Volume 2 Number 4 August-September 2007

Respiratory Therapy™

The Journal of Pulmonary Technique

COPD
AUTOPEEP
INHALATION TECHNIQUE
BRONCHODILATORS
ICU ADMISSIONS

WELCOME TO
THE FUTURE OF HUMIDIFICATION

Hydrate™

SMART HUMIDIFICATION
HIGH FLOW OXYGEN THERAPY

PENDING FDA CLEARANCE

The **PARI Hydrate**™ with **C-Force**™ **Technology**.

Assume no longer - know. 44 mg/L at up to 40 L/min.

Smart humidification is finally at your fingertips.

Contact PARI to receive more information on the future of humidification.

PARI 100 Years

PARI RESPIRATORY EQUIPMENT, INC.
For more information call
1.800.FAST.NEB *or visit us*
online at ***www.PARIHYDRATE.com***

**C-Force Technology utilizes Capillary Force Vaporizer, licensed by PARI from Vapore, Inc.*

NEBULIZERS NASAL DRUG DELIVERY HOLDING CHAMBERS **HUMIDIFICATION** COMPRESSORS

ML-33-001 REV 9/06

Aeroneb® Solo

Experience the excellence of the Aeroneb® Pro nebulizer in single patient use format

The Aeroneb® Solo offers you the same renowned performance you have come to expect from Aeroneb® Pro in a lighter, compact, single patient use format

Increased convenience
- *Single patient use device*

Increased flexibility
- *Infant through adult for up to 28 days*

Dual functionality
- *Intermittent and continuous* nebulization*

Optimum aerosol characteristics
- *Incorporates OnQ® micropump aerosol generator*

For more information on the Aeroneb® Solo - Tel: (866) 423-7643 (US)
+353 91 502 550 (INTL) | Email: products@aerogen.nektar.com or visit www.aerogen.com

*Available in conjunction with the Aeroneb® Pro-X controller and for up to 7 days.

Aerogen®

OxyView™

Do You Use Oxygen?

Don't get caught with a bad regulator or an empty tank. OxyView™ is the only in-line flow-meter available today!

- ✓ LOW-COST FLOW-METER
- ✓ NO BATTERIES REQUIRED
- ✓ SIMPLE AND FAST TO INSTALL
- ✓ POWERED BY THE FLOW OF OXYGEN
- ✓ BETTER ACCURACY AND CONVENIENCE
- ✓ FOR IN-PATIENT AND OUT-PATIENT USE
- ✓ INSTANT VERIFICATION OF OXYGEN FLOW
- ✓ GRAVITY INDEPENDENT WORKS IN ANY POSITION
- ✓ MADE OF NON-TOXIC, MEDICAL GRADE MATERIALS

INGEN TECHNOLOGIES, INC.

35193 Avenue "A" Suite C
Yucaipa, CA 92399-0000
FAX: 909-790-7185

For Use By:
- Hospitals
- Patients
- Respiratory Equipment Manufacturers
- Medical Supply Distributors

MADE IN THE USA

FDA Registration No. 3005686889
Packaged in a clean room under ISO standards.
100% non-toxic medical grade materials.

CALL US AT (909) 790-7180

U.S. And Foreign Patents Pending

For More Information and An Informative Video on the OxyView Device, Visit Our Website At HTTP://WWW.INGEN-TECH.COM

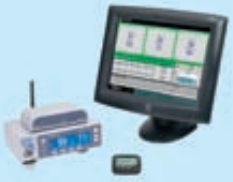
Patient safety from head to toe

New OxiMax®
NeoMax™ forehead
sensors for neonates
and infants

OxiMax N-600™
pulse oximeter
stands up to difficult
monitoring conditions

OxiMax N-85™
handheld capnograph/
pulse oximeter with
Microstream® capnography

OxiMax Max-Fast®
forehead sensor for
better performance
in poor perfusion



Oxinet® III remote
respiratory monitoring
system for the general
care floor

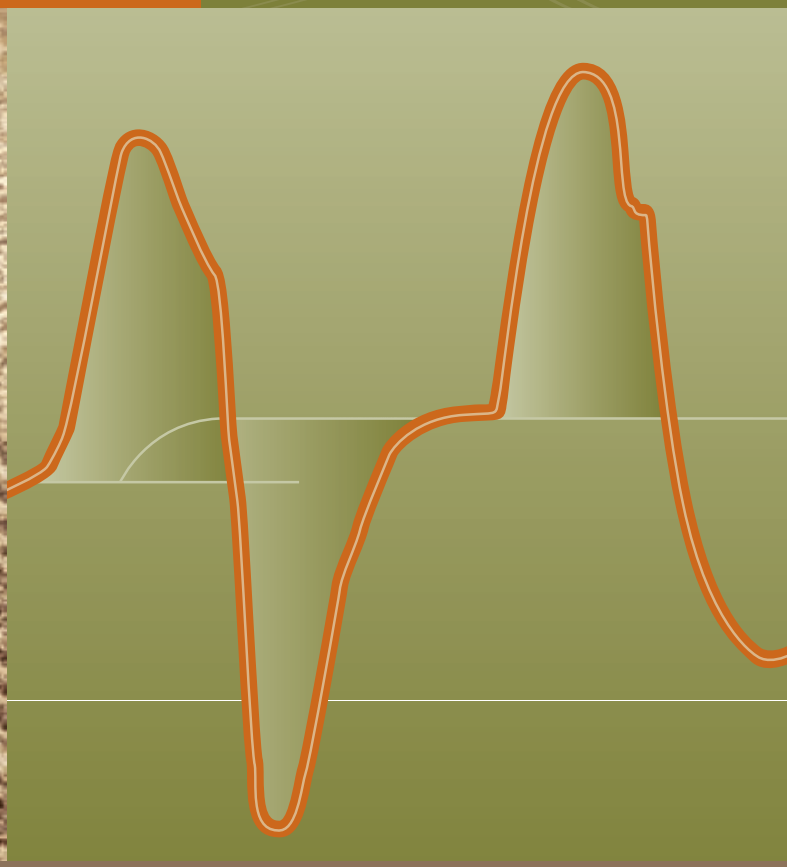
Nellcor® OxiMax® pulse oximetry assures you of accurate, reliable performance even during low perfusion, patient motion and other forms of signal interference. Compatibility with the innovative line of OxiMax adhesive, reusable and specialty sensors further expands your options for monitoring from head to toe. You'll find OxiMax technology in a variety of Nellcor pulse oximeters and in patient monitors from other manufacturers. With a proven record for performance and reliability, Nellcor remains the leading choice in pulse oximetry.

COVIDIEN

positive results for life™

www.covidien.com | 1-800-NELLCOR

RESPIRONICS®



CONSTANTLY ADAPTING. NATURALLY.

Breathing should be natural, even when it's assisted. To make mechanical ventilation more natural, you must constantly adapt to work around a patient's natural breathing patterns. So, it should come as no surprise that products like the **BiPAP® Vision®** with **Auto-Trak™ Sensitivity** define our commitment to leading the way to shorter, more comfortable and more cost-effective hospital stays. Our patented Auto-Trak algorithm is a revolutionary technology that tracks, detects and responds to breath-by-breath changes in leak rate and flow demand – which may reduce work of breathing and lead to more success in noninvasive ventilation. And it's just one of the ways that Respironics constantly adapts to the needs of medical professionals like you to improve ventilatory care for everyone. To see how the standard of care for noninvasive ventilation can improve patient outcomes and financial outcomes, contact us today for a pro forma assessment.

800.345.6443 **AUTOTRAK.RESPIRONICS.COM** **724.387.4000**

"The iVent$_{201}$'s versatility has really helped us to deal with the increased demands placed upon my department due to Hurricanes Katrina and Rita and proved to be an invaluable clinical tool"

-Ken D. Hargett, RRT

"I have been using the iVent for many years and have come to rely upon its ease of use and versatility. Its NIV capability is second to none!"

Joe Miro, RRT

"The varied clinical demands of the Emergency and Recovery Rooms is fully supported by my iVent$_{201s}$. We do Invasive and Non-Invasive ventilation - sometimes on the same patient without difficulty"

Steven Nylund, Clinical Coordinator

"The patient comfort level and management of their ventilatory needs is greatly increased with the use of the iVent$_{201}$, and it plays an important role in the Combat Support Hospital setting."

