

# A new diagnostic test for occupational asthma utilising the difference in hourly peak expiratory flow between work and rest days

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## ABSTRACT

Oasys-2<sup>1</sup> currently utilises the daily maximum, mean and minimum peak expiratory flow (PEF) to calculate a score for diagnosing occupational asthma (sensitivity 76%, specificity 94%). We aimed to improve the diagnostic value by utilising the area between the hourly plot of PEF on work and rest days.

**Methods:** The mean PEF for each 2-hours from waking was plotted separately for day shifts and rest days in 109 consecutive workers with occupational asthma (confirmed by methods other than a PEF record) and 117 control asthmatics. The area per hour score was analysed on records containing ≥4 day shifts and ≥4 rest days; records with respiratory infections, treatment changes and long periods off work were removed. Records were randomly split into 2 sets (analysis and test sets) and a cut off point determined (set 1), then validated (set 2), using receiver operator characteristic (ROC) curves.

**Results:** ROC curve analysis of set 1 showed an area under the curve of 0.869; a difference of 20 l/min/hour was chosen for optimal specificity. Set 2 analysis confirmed a specificity of 100% and sensitivity of 53.7%.

**Conclusion:** The area per hour from waking score requires shorter PEF records than needed for the Oasys-2 score to achieve similar specificity with slightly less sensitivity. A cut-off of 20 l/min/hr can be reduced without significant loss of specificity.

1. Gannon PF *et al.* Thorax 1996; 51: 484-489

## AIM

To evaluate the scoring of the average hour plots to find a specific score for diagnosing occupational asthma.

## METHODS 1

- The area between the 2 hourly plot of mean work PEF and rest PEF has been calculated by Oasys, to produce 4 scoring systems:
  - The total area by clock time
  - The total area by time from waking
  - The area per hour by clock time
  - The area per hour by time from waking
- Gold standard positive records were used to separate Occupational asthma from non-occupational asthma
- Records with uRTIs, changes in treatment or those that sloped more than 5L/min/day in either direction were removed
- Only records with at least 4 day shifts and 4 rest days were used and any rest periods longer than 3 days were removed. No other shift types were used

help with Oasys: [www.occupationalasthma.com](http://www.occupationalasthma.com)

## METHODS 2

- Records were split into 2 evaluation sets:
  - set 1 to determine a cut off score which gives the best specificity without greatly compromising sensitivity
  - set 2 to test this score to ascertain the actual sensitivity and specificity gained when using the cut off score
- cut off scores which gave a high specificity while maintaining a good sensitivity were found using ROC curve analysis
- logistic regression was used to see which scoring system was the best predictor of occupational asthma.

