Predicting Effective Continuous Positive Airway Pressure (CPAP) based on Laboratory Titration and Auto-titrating CPAP

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Objectives: Previous reports suggest an effective starting CPAP pressure for treatment of Obstructive Sleep Apnea (OSA) can be predicted using an algorithm. The goals of this investigation were to compare lab titrated CPAP pressure with auto-titrated CPAP (APAP), assess the difference in fixed CPAP treatment pressure obtained using APAP over multiple nights, and to evaluate the capability of predicting a CPAP starting pressure using APAP as the gold standard and different sets of predictive variables.

Materials and Methods: One data set included 77 patients who underwent attended laboratory polysomnography for the diagnosis of OSA and to obtain a CPAP titration setting (LabP) at Murrieta or Pomona Valley Hospital Sleep Center. Over 80% of the patients underwent split-night studies. The 95th percentile automated pressure setting was obtained using a ResMed S7-Spirit after one night (AutoP1), the average across three nights (AutoP3) and over approximately 30 nights (AutoP30)(Table 1).

A second data set included 66 patients evaluated in-home for two nights using the Apnea Risk Evaluation System (ARES) to diagnose OSA (mean valid recording time 10.2 $\pm$ 2.5 hours). The ARES data were analyzed using automated scoring algorithms to extract apnea (i.e., 10-sec cessation in flow) and multiple hypopnea indexes. All hypopnea indexes required a minimum 50% change in flow plus at least one arousal indicator (snoring sound change, pulse rate or head movement) with a minimum desaturation (2.2 - 4.0%) and resaturation (2.2 – 3.5%) resaturation. Additional variables used in this analysis (see Table 3) were automatically generated. A fixed CPAP pressure was obtained using the 95th percentile setting averaged over three nights. This data set was split into a model development (n=30) and cross validation data set (n=36). Linear regressions were applied to the model development data set to predict AutoP3 applying variables previously used (i.e., AHI, neck circumference, and BMI) (PredH) and an alternative set of variables (PredA). The coefficients were then applied to both data sets to assess the prediction accuracy.

Results: The Pearson correlation between LabP and AutoP30 for the 77 patients was 0.65 (Figure 1). In 21% of the cases the absolute difference between LabP and AutoP30 were $\geq$ 3 cm H_20 (8 cases $\geq$ 3 and 8 cases $\leq$ 3 cm H20). The correlation between AutoP3 and AutoP30 was 0.88 (Figure 2). Over 96% of the patients had an APAP pressure after 3-nights within 2 cm H20 of the mean APAP after 30-nights (Table 2). The correlations between AutoP3 and the PredA variables for the 66 patients are presented in Table 3. The R^2 values for the PredA equations derived with model development data set (n=30) was 0.56. The distribution of differences in pressure for AutoP3 vs. PredA between the model development and cross validation data sets were not significant. The distribution of predicted pressure errors across patients (n=66) for PredA is presented in Figure 3.

Conclusion: Over 20% of patients had pressure differences greater than 2 cm H20 when comparing lab titration with APAP (over approximately 30-days), raising the question as to which pressure should be accepted as the gold standard. The predominance of split-night studies in this data set most likely contributed to the poor correlation between lab and APAP pressure. The similarities in the APAP pressure after 3- and 30-days suggests the shorter titration window will achieve similar results. The accuracy of predicting APAP pressure can be improved by including variables such as the depth of desaturation and the nadir during obstructive events, and the apnea index.

Table 1: Characteristics of Laboratory and Auto-titrated Pressure Data Set

	Lab Data		Data from APAP Across 30-Days of Use			
	Pre-treat AHI	CPAP Pressure	Days	95% Pressure	Leak	APAP AHI
Mean $\pm$ S.D.	49 $\pm$ 35.4	10 $\pm$ 2.8	28 $\pm$ 3.5	10 $\pm$ 1.9	0.24 $\pm$ 0.15	6 $\pm$ 4.1
Range	4 - 114	6 - 20	14 - 40	6 - 16	0.02 – 0.66	0.2 – 20.9

Table 2: Difference in APAP after 30-nights vs. One- and Three-nights (n=77)

Difference with AutoP after 30 Days (cm H20)	Distribution (%) of Patients AutoP after 1 Night	AutoP after 3 Nights
+/- 1	80.5%	89.6%
+/- 2	90.9%	96.1%
+/- 3	94.8%	98.7%

Table 3: Correlations with 3-nights APAP Pressure (n = 60, p < 0.001; * = PredH variables)

Predict Variables	Mean + S.D.	Pearson r
Nadir of obstructive events (%O2)	89 + 5.5	-0.61
Mean desat (%O2) across events	6.5 + 4.2	0.55
Apnea Index	18 + 20.9	0.49
AHI Stepped 3% Desat *	44 + 28.7	0.48
BMI *	34.2 + 7.4	0.43
Neck circumference *	17.3 + 1.7	0.29