Matthew Crown, SFC, U.S. Army

VersaMed

VersaMed Inc.
Toll free: 1-800-475-9239
2 Blue Hill Plaza,
Pearl River, NY 10965 USA
www.versamed.com

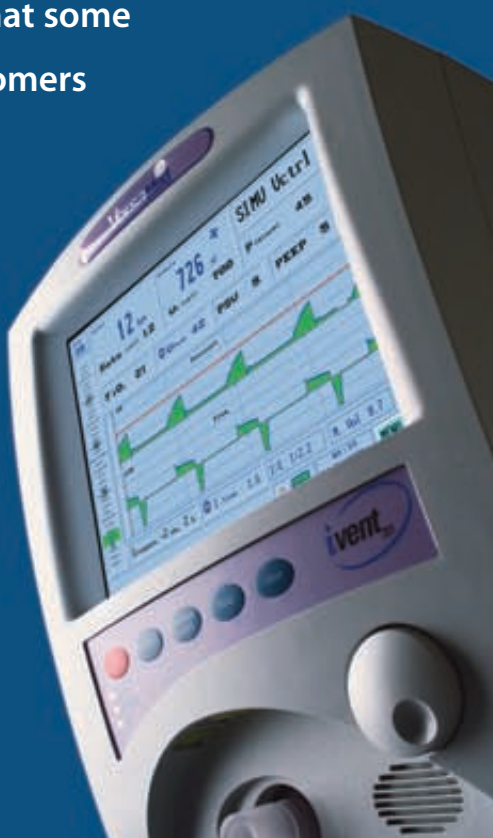
iVent$_{201}$

Anytime...Anywhere.

Regardless of what your ventilation needs are; invasive or noninvasive, or where they take you; ICU, MRi, Transport, rest assured the iVent $_{201}$ has got you covered.

In short, no other compact ICU grade ventilator can match the iVent's list of standard features, and versatility.

Don't just take it from us; listen to what some of our customers are saying.



PREPARE FOR A MAJOR VENTILATOR EMERGENCY

E-Vent Case™

- Uses a single gas source for multiple ventilators in Mass Casualty Incidents
- Includes a 7 port multi-outlet manifold and 20 feet oxygen supply tubing
- Organized for rapid deployment
- E-vent Case™ holds up to 10 each VORTRAN Automatic Resuscitators (sold separately)

VORTRAN Automatic Resuscitator (VAR™)

- Model VAR-Plus™ for pediatric and adult patients (10 kg and above)
- Automatically lowers TV and increases rate in ARDS with a decreasing compliance
- Hands-free, gas-powered, fully automatic
- For breathing and non-breathing patients
- Single patient use, disposable (reduces cross contamination)

- Cost effective for emergency preparedness
- FREE CEU Continuing Education 1 contact hour for RRT/RCP, RN and MD online at *http://www.accessce.com/courses.aspx*

VORTRAN
MEDICAL TECHNOLOGY 1, INC.

NEW ADDRESS

21 Golden Land Court, Sacramento, CA 95834

Tel: (800) 434-4034 **Website: *www.vortran.com***
Fax: (916) 648-9751 **E-mail: *office@vortran.com***

Guest Editorial

Medical Student Education and Practice of Medicine: A Gap Gets Wider

B.M. Petrikovsky, MD, PhD; Maiquel Carrasco, MD; Lennox Bryson, MD
The authors are with the Department of Obstetrics and Gynecology, Nassau University Medical Center.

The practice of medicine is an ever-changing process; new techniques appear every day and change the way we practice. It seems that every five to seven years a totally new concept comes along and changes not only the way we treat patients, but the way we think, perform research, and teach residents. Evidence based medicine (EBM) is well into its second decade, and yet worldwide, the challenges of bringing EBM into clinical practice are a constant cause of debate. In spite of its obvious benefits, according to our computer assisted search less than five percent of medical schools worldwide systematically teach EBM.

For this editorial we have reviewed various medical school curriculums randomly obtained from appropriate websites. Although randomly selected, they represent medical school curriculums available from various continents. We have also assessed how often these curriculums changed over time to reflect changes in the practice of medicine.

Website of SUNY Downstate (Brooklyn) displayed first-year students block objectives:

First-Year Medicine Block Objectives

- Block 1: Genes to Cells
- Block 2: Skin & Connective Tissue
- Block 3: Musculoskeletal System
- Block 4: Blood/Lymphoid/Head & Neck
- Block 5: Cardiovascular System
- Block 6: Respiratory System
- Block 7: Gastrointestinal System & Intermediary Metabolism
- Block 8: Urinary System
- Block 9: Endocrine & Reproductive Systems
- Block 10: Neuroscience
- Essentials of Clinical Medicine

Second year block objectives at SUNY Downstate as in the first year are basic sciences with some attention to immunity and infection:

Second-Year Medicine Block Objectives

- Overview Block
- Block 1: Immunity, Inflammation, and Infection
- Block 2: Hematology and Neoplasia
- Block 3: Gastrointestinal System
- Block 4: Cardiovascular System
- Block 5: Respiratory System
- Block 6: Renal System
- Block 7: Endocrine & Reproductive System
- Block 8: Nervous System & Psychopathology
- Essentials of Clinical Medicine 11

Basic clerkships start in the third year and involve major clinical disciplines, pediatrics etc:

Respiratory Therapy™
The Journal of Pulmonary Technique
Vol. 2 No. 4
August-September 2007

Table of Contents

Respiratory Therapy™
The Journal of Pulmonary Technique

Published six times each year by
Goldstein and Associates, Inc.
10940 Wilshire Blvd., Suite 600
Los Angeles, CA 90024 USA
Tel: 310-443-4109
Fax: 310-443-4110
E-mail: s.gold4@verizon.net
Website: www.respiratorytherapy.ca
Video website: www.rttv.ca

Publisher
Steve Goldstein

Editor
Les Plesko

Senior Editor
Carol Brass

Assistant Editor
Laszlo Sandor

Design and Production Management
http://accugraphics.net

Circulation, Coverage, Advertising Rates: Complete details regarding circulation, coverage, advertising rates, space sizes, and similar information are available to prospective advertisers. Closing date is 45 days preceding date of issue.

Change of Address notices should be sent promptly to Circulation Department. Provide old mailing label as well as new address. Allow two months for change.

Editorial Contributions will be handled with reasonable care. However, publishers assume no responsibility for the safety of artwork, photographs or manuscripts. All submissions may be emailed to s.gold4@verizon.net. Every precaution is taken to ensure accuracy, but the publishers cannot accept responsibility for the correctness or accuracy of information supplied herein or for any opinion expressed. Editorial closing date is the first day of the month preceding month of issue.

Editorial Advisory Board

- Emergency Medicine
- Internal Medicine
- Neurology
- Primary Care 1
- Primary Care 2
- Pediatrics
- Perioperative Care (Anesthesiology)
- Psychiatry
- Surgery
- Women's Health

The SUNY at Stony Brook's first year medical school schedule is very similar, with strong emphasis on anatomy (the body) and basic sciences, which they call "molecules, genes and cells." Introduction to public health is evident by classes in a Global Health elective, Foundations of Medical Practice, Occupational Hazards and Infection Control. We were amazed to see a mandatory class on stress management.

The Medical Education Program at Ponce School of Medicine in Puerto Rico is a four-year program with emphasis in primary care, and a duration of 152 weeks. It grants a doctor of medicine degree (MD). The courses are in the core disciplines of Gross Anatomy, Histology and Cell Biology, Biochemistry Physiology, Pathology, Pharmacology and Microbiology/Immunology. It also includes Human Genetics and Neuroscience.

The pre-clinical years provide integration of clinical content and early clinical experiences through pathophysiology. Introduction to clinical medicine, behavioral sciences and basic psychiatry. Longitudinal programs in preventive and community medicine, problem-based learning and medical ethics are integrated in the educational program of the first two years.

Curriculum at Ponce School of Medicine

First Academic Period, duration, 32 weeks

Required Courses

- Gross Anatomy, Imaging and Embryology
- Cell Biology and Histology
- Neuroscience
- Biochemistry
- Microbiology and Immunology
- Behavioral Science
- Physiology
- Problem Based Learning
- Medical Ethics
- Human Genetics
- Community Service

Second Academic Period, duration 32 weeks, includes a four-week period reserved for a USMLE review course (Skill Development Course)

Required Courses

- Pathophysiology
- Pharmacology
- Basic Psychiatry
- Introduction to Clinical Medicine 1 and 2 (includes Physical Diagnosis)
- Family and Community Medicine (includes Biostatistics/Epidemiology)
- Medical Ethics Skill Development (4 weeks)

A Dominican medical school has similar basic curriculum, which includes mathematics and physics classes.

Medical school curriculums had been mostly unchanged for years and hardly reflect the state of the art of medicine. For example, breast cancer, a very significant contributor to women's mortality, has very fragmented and incomplete attention in the medical school curriculums. This is apparent as none of the medical schools surveyed had departments or even courses on breast diseases, which are usually taught during surgical rotations. Another important issue is that by the time the medical students start their clinical rotations their knowledge of the anatomy and pathology as it relates to clinical field is no longer fresh and updated. One of the issues is that at the time they study anatomy or embryology these subjects are totally abstract and inapplicable to clinical practice. A refresher course, which is also understated and incomplete, is often needed. Therefore, based on our personal teaching experience and questioning of medical students, interns and residents, some reform of medical schools curriculums is long overdue. Fortunately, other medical educators agree with our approach. Tokyo Medical University put together a core curriculum for medical education which includes Medical English, preclinical medicine in the first and second year, clinical courses on the third and fourth year, followed by a year of clinical medicine.