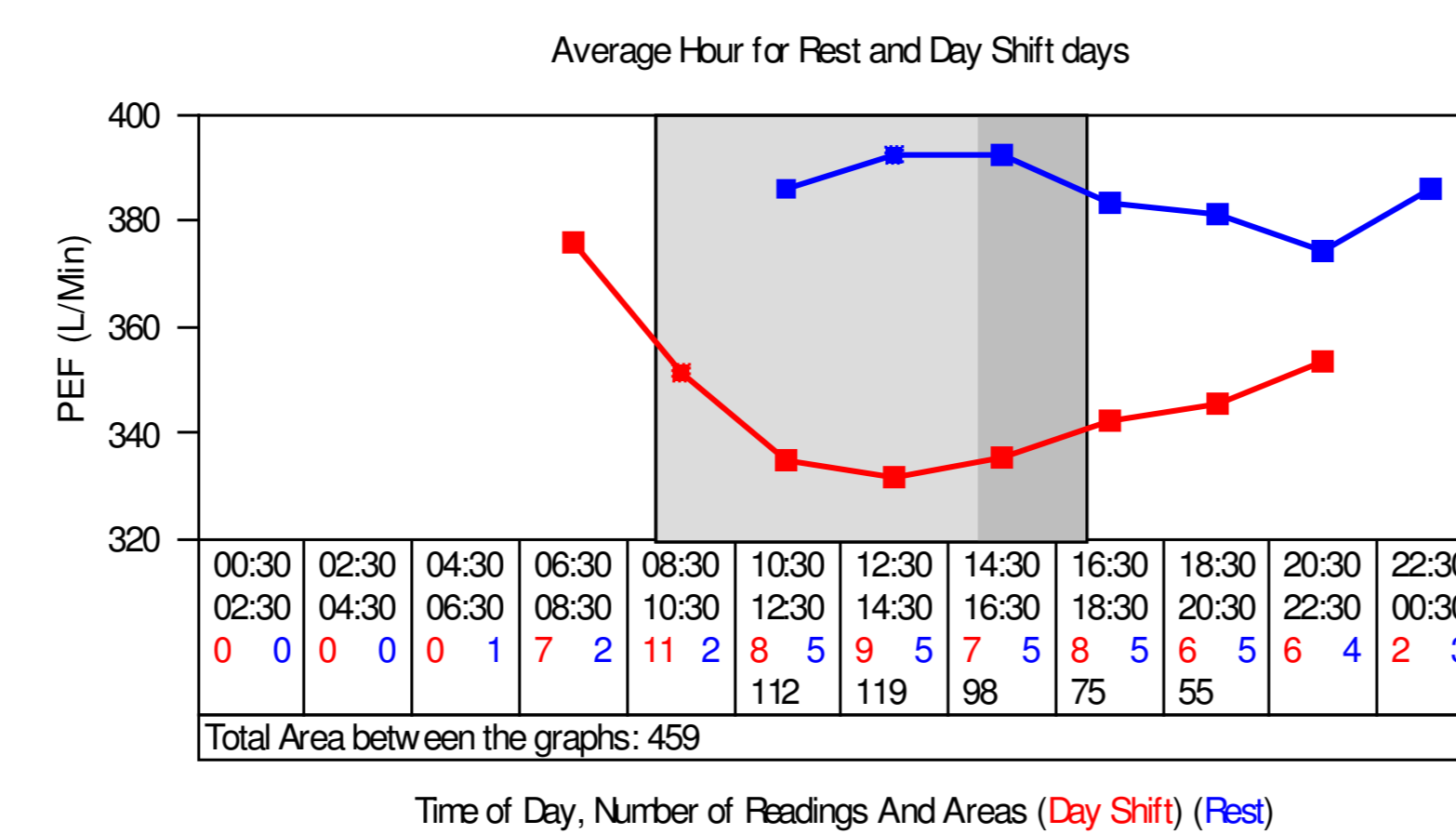


Figure 1 A 2-hourly plot of PEF by clock time from the Oasys program

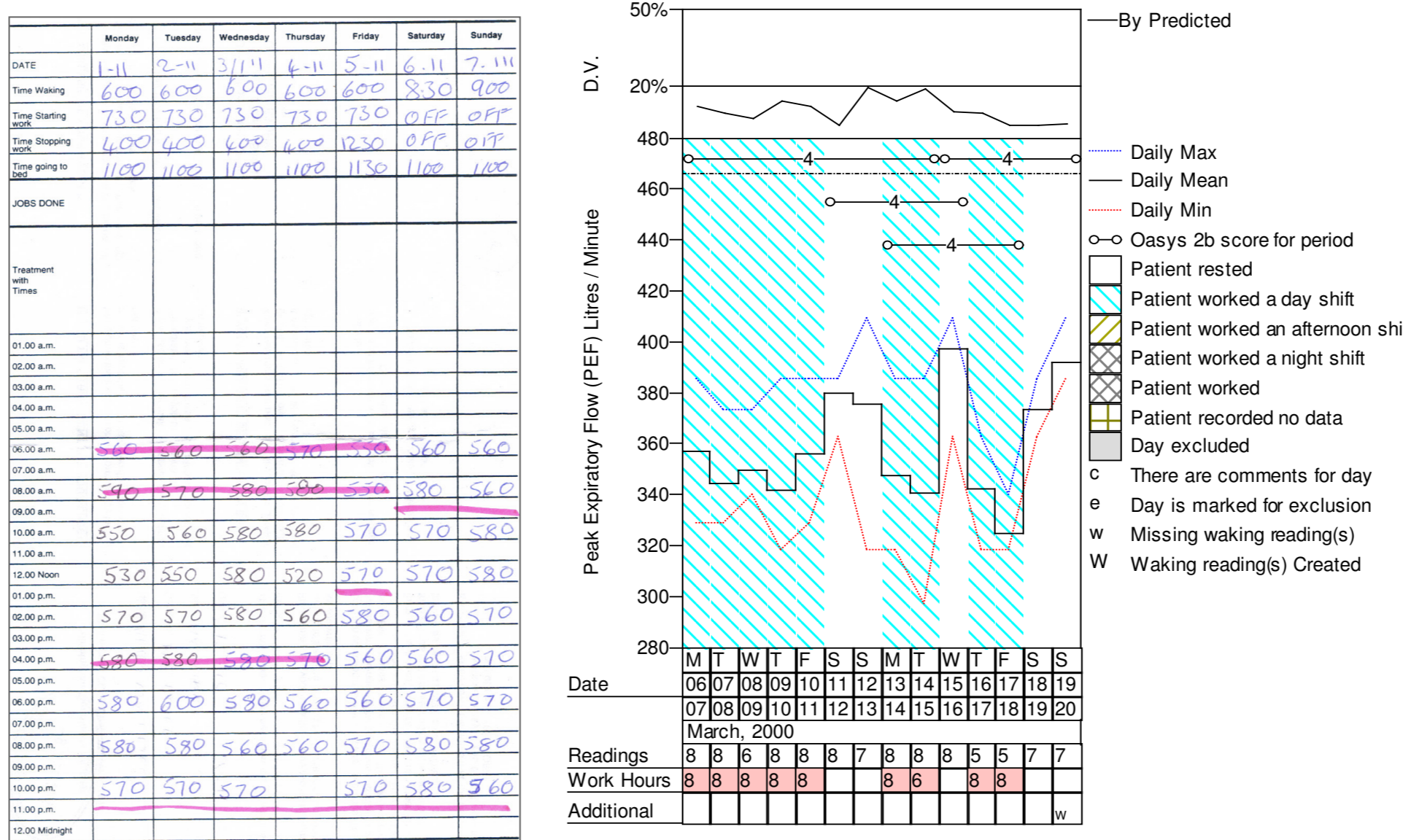


Figure 1 Written record Figure 2 Oasys Maximum, mean and Minimum PEF plot