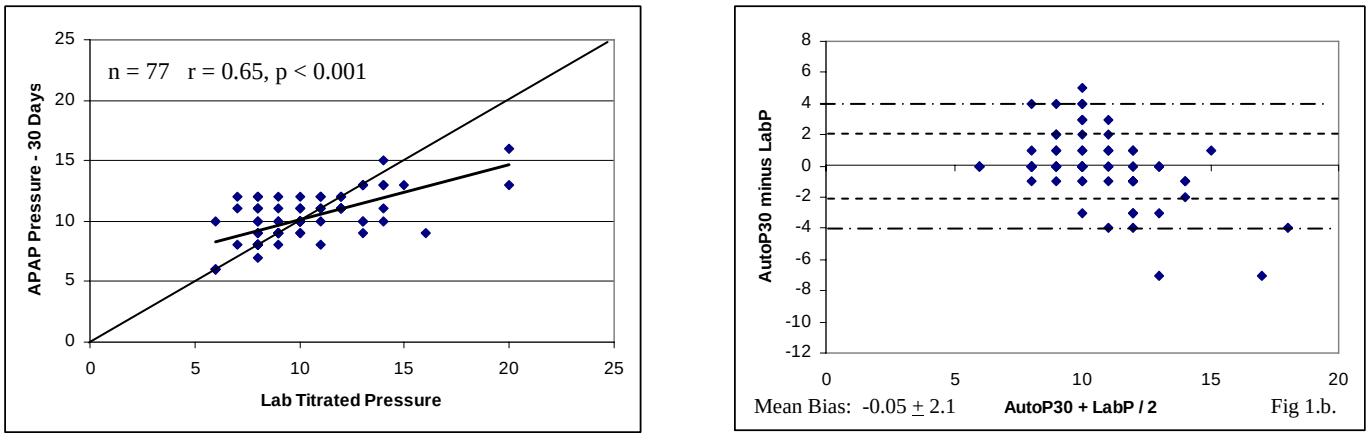

Figure 1: a. Correlation and b. Bland Altman plots showing the difference between CPAP treatment pressure derived during laboratory titration and with Auto-CPAP after 30-days.

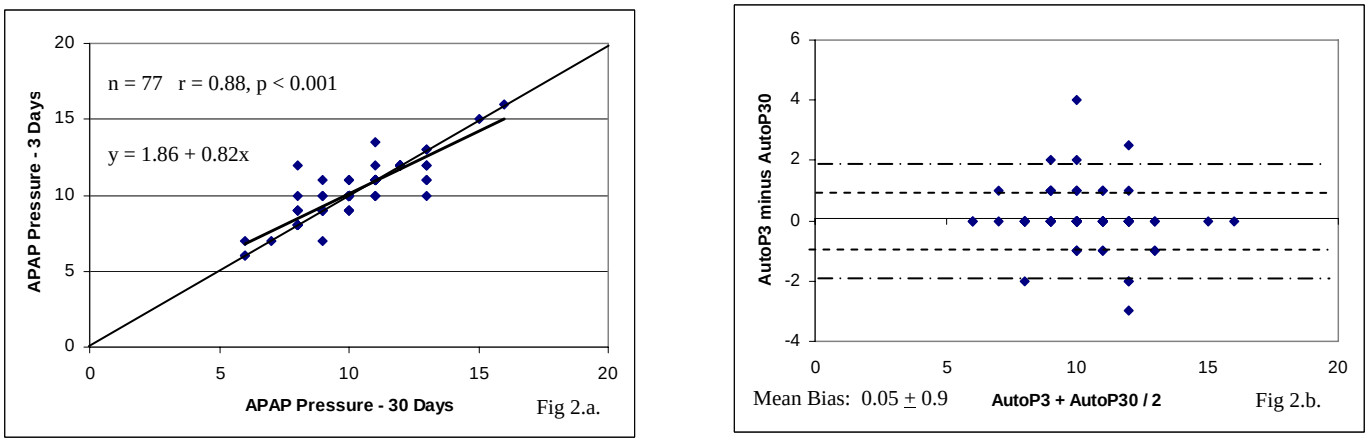

Figure 2: a. Correlation and b. Bland-Altman plots showing the difference between Auto-CPAP after 3-days and 30-days.

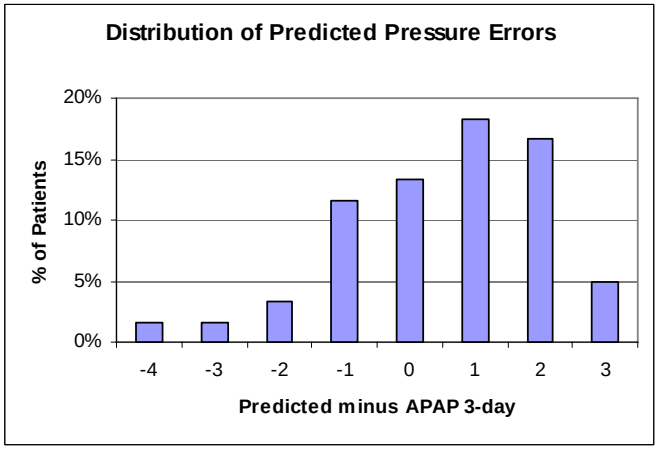

Figure 3: The distribution between APAP pressure derived after a 3-night titration and pressure obtained with the ARES predictive variables. (n = 66).