In conformity to the "model core curriculum for medical education" commonly used by medical universities and schools of medicine in Japan, the new curriculums are designed to meet the needs of the times without compromising the merits of the coherent 6-year wedge type curriculums, which is the characteristic of this university.

We propose to go a step further to attach basic science to the clinical sciences. For example, pelvic anatomy and pathophysiology would be taught as an introduction to clinical gynecology and urology. This approach does not exclude one year of general course of basic science (theoretical principles and introduction). Time will tell if such an approach will benefit medical students and medical science.

News

☐ August-September 2007

LETTER TO THE EDITOR

I found the recent article entitled High-Frequency Chest Compression: Advanced Therapy for Obstructive Lung Disease (April-May 2007) by Braverman and Nozzarella a very informative and complete review of the rationale for and use of the technology that they call High Frequency Chest Compression although many others refer to the technology as High Frequency Chest Wall Oscillation (HFCWO).[1] Regardless of the nomenclature used, the technology has become virtually standard of care for patients with cystic fibrosis (CF) in the United States and is expanding throughout the world. I write, however, to completely disagree with their last segment of the paper. In my opinion, the section regarding triangle waveform presents an inaccurate and severely biased perspective on the so-called "newest HFCC technology." The three studies cited as evidence in favor of the triangle waveform are of poor value for several reasons that include study design, use of appropriate outcome measures, and incomplete presentation and interpretation of the actual results of those studies.

The study by Milla and colleagues[2] included only 8 subjects with CF, a number so small as to be no more than a series of case studies. In addition, the primary outcome measure of sputum volume has long been considered and was recently determined to be a meaningless value in airway clearance studies. This determination was discussed at the American Association of Respiratory Care Journal Conference on Airway Clearance from April 21-23, 2007. It was decided by the experts in airway clearance who attended the Conference that due to the practical inability to control for the sputum collection methods — time of collection, methods of sputum removal and collection, composition of the secretion material (wet vs dry) measurement by volume versus weight — in any format were inappropriate and meaningless outcomes for airway clearance studies. This same rationale renders weak, if not meaningless, the results of the two other studies cited in support of the triangle waveform by Warwick et al[3] and by Kempainen et al.[4]

The Warwick study had three relevant findings – 1) "sputum production by subjects with CF who receive CPT by certified respiratory therapists can be as great as the sputum produced by the same subjects who receive HFCC." 2) there was greater water content in the sputum produced with high frequency chest wall oscillation and 3) use of a mechanical device is more consistent than varying abilities of respiratory therapists.[3] Each of these points would be the case regardless of waveform. In actuality, none of these findings by Warwick et al regard a comparison of triangular wave versus sine wave; rather, they study HFCWO compared to manual postural drainage and percussion.[3] Finally, the results actually reported by Kempainen et al at the North American Cystic Fibrosis Congress in November 2006 were that any differences within their study between the sine wave and the triangular wave were of limited and unclear clinical value. To suggest otherwise, as Braverman and Nozzarella have done, is inconsistent with the findings by Kempainen et al.[4]

Although Respiratory Therapy may not be a peer-reviewed journal in the classic sense, its publisher and editors must recognize that biased information related to a clear fiduciary conflict of interest by any author(s) does not present useful information. Because one of the authors of the paper noted above is Chief Executive Officer of Respirtech, a new entrant in competition with two other manufacturers of HFCWO devices, my comments above seem particularly germane.

Jan Stephen Tecklin, PT, MS
Professor, Department of Physical Therapy
Arcadia University
Consultant, Electromed-USA

1 Braverman J, Nozzarella MJ. High-frequency chest compression: Advanced therapy for obstructive lung disease. Respiratory Therapy 2007;2:48-56.
2 Milla CE, Hansen LG, Weber A, Warwick WJ.High-frequency chest compression: effect of the third generation compression waveform. Biomed Instrum Technol. 2004 Jul-Aug;38(4):322-8.
3 Warwick WJ, Wielinski CL, Hansen LG. Comparison of expectorated sputum after manual chest physical therapy and high-frequency chest compression. Biomed Instrum Technol. 2004 Nov-Dec;38(6):470-5.
4 Kempainen R, Hazelwood A, Williams C et al. Comparison of airway clearance efficacy of sine and triangular wave high frequency chest wall oscillation in patients with cystic fibrosis. North American Cystic Fibrosis Conference, Nov. 4, 2006.

CORRECTION

In the article "New Weaning Tools Bring New Hope for Difficult to Wean Patients," on page 51 of the April/May issue, the author's credentials were listed incorrectly, and should have read, Cindy Merideth, CRTT.

NEWS

DRUG RESISTANT

Extremely drug resistant TB, or XDR-TB, is a serious problem in India, according to a study presented at the American Thoracic Society 2007 International Conference. The study, the first in India to look at the prevalence of XDR-TB, found this type of TB accounts for 8% of multi-drug-resistant cases, compared with about 4% in the United States. MDR-TB (multi-drug resistant TB) describes strains of tuberculosis that are resistant to at least the two first-line TB drugs, isoniazid and rifampicin. XDR-TB is MDR-TB that is also resistant to three or more of the six classes of second-line drugs. XDR-TB leaves patients (including many people living with HIV) virtually untreatable using currently available anti-TB drugs. Recent findings from a survey conducted by the World Health Organization and the Centers for Disease Control and Prevention found that XDR-TB has been identified in all regions of the world but occurs most frequently in the countries of the former Soviet Union and in Asia. The death rate of XDR-TB patients in the study was 42%, which Dr.

Jain calls "alarmingly high." Reported in Medical News Today.

THE NOSE KNOWS

An "electronic nose" may one day be used to diagnose asthma, say researchers who presented a preliminary study of the device at the American Thoracic Society 2007 International Conference. The device contains chemical vapor sensors that react to the presence of volatile organic compounds, or VOCs, in a person's exhaled breath. The nose is a newer version of a sensor that has been used in the food, wine and perfume industries. It is also being used as an aid against terrorism, to sniff out explosives or toxic chemicals in the air. It responds to a given odor by generating a pattern, or smell print, which is analyzed and compared with stored patterns. An electronic nose has been developed that can diagnose respiratory infections such as pneumonia by comparing smell prints from the breath of a sick patient with those of patients with standardized readings. It is also being studied as a diagnostic tool for lung cancer. In the new study, the researchers compared the smell prints of 20 people with diagnosed asthma (half with severe asthma and half with mild disease) and 20 people without asthma to see if the electronic nose could classify them as asthmatic or non-asthmatic. The subjects breathed into a face mask attached to a bag connected to the electronic nose.

EXHALE

Broncus Technologies, Inc, has announced the start of its EASE (Exhale Airway Stents for Emphysema) Trial to explore an investigational procedure that may offer a new, minimally-invasive treatment option for millions of emphysema sufferers. The study focuses on a procedure called airway bypass that uses drug-eluting stents to reinforce new pathways in the lung for trapped air to escape. This in turn, may relieve severe emphysema symptoms such as shortness of breath. Leading pulmonologists and thoracic surgeons at medical centers around the world are participating in the EASE Trial to study the safety and effectiveness of airway bypass in people struggling with severe homogenous (or diffuse) emphysema. During the trial, patients are randomized two-to-one to the treatment group (receiving bronchoscopy with placement of the drug-eluting stents) or the control group (undergoing only a bronchoscopy procedure). The trial is underway at 15 leading research institutions. The airway bypass procedure creates new pathways in the lung with the intention of reducing the amount of air trapped in the lungs, thereby helping patients breathe easier. For patients in the treatment group receiving airway bypass, the physician advances a flexible bronchoscope through the mouth into the airways. There the physician creates new small pathways and places an Exhale Drug-Eluting Stent, manufactured by Broncus Technologies, Inc, to allow the trapped air in the lung to escape. The study is to determine if patients experience an improvement in dyspnea and lung function.

TOKE AND CHOKE

Marijuana worsens breathing problems in current smokers with COPD, according to a study presented at the American Thoracic Society 2007 International Conference. The study found that among people 40 and older, smokers were two-and-a-half times as likely as nonsmokers to develop COPD, while smoking cigarettes and marijuana together boosted the odds of developing COPD to three-and-a-half times the risk of someone who did not smoke either cigarettes or marijuana. In other words, adding marijuana smoking to cigarette smoking increased the risk by one-third. The odds of cigarette smokers having any respiratory symptoms was 2.36 times that of nonsmokers, while the odds of someone who smoked both cigarettes and marijuana having respiratory symptoms was 18 times that of someone who smoked neither. A majority of cigarette smokers in the study were also marijuana smokers. The findings come from a study of 648 adults ages 18 and older who answered questions on smoking, including their cigarette and marijuana use, and respiratory symptoms.

