cough sound signal. CSI was calculated for the actual cough sound duration and also for a constant duration (time constant) to assess the potential for automation. The repeatability of CSI and the effect of microphone position were assessed. For each subject, PCFRs and CSI data were normalised to values obtained during maximum voluntary cough (MVC).

Results The correlation between the optimal CSI and peak cough flow rate was best for the free-field microphone; median (IQR) correlation coefficient 0.88 (0.79–0.92) (Table 1). The median correlation for all cough sound intensity remained strong for males (r=0.90–0.91), females (r=0.79–0.84), patients with chronic cough (r=0.79–0.82) and healthy subjects (r=0.82–0.89). The intraclass correlation coefficient for repeatability was good, r=0.90, p<0.01. The CSI degraded when the microphone was positioned further away from the mouth, downwards, but not in any other position. The use of a constant cough sound duration to determine CSI did not impact on the association with PCFR (Table 1).

Conclusion Cough sound intensity correlates strongly with PCFR in voluntary cough and is a repeatable measure. The microphone position needs to be standardised as in this study. Further work is needed to automate the analysis of CSI; our preliminary findings suggest this is possible. The CSI has the potential to be developed into a non-invasive, ambulatory outcome measure of cough severity.

Abstract P158 Table 1 Correlation between cough sound intensity (CSI) and peak cough flow rate

	Correlation between cough sound intensity and peak cough flow rate
Cough sound intensity from laryngeal microphone	0.84 (0.75–0.90)
Cough sound intensity from free-field microphone	0.88 (0.79–0.92)
Time-constant CSI from laryngeal microphone	0.82 (0.77–0.90)
Time-constant CSI from free-field microphone	0.87 (0.79–0.91)

Data presented as median (IQR) Spearman correlation coefficients. All p-values <0.01.

P159 VALIDATION OF THE VITALOJAK™ 24 HOUR AMBULATORY COUGH MONITOR

doi:10.1136/thoraxjnl-2012-202678.220

[1]K McGuinness, [2]K Holt, [2]R Dockry, [2]J Smith. *[1]University Hospital South Manchester, Manchester, United Kingdom, Manchester, United Kingdom; [2]University of Manchester, Manchester, United Kingdom*

Introduction Development of novel treatments for cough and its management are hampered by the lack of well validated objective cough frequency methodologies. Previous validations have been performed over limited time periods or in laboratory conditions not always representative of typical usage. We describe the rigorous validation of a semi-automated 24 hour ambulatory cough monitoring system (Vitalojak; Vitalograph; Buckinghamshire, England) operating in a manner which completely replicates routine practise.

Methods In total 10 (4 female) patients (mean age 60.4 years [SD ±14.1] including 6 chronic cough, 2 asthma, 1 COPD and 1 healthy control underwent full 24 Hour ambulatory monitoring (VitaloJAK™). These recordings were manually counted by trained cough counters who also recorded the time at which each cough occurred. These 24 hour recordings were then compressed using custom designed compression software and the sensitivity to cough and the reduced file times were determined. Importantly in each case we confirmed that cough sounds identified in the compressed files were the same sounds identified by the trained manual cough counters in the full 24 hour recording. We tested the software algorithm using three distinct compression levels (1, 2 and 3).

Results All results are presented as median (IQR).

Sensitivities to cough (%) for compression levels 1, 2 and 3 are 100(100, 100), 100(99.53, 100) and 99.92(99.33, 100) and for reduced file times (minutes) 65.89 (62.40, 83.07), 43.21 (35.94, 57.23) and 26.30 (25.07,46.81) respectively (Table 1).

Conclusions The vitaloJAK™ is a reliable, robust and efficient tool for the objective measurement of cough frequency. Importantly it reduces 24 hour recordings by up to 98% whilst preserving close to 100% of recorded cough sounds. This development facilitates efficient and speedy manual cough counting and the level of compression achieved represents significant progress towards fully automated cough monitoring.

P160 INCREASED COUGH INTENSITY IN PATIENTS WITH CHRONIC COUGH

doi:10.1136/thoraxjnl-2012-202678.221

KK Lee, K Ward, E Raywood, J Moxham, GF Rafferty, SS Birring. *King's College London, London, UK*

Introduction and objectives Cough frequency is increased in chronic cough (CC) compared to healthy subjects. It is not known if patients with CC cough more intensely. We investigated cough intensity in maximum voluntary cough (MVC) in patients with chronic cough and in healthy controls.

Abstract P159 Table 1 Compressed output file times and sensitivities for each subject at compression levels 1, 2 and 3. Uncompressed file length=1440 minutes

	Output times and sensitivity					
	Level 1		Level 2		Level3	
Subject	Minutes	sensitivity	Minutes	sensitivity	Minutes	sensitivity
1	62.01	100.00	37.40	100.00	26.23	99.37
2	63.56	100.00	31.08	99.44	24.98	98.33
3	128.24	100.00	93.45	100.00	63.82	100.00
4	144.00	100.00	120.72	100.00	71.90	99.83
5	35.13	100.00	25.08	100.00	20.83	100.00
6	63.69	100.00	42.91	99.32	22.65	99.32
7	73.15	100.00	43.50	100.00	25.32	100.00
8	86.38	100.00	56.53	100.00	41.23	100.00
9	68.08	100.00	57.47	99.81	48.67	100.00
10	52.71	96.95	35.45	96.95	26.37	96.59
Mean	77.69	99.70	54.36	99.55	37.20	99.34
Median	65.89	100.00	43.21	100.00	26.30	99.92

Methods 28 subjects with chronic cough and 21 healthy subjects underwent measurement of oesophageal pressure (Poes), gastric pressure (Pga), peak abdominal electromyographic activity (EMGabd) and peak cough flow rate (PCFR) during 10 maximum voluntary cough manoeuvres. Coughs were performed at functional residual capacity. Inspiratory volume (IV) preceding cough efforts was calculated by integration of flow. Expiratory muscle strength was assessed by measuring twitch gastric pressure (TwPga) in response to magnetic stimulation. EMGabd data was normalised to EMGabd twitch compound muscle action potential and PCFR data normalised to predicted peak flow rate (PEFRp). The analysis of data was restricted to gender and expressed per unit IV.