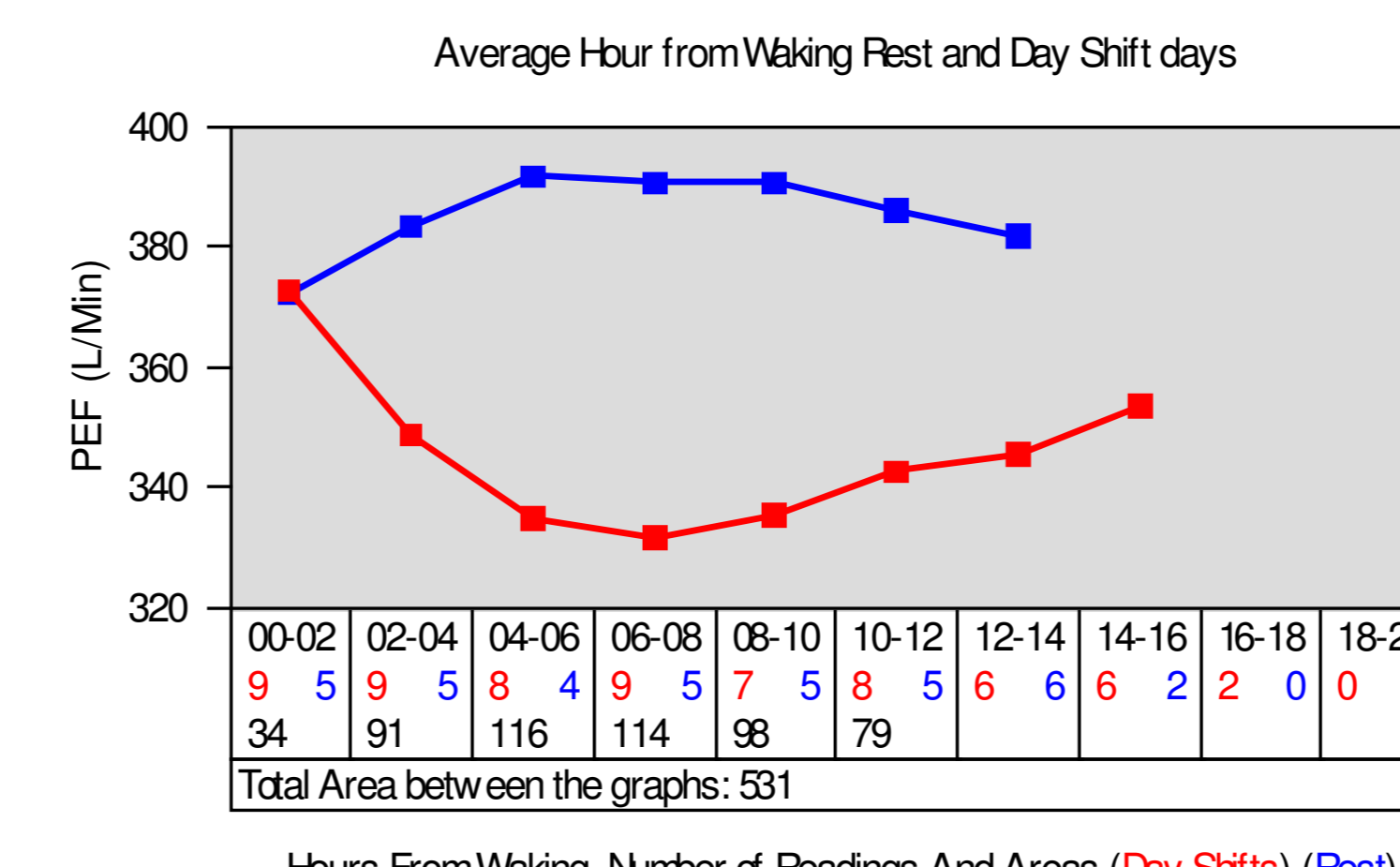


Figure 2 A 2-hourly plot of PEF by waking time from the Oasys program

## RESULTS 1

%	Set 1	Set 2
Specific Bronchial Challenge Test	60.0	64.8
4 fold change in methacholine reactivity	9.1	7.4
Specific IgE	30.9	27.8