PASS THE TORCH

Treatment with a commonly used drug slows the decline in lung function in patients with COPD, according to results from the TORCH (Towards a Revolution in COPD Health) study presented at the American Thoracic Society. The study of 6,112 patients from 42 countries found that those treated with salmeterol/fluticasone propionate (Advair) had a slower rate of lung function decline compared with patients receiving a placebo over three years (39 vs. 55 milliliters per year). This was the first time that pharmacotherapy had been shown to change the rate of decline in lung function. Patients who received either the long-acting beta2-agonist salmeterol (Serevent) or the inhaled corticosteroid fluticasone propionate (Flovent) alone also had less of a decline in lung function than those receiving the placebo, but the decline was smaller than with the combined salmeterol/fluticasone propionate treatment. The study also found that patients with a low body mass index lose more lung function than those with a higher BMI. The researchers also looked at geographic variations in lung function decline, and found that COPD patients who lived in East Asia and Eastern Europe lost lung function at a slower rate than those who lived in the United States or Western Europe. The study did not address the possible causes for this geographic difference. The TORCH study is the largest multicenter long-term COPD study to date. It compared salmeterol at a dose of 50 mcg plus fluticasone propionate at a dose of 500 mcg twice daily combined in a single inhaler, with placebo, salmeterol alone, or fluticasone propionate alone for a period of three years.

Earlier results of the study found that the reduction in death rates for patients taking the combination treatment was not significantly different from those in the placebo group. However, treatment with the combination treatment did result in significantly fewer COPD flareups and improved health-related quality of life and lung function, as compared with placebo.

WU WU WU

A new virus may be causing unexplained respiratory infections, according to a study at Washington University School of Medicine. Scientists can't yet prove that the new virus, known as the WU virus, is making patients sick, but the research has begun, using Koch's postulates. The research appeared in *Public Library of Science Pathogens*. For the study, collaborators at The Royal Children's Hospital in Melbourne provided samples from patients with respiratory infections. Despite an exhaustive battery of tests, Australian researchers had not been able to link the infections to any known pathogen. The Washington University study used high throughput DNA sequencing to study patients' nasal secretions. The approach involves chopping up all genetic material from the secretions and rapidly and randomly reading the coding of that material. Researchers found signs in one patient of a virus with limited similarity to

polyoma viruses. The genetic material of the new virus is arranged in a similar fashion, encoded in circular, double-stranded DNA, and the virus's five proteins have similarities to the proteins of other polyoma viruses. In patients with immune deficiencies, polyoma viruses can pose serious health threats. For example, one of the most infamous polyoma viruses, the JC virus, is a leading secondary infection in HIV patients, causing multifocal leukoencephalopathy. After identifying the WU virus in the lungs of the Australian patient, researchers found it in the respiratory tract secretions of another 43 patients in Australia and St Louis, suggesting that the virus may be geographically widespread. There are early suggestions that the virus may be a secondary infection more likely to invade when hosts already are dealing with another infectious agent.

WAKE UP AND BREATHE

A Vanderbilt study of intensive care unit patients who are breathing with the help of a mechanical ventilator has found that a two-step sedation and ventilator weaning protocol called a "wake up and breathe" strategy helps patients come off the ventilator faster so that they can be discharged from the ICU and hospital more quickly. The study was presented at the ATS Conference. In the first step of the protocol, the patient's sedation is turned off, also known as a "spontaneous awakening trial." The second step involves a spontaneous breathing trial. The multicenter study included 335 critically ill patients in four hospitals who were receiving mechanical ventilation. Patients managed with the combined wake up and breathe protocol (SAT+SBT) were compared with patients who were managed with daily spontaneous breathing trials and usual sedation practices (the SBT group). This group did not undergo formal awakening trials; their sedation was managed by their ICU doctors and nurses on a case-by-case basis. The patients in the SAT+SBT group were able to breathe without the ventilator's assistance an average of three days more and were discharged from the ICU and hospital an average of four days earlier than the SBT group. During the 28-day study, 47 patients in the SAT+SBT group died, compared with 58 in the SBT group.

GET SOME Z'S

Medical residents working within the mandated maximum of 80 hours per week experience severe sleepiness, a finding that may have implications for both patient care and resident safety, according to a new study presented at ATS. Previous studies have shown that sleep-deprived residents perform poorly in several areas like judgment and concentration and are at risk for motor vehicle accidents. There have been several instances where sleep-deprived residents have committed serious mistakes in patient care. This led the ACGME (Accreditation Council for Graduate Medical Education), in 2003, to limit their work hours to not more than 80 hours a week and 24 hours at a stretch. The impact of this standard has not been well studied. The study found that though residents are working within guidelines, they are reporting to work for a 24-hour shift already sleepy and, on post-call, exhibit sleepiness in the pathologic range. This degree of sleepiness is seen in obstructive sleep apnea and narcolepsy and has the potential to impact decisions about patient care, especially on a post-call day and has a bearing on their safety in driving home.

NEW OWNERSHIP

Viasys Healthcare Inc has accepted a $1.42 billion takeover offer from Cardinal Health Inc. On news of the takeover, Viasys shares jumped nearly 37%, to an all-time high. Cardinal Health will pay $42.75 per Viasys share, a 3.5.% premium to the stock's closing price on the date the news was announced. Including debt, the deal is valued at about $1.5 billion. Viasys took in $610 million in revenue in 2006. According to a Goldman Sachs analyst, "The Viasys deal will likely serve to advance Cardinal's long-standing agenda of international expansion, with 40 percent of Viasys revenue coming from international markets, in addition to having a dedicated overseas sales and distribution network." JP Morgan reiterated a "neutral" rating on Viasys shares, and noted that other bids for Viasys could come in at the time we went to press. Reported by the Associated Press.

ALLERGY UPDATE

The World Allergy Organization's Richard Lockey, MD, offered two top picks for practicing allergists in the WAO's recent web message. The WAO's mission is to build a global alliance of allergy societies to advance excellence in clinical care, research, education and training. Contact the WAO at worldallergy.org.

Salmeterol (S) and Fluticasone Propionate (FP) and Survival in Chronic Obstructive Plumonary Disease: This is a randomized, double-blind trial comparing S 50 µg plus FP 500 µg in a single inhaler two times daily with placebo, S 50 µg alone, or FP 500 µg alone for 3 yrs to treat COPD. The primary outcome was death from any cause. Secondary outcomes included frequency of exacerbation, spirometric values and health status. 6,112 patients were included, and 875 died within 3 yrs, 12.6% in the combination–therapy group, 15.2% in the placebo group, 13.5% in the S group, and 16.0% in the FP group, corresponding to a difference of 2.6 percentage points or a reduction in the risk of death of 17.5% (P=0.052). S alone or FP alone did not differ significantly from placebo. Compared with placebo, the combination regimen reduced annual exacerbation rates from 1.13 to 0.85 and improved health status and spirometric values (P<0.001 for all comparisons with placebo). Pneumonia as an adverse event was higher among patients receiving medications containing FP (19.6% in the combination-therapy group and 18.3% in the F group) vs. placebo (12.3%, P<0.001 for comparisons between these treatments and placebo). The reduction in deaths from all causes did not reach statistical significance; however, there are significant benefits in other outcomes with the combined therapy. WAO Editor's comment: Combination-therapy reduced annual exacerbation rates and improved health status and spirometric values (secondary outcomes) but had no statistical effect on mortality (primary outcome). Calverley PMA, et al, N Engl J Med 2007; 356:775.

Vancomycin-Induced Immune Thrombocytopenia: Vancomycin-dependent, platelet-reactive IgG or IgM antibodies were identified in 34 patients suspected of having vancomycin-induced thrombocytopenia. Clinical follow-up information on 29 patients revealed a mean nadir platelet count of 13,600 per mm3 and severe bleeding in 10 patients (34%). Platelet levels returned to baseline in all 26 surviving patients when vancomycin was stopped. Vancomycin-dependent antibodies were not found in 25 controls given vancomycin without thrombocytopenia. The authors conclude that severe bleeding occurs in vancomycin-induced immune thrombocytopenia and the diagnosis can be confirmed by the detection of vancomycin-dependent antiplatelet antibodies. WAO Editor's comment: Add vancomycin to the list of drug-induced thrombocytopenia. Von Drygalski A, et al, N Engl J Med 2007; 356:904; Editorial, Warketin TE, N Engl J Med 2007; 356:891.

ATS AT A GLANCE

Highlights from papers presented at the recent ATS Conference in San Francisco. For specific information on papers presented at the conference, please contact the ATS.

Women who eat **apples and fish** during pregnancy may reduce the risk of their children developing asthma or allergic disease.The SEATON study, conducted at the University of Aberdeen, UK, found that the children of mothers who ate the most apples were less likely to ever have wheezed or have doctor-confirmed asthma at the age of 5 years, compared to children of mothers who had the lowest apple consumption. Children of mothers who ate fish once or more a week were less likely to have had eczema than children of mothers who never ate fish.`The researchers studied 1,212 children born to women who had filled out food questionnaires during their pregnancy. Previous studies in the same children have found evidence for protective effects of vitamin E and D and zinc during pregnancy in reducing the risk of children's wheeze and asthma. The researchers concluded that at least until age 5, a mother's diet during pregnancy might be more influential on a child's respiratory health than the child's own diet. Apples may derive their benefit from flavonoids, and the fish from omega-3 fatty acids.