Results Subjects were matched for age, gender, BMI and had normal lung function. All measures of cough intensity were significantly higher in chronic cough compared to healthy controls, irrespective of gender (Table 1). However, this was not due to increased activation of the abdominal muscles since there were no significant differences in EMG ($p>0.2$) or due to increased expiratory muscle strength ($p>0.36$). There was no significant difference in Poes/IV and Pga/IV between male and female patients or controls ($p>0.28$), but female cough subjects produced significantly higher PCFR/IV compared to males ($p<0.01$).

Conclusions Cough intensity is increased in patients with chronic cough, during MVC. This raises the possibility that cough intensity in these patients may contribute to cough severity and health status. The mechanism is unclear and deserves further investigation in studies of VC and spontaneous cough.

Abstract P160 Table 1 Maximum cough intensity during voluntary cough per unit inspired lung volume

	Females			Males		
	Cough	Controls	P-value	Cough	Controls	P-value
Poes (cmH2O)	110±51	72±23	0.02	138±69	80±27	0.02
Pga (cmH2O)	126±30	82±27	<0.01	162±82	93±29	0.04
PCFR:PEFRp ratio	1.2±0.9	0.78±0.39	<0.01	0.94±0.22	0.70±0.15	0.02

Data presented as mean±SD IV: inspiratory volume; Poes: oesophageal pressure; Pga: gastric pressure; PCFR: peak cough flow rate; PEFRp: predicted peak cough flow rate.

P161 COUGH INTENSITY IN VOLUNTARY, INDUCED AND SPONTANEOUS COUGH

doi:10.1136/thoraxjnl-2012-202678.222

KK Lee, K Ward, E Raywood, J Moxham, GF Rafferty, SS Birring. *King's College London, London, UK*

Introduction Cough intensity is an important determinant of cough severity. We set out to investigate and compare the physiological characteristics and intensity of voluntary (VC), induced (IC) and spontaneous cough (SC) in subjects with chronic cough.

Methods 28 subjects with chronic cough (17 female, mean age 57 years) underwent measurement of oesophageal pressure (Poes), gastric pressure (Pga), normalised peak cough flow rate (PCFR) and peak abdominal electromyographic activity (EMG) were measured during **(1)** maximum VC (MVC), **(2)** capsaicin IC (2 doses: C_5 and supra-C_5; 1st effort in a bout) and **(3)** SC (mean of 1st efforts of all bouts), in a subset of patients (n=9). Cough efforts were categorised as bouts or single events and as true cough or expiratory reflex (ER: absence of preparatory inspiration).

Results MVC by definition was always a single effort and all efforts were true coughs; no subject initiated an ER during MVC manoeuvres. The majority of efforts in IC (C_5) and SC occurred within coughing bouts. ERs were the most frequent type of efforts in both IC and SC, 61–67% of all efforts, but accounted for only one third of the initial efforts of bouts in both IC and SC; true cough was the most frequent 1st effort (Table 1). Cough intensity was greatest in MVC for all measures. Poes, Pga and EMGabd were similar for IC and SC, and were approximately 60–70% of MVC intensity. PCFR:PEFRp however, was significantly higher in SC compared to IC. The analysis was similar for supra-C_5 stimulus with capsaicin. When restricted to the subgroup that underwent studies of all cough models (VC, IC and SC), the analysis was also similar.

Conclusions This is the first study of the physiology of cough in patients with chronic cough and spontaneous cough. MVC produces the most intense cough. The type of cough effort in IC and SC is similar but there were important differences in cough intensity (flow). The reason for this and its implications for the induced cough model are unclear and warrant further investigation.

Lung cancer epidemiolgy, presentation and survival

P162 WHEN DO PATIENTS WITH KNOWN LUNG CANCER PRESENT TO EMERGENCY SERVICES?

doi:10.1136/thoraxjnl-2012-202678.223

P Joshi, MPR Berry, F Bowen. *Imperial college NHS Trust, London, UK*

Introduction Use of electronic patient alerts systems are encouraged by government initiatives, especially within the realms of oncology, as a way of expediting relevant clinical review of oncology patients. When a known cancer patient attends an emergency unit,

Abstract P161 Table 1 The physiological characteristics of cough in patients with chronic cough

	MVC	IC	SC	ANOVA p-value	IC vs SC p-value
Type of cough effort Efforts occurring in bouts (%)	N/A	91±14	82±19	N/A	0.04*
ERs (% of all efforts)	0	67±14	61±19	N/A	0.40
ER was 1st effort in bout (%)	N/A	25±28	27±22	N/A	0.49
Cough intensity					
Poes (cmH2O)	179±45	112±61	128±28	<0.001*	0.42
Pgas (cmH2O)	194±59	116±68	141±43	<0.001*	0.36
EMGabd	0.14±0.11	0.09±0.07	0.07±0.07	0.05	0.57
PCFR:PEFRp ratio	1.52±0.38	0.38±0.12	0.82±0.32	<0.001*	<0.001*

Data presented as mean±SD MVC: maximum voluntary cough; IC: induced cough; SC: spontaneous cough; ER: expiratory reflex; Poes: oesophageal pressure; Pga: gastric pressure; EMGabd: peak abdominal electromyographic activity; PCFR: peak cough flow rate; PEFRp: predicted peak expiratory flow rate.