

**Comparison of Polyvinylidene
Fluoride (PVDF) Airflow Sensor
and Nasal Cannula Pressure Sensor
Output During Simulated
Breathing With and Without
Temperature Change**

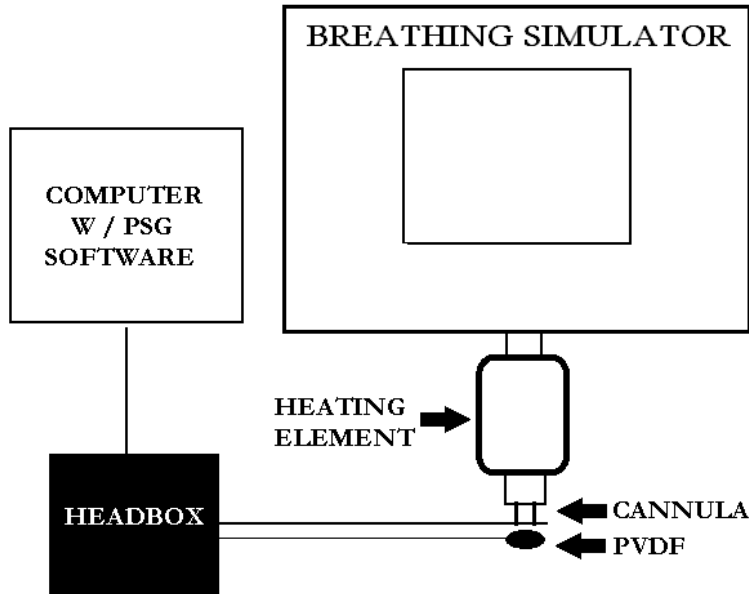
Introduction

Traditional methods of monitoring airflow during polysomnography (PSG) include thermal sensors (thermistors or thermocouples) that can detect changes in temperature and nasal cannula that can detect changes in air pressure. Polyvinylidene fluoride (PVDF) film sensors have been available as an option for monitoring airflow during PSG as they are responsive to changes in both air temperature and pressure.¹ Unlike the use of simultaneous thermal sensors and nasal pressure cannulas that require multiple recording channels to identify apnea and hypopnea events in PSG monitoring, PVDF airflow sensors require only one channel, have a linear output, and can rapidly detect changes in both nasal and oral airflow, making PVDF a natural tool for PSG.

The purpose of this bench study was to compare the output of a traditional nasal pressure sensor to that of a PVDF airflow sensor in simulated breathing conditions with and without temperature change to see how temperature / heat may affect each method of measurement. Resulting nasal pressure and PVDF traces taken from the PSG software were compared.

Methods and Materials

A breathing simulator (Series 1101, Hans Rudolph, Inc.) was equipped with an adjustable heating element placed at the patient connection port. The simulator was programmed to mimic a sleeping patient breathing at 12 breaths per minute and with a 400 mL tidal volume. This program was set to run for one minute, followed by 30 seconds of no breathing (apnea), and then back to the active breathing pattern for another 30 seconds. A nasal pressure monitoring cannula (SleepSense Ref 15805*, S.L.P. Inc.) was placed at the outlet of the heating element fixture. Additionally, a PVDF airflow sensor (Ref 10-10000-0510, Dymedix Diagnostics) was placed at the same outlet so that airflow to and from the simulator passed over the heating element and both devices. Each device's connectors were plugged into the head box of a PSG monitoring system (Embla N7000, Remlogic 1.2.). With the breathing simulator running the sleeping patient simulation, data output from each device was confirmed by observing traces on a PC operating the PSG monitoring software.

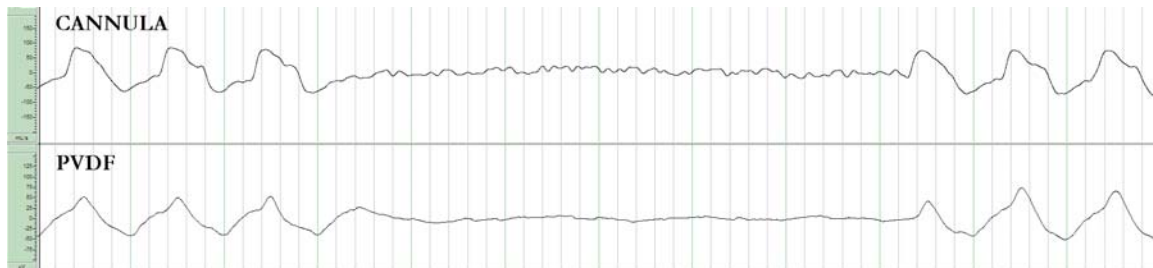


With the test setup and PSG software operational, and the heating element set to “off”, the sleeping breathing pattern was initiated. Data was automatically recorded by the PSG software. A second test was then run, with the heating element set to “on” and at the minimum available setting. On completion of the breathing simulations, data was extracted and screenshots of the nasal pressure and PVDF traces over the 2-minute simulated breathing period were taken.

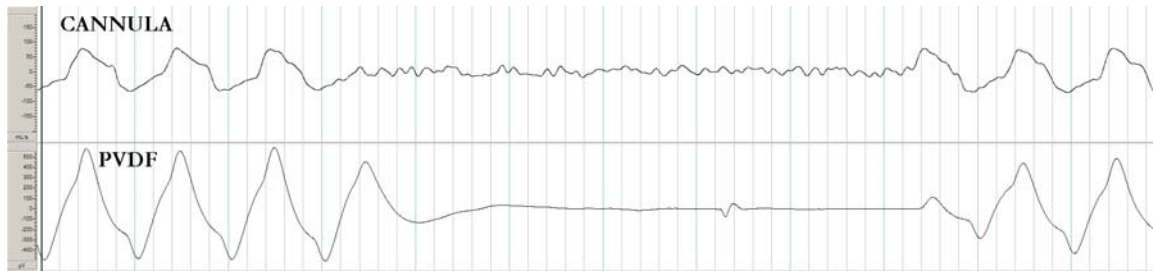
Results and Discussion

Data shown is taken from a one minute segment of the two minute breathing simulation. Each trace shows 15 seconds (3 breaths) of normal breathing, 30 seconds of apnea, and 15 seconds (3 breaths) of resumed normal breathing.

No Heat Applied



With Heat Applied



In both test cases, visual inspection of the response waveform characteristics of PVDF output compared to nasal pressure output showed similar traces throughout the test period. Peaks and valleys seen in the traces, as well as flattening of the signal during apnea, were near synchronous between the two methods, indicating that response times between the two methods are similar.

The application of heat did not impact the nasal pressure cannula output signal, but did impact the PVDF signal. With added heat, the PVDF signal output increased in amplitude, resulting in wider peak-to-peak amplitudes without otherwise decreasing the response similarity to the cannula signal.

Conclusion

Results suggest that PVDF airflow sensors respond to both changes in pressure alone, and simultaneous changes in temperature and pressure. Additionally, this bench test indicated that a PVDF airflow sensor signal output is increased as compared to nasal pressure when both changes in temperature as well as pressure are being monitored and is a viable option for measuring both apnea and hypopnea events during PSG.

References

1. Eiken, Todd. "Going With the Flow." *Sleep Review*. Sleep Review: The Journal for Sleep Specialists, 4 Sept. 2005. Web. 07 Nov. 2014. <<http://www.sleepreviewmag.com/2005/09/going-with-the-flow/>>.