The latest research from two CDC studies looking at the **epidemiology of TB** in the United States focuses on two groups with higher-than-average rates of TB: foreign-born persons and African Americans living in the southeastern United States. The incidence of TB is nine times higher in foreign-born persons than in US-born persons. The study was conducted at 22 sites in the US and Canada, and included about 1,700 foreign-born people with TB, including 200 children. Another related study is looking at the incidence of tuberculosis among African Americans in eight southeastern states and is a multi-phase research project developed to understand the individual, institutional, and community-level barriers and facilitators to TB control in African Americans in the southeastern region of the U.S. Nationally, the TB rate among African Americans is more than eight times the rate among whites and has been for some time. Over one-third of the TB cases in African Americans are in the southeastern United States.

Children of smokers who don't show any signs of respiratory problems may still be experiencing damaging changes in their airways that could lead to lung disease later in life. A study conducted at the University Medical Center Utrecht in the Netherlands included 244 children ages 4 to 12 without any history of lung or airway disease. They were divided into four groups according to the smoking pattern of their parents. The researchers found that children of smoking parents had significantly reduced lung function similar to that seen in smokers. Smoking after birth appeared to be more harmful than smoking during pregnancy alone.

A new study finds that the **heat setting when doing laundry** makes all the difference when it comes to killing dust mites. The researchers found that washing laundry in hot water, 140º F (60º C) or higher, kills all house dust mites, compared with just 6.5% of dust mites in laundry washed at 104º F, or warm water. Hotter water temperatures are also more effective in removing dog dander and pollen. Washing at a lower temperature (between 86-104° F, then rinsing the laundry twice with cold water for three minutes each, also works.

Endotoxin may reduce the risk of developing eczema or wheezing in children if they are exposed to it up to age 3. A new study found that the lower the amount of endotoxin in young children's homes, the more likely they were to have wheezing or eczema by age that age. Certain environmental factors increased the levels of endotoxin in a home: having a home older than 30 years, substandard home conditions, carpeting, a musty smell and interior wall.

A recent study in Athens, GA studied whether **secondhand smoke** from smokers clustered outside these establishments is posing a health hazard of its own. Athens was picked because of a large student population that typically congregates outside bars. Researchers measured carbon monoxide and small particles which penetrate deep into the lung. Both substances are found in secondhand smoke, but they are also found in car exhaust. To determine how much of these substances came from smoke, the researchers went downtown for four weekend afternoons and evenings and measured the air in front of five locations, including two restaurants, two bars and one area with no smokers. They measured the particles and carbon monoxide every 30 seconds, and then every five minutes they counted the number of cars, smokers and nonsmokers who passed by. A rise in the pollutants was associated with an increase in the number of smokers, and not with motor vehicle traffic, suggesting that secondhand smoke was adding to the pollution levels.

Some **children** may not be able to keep their asthma under control even if they consistently report using **inhaled corticosteroids**. The study of 914 children with mild to moderate asthma found that over a one-year period, children who reported consistent inhaled steroid use were 20% less likely to report having well-controlled asthma compared with those not using any inhaled steroids. This finding held even when the severity of the children's asthma was taken into account. Of the 914 children in the study, inhaled steroids were recommended for 435 who had persistent asthma. Among those recommended for inhaled steroid treatment, 44% reported consistently using the medicine; 35% said they intermittently used the medicine and 21% said they didn't use it at all.

Obese people are significantly more likely to have persistent or severe persistent **asthma** than their thinner counterparts. The study looked at 3,059 adults with asthma, who were divided into three groups: non-overweight, overweight and obese, based on their body mass index (BMI). Compared with non-overweight asthma patients, obese patients were more likely to report having continuous symptoms, have more ER visits, miss more days of work, use more rescue inhaler medications and use inhaled steroids to control asthma. Obese patients were 66% more likely to report having asthma symptoms all of the time, were 47% less likely to be in asthma remission, and 52% more likely to have severe persistent asthma than non-overweight people with asthma. Obese asthmatics were also 36% more likely to miss more than two days of work per year due to asthma than non-overweight asthma patients. The study also noted that the link between asthma and obesity was more prominent in women. While it's not known for sure how asthma and obesity are linked, one potential mechanism seems to be an association between leptin and inflammation of airways.

Three recent asthma studies include the effect of **inhaled-corticosteroid therapy on children** with asthma. Recent studies showed that preschool children at high risk for asthma

had decreased asthma-like symptoms while on two years of inhaled-corticosteroid therapy; however, this therapy did not change the development of asthma symptoms or lung function during a third, treatment-free year. The question raised was, can you protect the airways by using inhaled steroids early in life in high-risk kids to modify the development of wheezing and protect lung function? The answer posited was, no. You can control asthma, but you can't make it go away. In the current study, children considered to be at high risk of asthma included those with recurrent wheezing in the first three years of life, as well as those with eczema or a parent with asthma.

A second presentation looked at whether there were ways to predict which high-risk children will do poorly with their asthma. It was posited that these high-risk children do respond to inhaled steroids, but if you take them off, they tend to do worse. A third study looked at the impact of overweight and obesity on asthma severity and response to asthma therapy. The study is used data from 1,200 people with asthma and found that in patients with mild-to-moderate asthma, increased weight does not substantially worsen physiologic and inflammatory markers of asthma. However, overweight and obese patients with asthma do appear to respond less well to traditional asthma therapies than do their lean counterparts..

Sleep apnea is associated with a greatly increased incidence of **pregnancy**-induced diabetes and high blood pressure. In the study presented at ATS, when the women's weight was taken into account, sleep apnea was associated with a doubling of the incidence of gestational diabetes and a fourfold increase in the risk of pregnancy-induced hypertension. The researchers analyzed data from all pregnancies associated with sleep apnea, gestational diabetes, and pregnancy-induced high blood pressure nationwide in 2003. Out of almost 4 million deliveries, 452 had sleep apnea. Of the 167,227 women who had gestational diabetes, 67 had sleep apnea. Of the 200,902 pregnancies with pregnancy-induced high blood pressure, 166 had sleep apnea. It was found that the repetitive decrease in oxygen that occurs during the night in someone with sleep apnea heightens the body's fight or flight state, which can raise blood pressure, and that the body also secretes more hormones such as cortisol and epinephrine, and responds by producing more glucose coupled with a decreased sensitivity to insulin, which can lead to diabetes. Pregnancy can worsen sleep apnea, especially during the third trimester when a woman's weight is greatest, and may also affect the oxygen level of the fetus. It was recommended that pregnant women with sleep apnea be treated with CPAP, and that pregnant women who are obese, hypertensive or diabetic be closely evaluated for the presence of sleep apnea.

Obstructive sleep apnea increases a person's risk of having a **heart attack** or **dying** by 30% over a period of four to five years. While previous studies have shown an association between sleep apnea and heart disease, a study followed patients for five years and looked at the association between sleep apnea and the combined outcome of heart attack and death, and also adjusted for other traditional risk factors for heart disease. The study included 1,123 patients referred for sleep apnea evaluation. Over the next four to five years, they were followed to see how many had any heart disease events (heart attack, coronary angiography or bypass surgery) or died.

Researchers at the Yale University School of Medicine have found that patients with **obstructive sleep apnea** are at increased risk for developing of **type II diabetes**, independent of other risk factors. A study looked at 593 patients at the VA Connecticut Health Care System referred for evaluation of sleep-disordered breathing. Each patient spent a night in a sleep laboratory to undergo polysomnography. The researchers followed the subjects for up to six years and found that patients diagnosed with sleep apnea had more than two-and-half times the risk of developing diabetes compared with those without the nighttime breathing disorder. The patients were then divided into groups based on the severity of their sleep apnea, and the more severe a patient's sleep apnea, the greater the risk of developing diabetes.

People with obstructive **sleep apnea** have a markedly increased risk of severe **motor vehicle crashes** involving personal injury, according to another study presented at ATS. The study of 800 people with sleep apnea and 800 without it found that patients with sleep apnea were twice as likely as people without sleep apnea to have a car crash, and three to five times as likely to have a serious crash involving personal injury. Overall, the sleep apnea group had a total of 250 crashes over three years, compared with 123 crashes in the group without sleep apnea. Researchers were surprised that some patients had fairly mild sleep apnea and were still having serious crashes. The study also found that while in the general population men have more vehicle crashes than women, among sleep apnea patients, men and women crash at a similar rate.

A study of more than 75,000 adults found that taking **supplemental multivitamins**, vitamin C and E and folate do not decrease the risk of **lung cancer**. The study also did not find any increased lung cancer risk from the supplements. The 77,738 men and women in the VITamins And Lifestyle (VITAL) study, ages 50-76, filled out an extensive questionnaire on vitamin intake over the previous 10 years, including how much of each supplement they took. The researchers then checked to see how many of the people in the study had lung cancer, using a government cancer registry. They found 393 cases of lung cancer. Adjusting for such risk factors as smoking, age, sex, cancer history, other lung disease and history of lung cancer, they found no statistically significant relationships between different types of supplements and lung cancer.