Table 1 Confirmatory Tests

	Set 1 GS+ve N=55	Set 1 GS-ve N=59	Pearson's Chi square/ Z value	P value	Set 2 GS+ve N=54	Set 2 GS-ve N=58	Pearson's Chi square/ Z value	P value
Mean age (SD)	43 (11.0)	51 (9.3)	-4.044 <sup>+</sup>	<0.001	43 (10.0)	51 (9.3)	-4.303 <sup>+</sup>	<0.001
% males	59	73	2.579 <sup>#</sup>	0.108	61	52	0.904 <sup>#</sup>	0.342
% atopics	44	49	0.247 <sup>#</sup>	0.619	62	57	0.318 <sup>#</sup>	0.573
% current smokers	32	22	0.852 <sup>#</sup>	0.306	20	19	0.008 <sup>#</sup>	0.930
% methacholine reactive	74	42	8.717 <sup>#</sup>	0.003	69	43	5.461 <sup>#</sup>	0.019
% taking ICS; ICS+LABA	50; 19	36; 49	8.916 <sup>#</sup>	0.012	34; 25	33; 50	8.549 <sup>#</sup>	0.014
Mean FEV1 % predicted (SD)	82 (22.4)	85 (20.7)	-0.359 <sup>+</sup>	0.719	80 (23.0)	84 (24.3)	-0.274 <sup>+</sup>	0.784
Mean record diurnal variation (SD)	23 (14.6)	23 (11.6)	-1.591 <sup>+</sup>	0.112	21 (15.5)	18 (9.9)	-2.405 <sup>+</sup>	0.016
Mean hourly plot score (SD)	29.6 (32.4)	0.7 (7.8)	-6.785 <sup>+</sup>	<0.0001	33.3 (34.6)	0.0 (5.9)	-6.522 <sup>+</sup>	<0.0001

Table 2 Demographics of Gold Standard sets

# Analysed using Chi-square test  
+ Analysed using Mann Whitney U Test

## RESULTS 2

%	Set 1	Set 2
High molecular weight agents	21.8	33.3
Low molecular weight agents	78.2	66.7
Latex	3.6	5.6
Flour	7.3	5.6
Isocyanates	14.5	5.6
Solder flux fume	5.5	7.4
Metal working fluid	10.9	7.4
Metals	7.3	13.0
Biological detergent enzymes	10.9	18.5
Cleaning agents	14.5	11.1
Adhesives	1.8	5.6
other low molecular weight agent	23.6	16.7
other high molecular weight agents	0	3.7

Table 3 Gold Standard Agents

	R <sup>2</sup> (Cox & Snell)	Odds Ratio*	Lower 95% CI for exp b	Upper 95% CI for exp b	P value
Area per hour from waking	0.61	13.1	1.12	1.54	0.001
Total area from waking	0.60	10.2	1.01	1.03	0.001
Area per hour by clock time	0.61	13.8	1.13	1.69	0.001
Total area by clock time	0.59	10.2	1.01	1.03	0.001

Table 4 Logistic regression for best predictor of Occupational Asthma \*Odds Ratio per 10 L/min/hr

Cut off score (L/min/hr)	Set 1		Set 1		Set 2		Set 2	
	Sensitivity (%)	aph FW (%)	Specificity (%)	aph CT (%)	Sensitivity (%)	aph FW (%)	Specificity (%)	aph CT (%)
20	52.7	45.5	98.3	100	53.7	53.7	100	100
15	65.5	60.0	94.9	94.9	64.8	66.7	100	100
10	70.9	65.5	88.1	89.8	77.8	74.1	98.3	99.8
1	91.0	87.3	57.6	55.9	85.2	83.3	56.9	60.3

Table 5 Cut off scores and their associated sensitivity and specificity

## CONCLUSIONS

- The hourly (from waking) score and hourly (by clock time) are new scoring systems which are able to analyse shorter records, than needed for the max, min mean score from Oasys-2.
- A cut-off of 20 l/min/hr can be reduced without significant loss of specificity, and even at 10L/min, specificity is likely to remain high.
- The hourly scores are therefore a useful additional scoring system for the diagnosis of occupational asthma.

