



US007588543B2

(12) **United States Patent**  
**Euliano et al.**

(10) **Patent No.:** **US 7,588,543 B2**  
(45) **Date of Patent:** **\*Sep. 15, 2009**

(54) **METHOD AND APPARATUS FOR PREDICTING WORK OF BREATHING**

5,490,502 A \* 2/1996 Rapoport et al. .... 128/204.23  
5,752,921 A 5/1998 Orr  
5,953,713 A 9/1999 Behbehani et al.  
6,004,267 A 12/1999 Tewari et al.  
6,058,322 A 5/2000 Nishikawa et al.

(75) Inventors: **Neil R. Euliano**, Gainesville, FL (US);  
**Victor L. Brennan**, Gainesville, FL (US);  
**Paul B. Blanch**, Alachua, FL (US);  
**Michael J. Banner**, Alachua, FL (US)

(73) Assignee: **University of Florida Research Foundation, Inc.**, Gainesville, FL (US)

(Continued)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 23 days.

FOREIGN PATENT DOCUMENTS  
WO WO 01/00265 1/2001

This patent is subject to a terminal disclaimer.

(Continued)

(21) Appl. No.: **11/758,159**

OTHER PUBLICATIONS

(22) Filed: **Jun. 5, 2007**

Neil Macintyre, "Weaning from Mechanical ventilatory Support: Volume-Assisting Intermittent Breaths versus Pressure-Assisting Every Breath", *Respiratory Care*, 1988 33(2) pp. 121-125.\*

(65) **Prior Publication Data**

US 2007/0232951 A1 Oct. 4, 2007

(Continued)

**Related U.S. Application Data**

*Primary Examiner*—Robert L Nasser  
(74) *Attorney, Agent, or Firm*—Saliwanchik, Lloyd & Lloyd

(63) Continuation of application No. 10/652,992, filed on Aug. 29, 2003, now Pat. No. 7,425,201.

(60) Provisional application No. 60/407,099, filed on Aug. 30, 2002.

(57) **ABSTRACT**

(51) **Int. Cl.**  
**A61B 5/00** (2006.01)

A method of creating a non-invasive predictor of both physiologic and imposed patient effort from airway pressure and flow sensors attached to the patient using an adaptive mathematical model. The patient effort is commonly measured via work of breathing, power of breathing, or pressure-time product of esophageal pressure and is important for properly adjusting ventilatory support for spontaneously breathing patients. The method of calculating this non-invasive predictor is based on linear or non-linear calculations using multiple parameters derived from the above-mentioned sensors.

(52) **U.S. Cl.** ..... **600/529**; 600/533; 600/538; 600/300

(58) **Field of Classification Search** ..... None  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,261,397 A 11/1993 Grunstein  
5,316,009 A 5/1994 Yamada

**12 Claims, 4 Drawing Sheets**