In 1996, a large study known as the CARET study which was looking into the effects of the dietary supplements beta-carotene and retinol (vitamin A), was halted after the supplements were found to increase lung cancer risk, particularly among smokers.

NEWS FEATURE

Pediatric Ventilation and Surfactant Administration

Justin Tse, RRT-NPS
This article was provided by Hamilton Medical.

Care for the pediatric patient is a very complex and challenging

situation which requires constant vigilance. Acute Lung Injury & Acute Respiratory Distress Syndrome (ARDS) are reported to account for 15-45% of respiratory failure in both pediatric and adult patients. ARDS is manifested by an inflammatory response to pulmonary insults as well as a decrease in lung compliance. ARDS is characterized by acute onset of hypoxemia as well as bilateral infiltrates on chest x-ray. It is associated with significant mortality. Lung protective strategies have helped decrease mortality in the pediatric population. Lung protective strategies are complex and require the clinician to be ready to make adjustments as the patient's compliance changes. It becomes even more complex when exogenous surfactant is administered.

Surfactant therapy has become a widely used therapy in the neonatal population and is growing in popularity in the pediatric population. Surfactant is naturally formed by type II alveolar cells. Surfactant reduces surface tension in the alveoli which helps maintain normal pulmonary compliance as it prevents the lung from collapsing at the end of expiration. Laplace's Law states that the pressure inside an inflated elastic container with a curved surface, e.g., a bubble or a blood vessel, is inversely proportional to the radius as long as the surface tension is presumed to change little. In ARDS, the ability of the type II alveolar cells to produce surfactant is impaired. This causes the alveoli to require more pressure to maintain patency. In order to prevent volutrauma and/or atelectrauma from increased ventilating pressures, surfactant can be administered to improve pulmonary compliance by greatly reducing surface tension, thereby increasing pulmonary compliance and allowing the lung to inflate more easily, which decreases work of breathing. Surfactant also decreases the pressure needed to allow the lung to inflate.

Clinicians need to adjust the ventilator as improved pulmonary compliance develops. Depending on the mode, many setting adjustments may be needed. Let us take a look at a few ventilator modes and how they need to be adjusted. The table below shows the mode being utilized and what occurs with pressure and volume as compliance improves and what the clinician needs to change as a result of this improved compliance.

Other controls that may need to be adjusted are inspiratory time, pressure support, rate, and positive end expiratory pressure (PEEP). Indeed, as surfactant alters compliance, the time constant or time needed to fill and empty the lung will change. So adjustments in I: E ratio, rate and Vt may need to be done in addition to the adjustments in ventilating pressures. There are so many parameters that may need to be adjusted which require the clinician to be at the bedside once surfactant is administered. Unfortunately, we do not have the staff to be at the bedside at all times. What is needed are modes that can adapt to changes in lung mechanics (compliance, resistance, time constants) . Automated or closed loop control systems can provide real-time setting adjustments to maintain optimal I:E ratio, tidal volume and rate combinations while maintaining adequate minute ventilation and lung protective strategies at the same time.

Closed loop control can be an effective and safe method of maintaining and monitoring pressure and tidal volume while within a safe margin determined by the clinician. By creating a "care plan" for the ventilator, the ventilator can adapt to the patient and allow for optimal ventilation. "Intelligent Ventilation" has this ability. As surfactant administration is performed by the clinician, the ventilator adjusts to the changing compliance of the lungs and provides optimal tidal volume and rate for the patient.

Having a "mode" that adapts to the patient's condition has many advantages. These include, but are not limited to, improved response to potentially harmful changes in patient condition, better patient synchrony, decreased time on ventilator, decreased sedation, and decreased length of stay. With the changing climate of patient safety and reducing medical errors, a paradigm shift is occurring. "This is an era of lung-protective ventilation; overwhelming evidence indicates that mechanical ventilation can no longer be viewed simply as a supportive technique. Instead, it must be considered a true treatment modality capable of positively or negatively influencing the course of lung disease." [3]

Mode	Pressure	Volume	Change
Pressure Controlled: (PC-A/C, PC-SIMV, DuoPAP, Bi-Level)	Remains Constant	Increases	Decrease pressure to prevent overdistension
Volume Controlled **(with constant flow) (CMV, SIMV)**	Decreases	Remains Constant	May need to increase tidal volume to meet patient demand or may need to increase flow if air hunger occurs
Volume Targeted Pressure modes (APV_{CMV}, APV_{SIMV}, PRVC, Autoflow)	Decreases	Remains Constant	No change needed as pressure will adjust to maintain target VT.
In all cases, if ventilation pressures drop significantly, assess mean airway pressure vs. oxygenation, WOB and patient Vt demand vs. set/target tidal volumes.			

References

1 Shane M. Tibby, Mark Hatherill, Sarah M. Wright, Peter Wilson, Anthony D. Postle, and Ian A. Murdoch "Exogenous Surfactant Supplementation in Infants with Respiratory Syncytial Virus Bronchiolitis" Am J Respir Crit. Care Med., Volume 162, Number 4, October 2000, 1251-1256.

2 Hall, Robert T. "Indications for Surfactant Therapy- The aAPO2 Coming of Age." Pediatrics Vol. 103 No. 2 February 1999, p. e25

3 Rotta, Alexander T. "Lung-protective Ventilation in Pediatrics" Business Biefing: US. Respiratory Care 2006, pg 101-103.

Using Pulmonary Mechanics as a Compass

Melissa Turner, BS, RRT

This article was provided by Hamilton Medical.

When it comes to assessment & management of mechanically ventilated patients, clinicians gather information from a multitude of different measurements to be sure the patient is being ventilated optimally. Measurements of pulmonary mechanics and other indices can be used to assess the efficacy of ventilation and be a guide map as to which direction certain controls should be adjusted in order to provide optimal ventilation to the patient.

There are several different measurements that are included under pulmonary mechanics. Measurements to be reviewed in this article are work of breathing (WOB), rapid shallow

breathing index (RSB), airway occlusion pressure (P0.1), inspiratory airway resistance (Rinsp), expiratory airway resistance (Rexp), static compliance (Cstat), inspiratory time constant (RCinsp), and expiratory time constant (RCexp). As clinicians, we must understand these measurements and the information provided. These measurements provide information on respiratory function so that appropriate decisions can be made in reference to the controls on the ventilator and how to set them optimally. Let's take a closer look at each of these measurements and what each means.

Imposed work of breathing (WOBimp) is the measurement of work performed by the patient to breathe through the ventilator's demand flow system, the circuit, and the endotracheal tube. This work is WOBimp or the imposed work of breathing. The total WOB is the sum of the imposed WOB plus the patients WOB. The patients WOB can only be measured with an esophageal balloon which measures the pleural pressure (or indirectly- see P0.1 below). If the ventilator "WOB" measurement is based on circuit pressure, then the WOB readout is only WOB imposed. WOB is expressed in joules per liter (J/L). Work in physics is 'force x distance', for the respiratory system work is defined as pressure (force) x volume (distance). Any negative pressure or pressure below PEEP seen while the patient is moving Vt is imposed work. If WOBimp is elevated, the clinician should be prompted to check for conditions such as water in the patient circuit, an occluded HME, a kinked circuit, or inappropriate settings for patient sensitivity or flow.

The rapid shallow breathing index (RSB) is a measurement used to predict the outcome of weaning. It is measured as the respiratory rate divided by the tidal volume in liters. The RSB should be calculated during an unassisted breathing trial in order to rely on the measurements obtained. Yang and Tobin[1] have given us the following scale:

RSB < 100 = positive weaning predictor
RSB > 105 = negative weaning predictor
RSB < 130 = acceptable for some elderly or long term COPD patients.

In practice, the RSB is often measured on CPAP or low levels of pressure support and several studies suggest this does not significantly affect the RSB predictive values.

Airway occlusion pressure (P0.1), is the amount of pressure that is generated during the first 100 milliseconds of an occluded breath. This measurement, expressed in cmH_2O, reflects respiratory drive and correlates indirectly with the patient's WOB. Values between -1 and -3 cmH_2O can be considered normal values. As the values become more negative (-3 to -5 cm H_2O), the patient may have a moderate WOB and values more negative than -5cmH2O indicate elevated WOB. Continuous measurement of P0.1 trends are helpful in assessing a wean trial and in titrating the amount of ventilatory support needed to provide a non-fatiguing level of support.

Measuring airway resistance can be broken down into measuring inspiratory resistance (Rinsp) which is the dynamic resistance to inspiratory airflow created by the endotracheal tube and the patient airways, and expiratory resistance (Rexp) which is the dynamic resistance to expiratory airflow. Resistance values are expressed in cmH_2O/L/sec. Resistance is the pressure needed to generate flow across the circuit and airways. Normal values for both Rinsp and Rexp in an intubated adult patient are 3-6 cmH_2O/L/sec. A moderate elevation in resistance is 10-20 cmH_2O/L/sec and anything above that is a severe increase in resistance. If airway resistance is high and Rinsp is close to Rexp, the clinician should assess the patient to find out the cause of the increase in resistance. Some causes could be identified as bronchospasm, clogged HME, secretions, etc. If the Rinsp is higher than Rexp, it could be caused by the need to set a high peak flow rate. If Rexp is higher than Rinsp, the most likely cause is patient airway obstruction.

