3: Puffing Topography Comparison – Lit Cigarette

		CReSSmicro™	SA7	P (paired t test)
Puff Duration (s)	Mean	1.7	1.8	0.157
	sd	0.6	0.6	
Puff Volume (mL)	Mean	59.2	54.2	0.283
	sd	23.2	21.3	
Average Puff Flow (mL/s)	Mean	36.4	31.7	0.020
	sd	12.8	12.3	

Table 4: CReSSmicro™ vs SA7 Comparison at Central Location

		CReSSmicro™	SA7	P (paired t test)
Puff No. (per cig)	Mean	13.6	14.0	0.405
	sd	4.0	3.7	
Total Puff Volume (mL)	Mean	800	797	0.918
	sd	260	219	
Mean Puff Duration (s)	Mean	1.6	1.6	0.378
	sd	0.4	0.4	
Avg Puff Volume (mL)	Mean	59.7	58.1	0.335
	sd	14.9	13.3	
Average Puff Flow (mL/s)	Mean	39.7	37.2	0.010
	sd	8.2	8.2	
Butt Length (mm)	Mean	36.4	38.1	<0.001
	sd	3.8	3.9	
Tar In-Use (mg/cig)	Mean	17.8	16.4	0.015
	sd	5.1	4.5	
Nicotine In-Use (mg/cig)	Mean	1.49	1.37	0.012
	Sd	0.42	0.36	

Table 5: CReSSmicro™ Comparison at Central Location vs Home

		Central Location	'Home'	P (paired t test)
Puff No. (per cig)	Mean	13.6	12.2	<0.001
	sd	4.0	4.3	
Total Puff Volume (mL)	Mean	800	683	<0.001
	sd	260	248	
Mean Puff Duration (s)	Mean	1.6	1.6	0.596
	sd	0.4	0.4	
Avg Puff Volume (mL)	Mean	59.7	57.0	0.023
	sd	14.9	13.0	
Average Puff Flow (mL/s)	Mean	39.7	37.8	0.015
	sd	8.2	8.5	

Table 6: 'Home' Smoking with and without CReSSmicro™

		With CReSSmicro™	Without CReSSmicro™	P (paired t test)
Tar In-Use (mg/cig)	Mean	15.5	12.3	<0.001
	Sd	.9	3.2	
Nicotine In-Use (mg/cig)	Mean	1.32	1.06	<0.001
	Sd	0.39	0.26	

DISCUSSION

The CReSSmicro™ appears to be as precise as the SA7 in the measurement of individual puff data (Tables 2/3, similar standard deviations), but the puff volumes of air and smoke were higher on average than the SA7 (7.4mL and 5.0mL respectively). This was significant for air which would be used for calibrating the device. As a consequence, the average puff flow was correspondingly higher. This could be due to differences in the methods of calibration or because the average puff flow is determined differently by the two analysers. The SA7 average flow rate is calculated within an Excel macro based on the Total Puff Volume divided by the Puff Duration for each puff, whereas the CReSSmicro™ calculates the Average Puff Flow based on the total of the individual flows recorded within the puff, divided by the number of readings.

The CReSSmicro™ volume check could be improved by using a better calibrated syringe with stops to draw consistent volumes rather than the use of the plastic syringe provided.

Analysis of the data from both units at the central location (Table 5) showed no significant differences in the recorded puffing behaviour, with the exception of the average puff flow and butt length. In-Use yields for tar and nicotine estimated from filter analysis suggest the cigarettes had been smoked more intensely through the CReSSmicro™ than the SA7, consistent with the shorter butt length.

Puffing parameters measured by the CReSSmicro™ in the subjects' 'normal' smoking situation were, with the exception of mean puff duration, significantly lower than those from the central location (Table 6), confirming the importance of testing in an appropriate environment.

Estimated In-Use yields from cigarettes smoked at 'home' using the CReSSmicro™ were significantly higher than those smoked without the device (Table 7).

Consumers were generally comfortable carrying the CReSSmicro™ with them and to be seen smoking with it. Combining the CReSSmicro™ technology with the part filter analysis method would provide supporting data to the 'In-Use' deliveries estimated.

CONCLUSIONS

- With the exception of puff volume, puffing parameter measurements were similar from machine and human puffing
- Calibration of CReSSmicro™ could be improved with a more accurate syringe
- CReSSmicro™ readily portable and easily used by subjects in 'normal' smoking environment
- Subjects smoked more of the cigarette and had higher YIU using CReSSmicro™ than SA7
- Subjects smoked more intensely at the 'central location' than at home
- Subjects smoked more intensely at home when using the CReSSmicro™ than without

FUNDING

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