Static compliance (Cstat) is expressed in ml/cmH_2O and reflects the change of volume per unit of pressure change. Static compliance is the pressure needed to distend or hold the lung at a given volume and reflects the 'stiffness' or elastance of the lung. Normal values are 45-55 ml/cmH_2O in ventilated adults. Any measurements above ~80 ml/chH_2O (high compliance) may be indicative of emphysema. For a moderate decrease in compliance, the values will be reflected as 30-40 ml/cmH_2O and less than 30 ml/cmH2O are indicative of a severe decrease in compliance. WOB increases in active patients with low compliance. This is why patients with restrictive disease (low compliance) adopt a rapid shallow breathing pattern; it's too much work to move a large Vt. Setting optimal PEEP and/or recruitment maneuvers will help to improve compliance if the lung is 'recruitable' and decrease WOB. Automated generation of 'static' pressure volume curves, eg the Hamilton PV Tool allows for rapid assessment of the lower inflection point as well as point of maximal curvature which will assist the clinician in setting optimal PEEP for the patient.

Time constants include the inspiratory time constant (RCinsp) and the expiratory time constant (RCexp). RCinsp is the time it takes the lungs to fill. RCexp is the time it takes the lungs to empty. Time constants are expressed in seconds. It takes 3 time constants for inspiration to be 95% complete and, likewise, 3 time constants for expiration to be 95% complete. For expiration, at one time constant approximately 63% of the lung volume has been emptied, at 2 time constants approximately 87% has been emptied and at 3 time constants approximately 95% of the volume has been emptied. Inspiratory times on ventilators should be set at a minimum of 1x RCinsp. For passive patients, a maximum of 3x RCinsp may be set to maximize gas exchange. Expiratory time should be targeted to equal 3x RCexp and at the very minimum 2x RCexp. Achieving 3x RCexp should take priority over the inspiratory time setting. Normal values for RCexp are 0.6-0.8 seconds. Less than 0.5 seconds is indicative of restrictive disease/ARDS. Greater than 0.8 seconds primarily indicates obstructive disease as these patients need a longer time to exhale to get the air out. Setting inspiratory times that do not allow enough expiratory time for patients, especially patients with long RCexp can cause air trapping to occur.

All of these tools allow clinicians to obtain measurements that can be used as a compass to direct the optimal settings during mechanical ventilation. Even better, these measurements are used in intelligent closed loop ventilation to automatically implement the optimal settings breath by breath to keep patients safe.

1 Yang KL, Tobin MJ. A prospective study of Indexes predicting the outcome of trials of weaning from mechanical

ventilation. N Engl J Med. 1991; 324: 1445-1450
i Braverman J, Nozzarella MJ. High-frequency chest compression: Advanced therapy for obstructive lung disease. Respiratory Therapy 2007;2:48-56.
ii Milla CE, Hansen LG, Weber A, Warwick WJ.High-frequency chest compression: effect of the third generation compression waveform. Biomed Instrum Technol. 2004 Jul-Aug;38(4):322-8.
iii Warwick WJ, Wielinski CL, Hansen LG. Comparison of expectorated sputum after manual chest physical therapy and high-frequency chest compression. Biomed Instrum Technol. 2004 Nov-Dec;38(6):470-5.
iv Kempainen R, Hazelwood A, Williams C et al. Comparison of airway clearance efficacy of sine and triangular wave high frequency chest wall oscillation in patients with cystic fibrosis. North American Cystic Fibrosis Conference, Nov. 4, 2006.

Chronic Obstructive Pulmonary Disease – A Role for High Frequency Chest Compression Therapy

Jane Braverman, PhD, Amy Kulenkamp, MS, RRT

"It has long been speculated that mucus clearance is important for airway defense, but only recently have important details of this system become available...as long as mucus clearance is maintained, chronic airway infections do not occur."
— Knowles MR, et al., J Clin Invest 2002; 109 (5): 571-577.

Management of Chronic Obstructive Pulmonary Disease (COPD) is a topic of unrelenting debate. However, the urgent need for better strategies is not in dispute. Tens of billions of dollars are spent annually to combat a condition soon to become the third most common cause of death worldwide.[1] As the American population ages, if effective interventions remain elusive, healthcare resources will be overwhelmed.[2] New insights into COPD pathophysiology suggest that, for selected patients, high-frequency chest compression (HFCC) therapy may be a simple, practical way to stabilize or slow disease progression and provide symptomatic relief.

Introduction

COPD is complex, variable and incompletely understood. The term, used to classify an heterogeneous spectrum of non-cystic fibrosis (CF) obstructive lung disorders, defies consensus definition.[3] It is agreed, however, that COPD encompasses an array of chronic respiratory disorders distinguished by obstructive-pattern alterations of the respiratory system. Pathological features include structural changes of the small airways, loss of alveolar attachments and decreased elastic recoil of the lung.[4] Airflow limitation, impaired gas exchange, dyspnea, inflammation and impairment of mucociliary clearance (MCC) mechanisms are characteristic. Significantly increased sputum production, or chronic bronchitis (CB), is common but not universal.[5,6]

Until recently, COPD has been considered progressive, irreversible, and incurable.[7,8] Therapeutic interventions, largely unrewarding, were limited to relief of symptoms and management of acute exacerbations.

After decades of therapeutic nihilism, understanding of the pathophysiology of COPD has advanced significantly. New insights have encouraged development of novel strategies with the potential to modify or control some causes and effects of disease progression.[9] Discoveries concerning inflammation, oxidative stress and proteolysis within the lungs drive the search for targeted drugs.[10] Recognition that mucus hypersecretion and airway hyperreactivity trigger episodes of acute illness motivate efforts to manage pulmonary secretions.[11,12] The implications are immense.

Airway Mucus and COPD: The British hypothesis

Historically, airway mucus has been dismissed as an annoying but benign feature of COPD. In 1977, Fletcher and Peto published an influential paper affirming the view, widely known as the "British hypothesis," that the effects of mucus hyperproduction on lung capacity were insignificant.[13] In a subsequent paper, they reported results of a 20-year prospective questionnaire-based assessment and follow-up of nearly 3,000 British occupational cohort male smokers.[14] The data showed a strong correlation between airflow obstruction - but not mucus hypersecretion- and death. On the strength of this and other evidence suggesting the harmlessness of excess mucus in COPD, most clinicians did not consider it worthy of aggressive treatment.

New insights

In the early 1990s, a rapid succession of robustly powered epidemiological studies challenged conventional views about the role of mucus in COPD. Those observations showed clear, increasingly powerful correlations between chronic mucus hypersecretion and clinical consequences. Outcome findings include increased frequency and severity of disease exacerbation, increased rates of hospitalization, sharply accelerated decline in FEV1 and premature death.

- A ten-year follow-up study of 13,756 randomly selected Danes found that risk of death was significantly higher for individuals with COPD, impaired ventilatory function, and chronic mucus hypersecretion.[15]
- A 12-year follow-up study of nearly 4,000 individuals with respiratory symptoms showed that men with chronic mucus

production had accelerated rates of decline in FEV1.[16]

- A 10-12 year follow-up of 14, 223 COPD subjects showed that mucus hypersecretion together with pulmonary infection is a significant predictor of death, but not of death without pulmonary infection.[17]
- An 8-10 year follow-up of nearly 9,500 COPD subjects found that chronic mucus hypersecretion was significantly and consistently associated with both an excess in FEV1 decline and increased risk for hospital admission.[18]
- A 12-year study of more than 13,000 Danish men and women found that mucus hypersecretion and reduced FEV1 were important risk indicators for severe pneumonia, hospitalization, and death.[19]
- A cross sectional study of ambulatory COPD patients seen in more than 200 pulmonology practices in Spain concluded that chronic mucus hypersecretion is significantly associated with the risk of frequent exacerbations.[20]

Growing interest in the effects of chronic mucus hypersecretion has inspired a sharp increase in basic research concerning mucus, cilia, and mucociliary interactions. Symposia publications and electronic databases cite hundreds of papers describing the role of mucus in respiratory pathophysiology in general and in COPD in particular.[21,22] Histological studies of lung tissue affected by stagnant mucus demonstrate epithelial damage, inflammation, alterations in gas exchange structures and dysfunctional or absent airway cilia.[5,8] Studies of abnormal mucus production, rheology, clearance and cough function reinforce epidemiological and observational evidence.[11,12, 23]

Chronic cough and daily mucus hypersecretion are now recognized as predictive of frequent COPD exacerbations and accelerated decline in health status.[24] Evidence unequivocally demonstrates that excess, retained mucus contributes to progressive lung injury and obstructed airflow.[18,25,26] Health consequences are measurable. Annually, patients with advanced COPD have a median of two acute exacerbations requiring hospitalization.[27] An estimated 29-50% of COPD have demonstrable bronchiectasis.[25,28] Those with lower lobe bronchiectasis generally experience more refractory exacerbations owing to bacterial colonization in the lower lobes.

Rationale for mucus clearance techniques in COPD

Improved understanding of the role of mucus as a vehicle of pulmonary destruction in COPD provides a compelling rationale for the use of assistive secretion clearance interventions. Routine airway clearance therapy (ACT) is accepted universally as a cornerstone of treatment for cystic fibrosis (CF) and primary ciliary dyskinesia (PCD). Both conditions are characterized by impaired MCC, mucus hypersecretion and ultimately, bronchiectasis.[29,30] Extrapolation of evidence supporting ACT in these diagnoses suggests that COPD patients with a similar pattern of impaired MCC should also show therapeutic benefit.

Despite the intuitive rationale for managing secretions in affected COPD patients, ACT is rarely provided. This neglect is explained, at least in part, by the emphasis upon development of pharmacologic solutions. A second explanation is found in the poor or equivocal outcomes of a small number of dated studies evaluating the usefulness of chest physiotherapy (CPT) in COPD.

Mucoactive drugs

Several pharmaceutical firms have launched major initiatives to develop mucoactive drugs aimed specifically at moderating mucus production and enhancing mucus clearance in COPD.[31,32] Currently, most patients receive at least one and frequently two such drugs. Clinically, however, the benefits of mucolytic and mucokinetic agents have been disappointing. Among more than fifty such commercially available compounds, fewer than ten are listed consistently in publications for prescribing physicians.[32] Randomized controlled trials involving five different drugs failed to show clinical benefit in terms of accelerated recovery from acute exacerbations.[33] Although some COPD/CB patients may show symptom relief from mucoactive drugs, most consensus statements find that current evidence does not justify general use.[32]

COPD and chest physiotherapy

For more than 30 years, conventional CPT, defined as any combination of postural drainage, chest percussion and vibration and cough techniques, has been tried and studied in a limited number of COPD patients. Although most studies confirm that CPT does what is intended to do - transport and help evacuate mucus - few have captured data to support its routine use in patients with COPD.[34,35,36] On the basis of randomized clinical trial results, consensus statements on the treatment of acute exacerbations echo the general view that "chest physiotherapy does not appear to be of benefit." [24,37]

Absence of evidence of benefit vs evidence of absence of benefit

Re-evaluation of the usefulness of ACT in COPD is urged in a recent critique of the limitations of existing CPT studies.[38] Most published CPT/COPD trials have broad inclusion criteria that do not select for clinical evidence of mucus hypersecretion. Unsurprisingly, those studies fail to demonstrate statistically significant benefit from CPT. Poor control of both subject-related and CPT technique-related variables confound outcomes data further. Perhaps equally important, those COPD/CPT studies are limited by failure to recognize barriers to the effective use of the therapy. CPT is a technique-dependent modality requiring considerable skill, physical strength and caregiver commitment. On the patient side of the equation, many individuals with COPD are fragile, obese, disabled and mentally challenged. Physical fragility or deformities increase risk for therapy-related injury. Ventilators, intravenous lines, catheters, pacer wires etc further complicate repeated positioning of patients safely and effectively. Cognitive impairment or depression contribute to unwillingness to cooperate. In fact, patient inability to tolerate required maneuvers may preclude use of CPT altogether. Gravitational postural drainage may increase dyspnea, induce hypoxemia and increase work of breathing. CPT is associated with increased episodes of gastroesophageal reflux (GOR).[39] Recent studies have shown that the effects of CPT- induced GOR may have serious adverse respiratory consequences including accelerated progression of lung disease in susceptible patients.[40,41]

Trials investigating the benefit of CPT in COPD were doomed to failure by enrollment of inadequately screened subjects and disregard for confounding limitations of the interventional therapy. It is unfortunate that results of those studies are often accepted as evidence of absence of treatment benefit.[24,37] Because the rationale for secretion clearance therapy in COPD is so compelling, negative studies should be subjected to

renewed scrutiny. Methodological flaws should be identified and used to guide the design of new trials targeting only those patients whose clinical status suggests the possibility of therapeutic benefit. CPT is simply not a practical therapy for COPD patients. That fact should not discourage the search for a better method.

A practical choice: high-frequency chest compression (HFCC)

In patients lacking the ability to tolerate CPT and other technique and/or effort-dependent forms of ACT, only one therapeutic modality holds promise: high-frequency chest compression (HFCC). HFCC therapy is an FDA-approved airway clearance technology. Phase I and Phase II studies provide qualifying safety data and demonstrate a variety of physiological effects influencing mucus mobilization and clearance.[42] Dozens of clinical trials demonstrate the safety and efficacy of HFCC in a broad range of patient populations.[42] The therapy has been used widely and successfully in patients with CF. Patients with acute illness, serious trauma, status post-operative or with airway clearance compromise arising from an array of other conditions that compromise MCC have shown benefit. In numerous published studies, investigational endpoints include the comparative volume of expectorated secretions, changes in pulmonary function scores, quality of life gains and reductions in healthcare utilization.[42,42,43,44,45]

HFCC therapy is administered by means of an air pulse generator attached by two lengths of tubing to an adjustable, inflatable jacket garment fitted over the users' thorax. The jacket component of the device transmits compressive forces to the chest wall to produce increased airflow and oscillatory effects within the airways, thus enhancing mucus mobilization and clearance. The therapy is technique-independent and requires no active effort from the user.

HFCC technology allows self-administered therapy; most patients require little or no caregiver assistance. Tolerance barriers and risk for GOR are eliminated because, unlike CPT, the therapy does not require trendelenberg positioning, physical or mental cooperation. During HFCC, all segments of the lung are treated simultaneously. Aerosolized medications may be administered during therapy, thus reducing time and burden of treatment. Because HFCC is automated, treatments are consistent and reliable.

HFCC and COPD

Although some COPD/HFCC studies have been done, they are small in scale and not widely known. Unfortunately, the comparatively limited resources of medical device manufacturers usually do not permit studies matching the power, rigor and complexity of those conducted by major pharmaceutical firms. Nevertheless, existing COPD/HFCC studies are consistently positive and suggest benefit sufficient to pursue further studies.

- HFCC therapy may alleviate COPD symptoms by: 1) improving respiratory muscle function, resulting in better ventilation and gas exchange; 2) improving secretion clearance, resulting in reduced airway obstruction and dyspnea; and 3) facilitating better disease self-management.[46]
- HFCC therapy may augment respiratory muscle training by strengthening respiratory muscles.[47]
- HFCC may facilitate inspiratory muscle work and enhance both gas exchange and inspiratory muscle function in patients with severe COPD thus facilitating pulmonary rehabilitation.[32]
- In a 90-day trial of high frequency chest compression (HFCC), COPD patients that completed the trial program and then elected to continue HFCC therapy experienced statistically and/or clinically significant improvements in treatment and quality-of-life outcomes measured by validated instruments. Outcome domains include: 1) dyspnea; 2) six-minute walk distance; 3) quality of life (general health category); 4) treatment satisfaction and; 5) treatment adherence.[48]
- A comparison of the safety and efficacy of percussion and postural drainage (P&PD) and high frequency chest compression (HFCC) in treatment of long-term mechanically ventilated patients showed equivalent safety and efficacy; 80% of therapists believed HFCC reduced their workload.[49]

Conclusion

In selected COPD patients, the rationale for aggressive secretion clearance interventions is compelling. The strong relationship between mucus hypersecretion and poor clinical outcomes, escalating healthcare expenditure and premature death is indisputable. Poorly designed studies, chiefly investigating CPT, have yielded conclusions suggesting that ACT offers little or no benefit. Uncritical acceptance of those conclusions may have devastating consequences. Failure to scrutinize counterintuitive data and to identify methodological flaws in such studies may delay identification of therapies potentially useful to many patients.

Results of studies investigating the use of HFCC in COPD are uniformly positive. Because HFCC technology eliminates virtually all the extrinsic and intrinsic limitations associated with CPT, it is also practical. Negative attitudes about the use of physiotherapy in COPD should be suspended until clinicians and investigators have tried HFCC in appropriately selected patients. HFCC may prove to be a simple, effective way to stabilize or slow disease progression and provide symptomatic relief for many COPD sufferers. Further studies should be encouraged.

References

1 Yelin E, Trupin L, Cistermas M, Eisner M, Katz P, Blanc P. A national study of medical care expenditure for respiratory conditions. Eur Respir J 2002; 19: 414-421.

2 Afessa B, Morales U, Scanlon PD, et al. Prognostic factors, clinical course, and hospital outcomes of patients with chronic obstructive pulmonary disease admitted to intensive care for respiratory failure. Crit Care Med. 2002; 30: 1610-1615.

3 Rodriguez-Roisin R: Towards a consensus definition for COPD exacerbations. Chest 2000, 117:398S-401S.

4 Decramer M, De Benedetto F, Del Ponte A, Marinari S. Systemic effects of COPD. Resp Med 2005; 99, S3-S10.

5 Hogg JC. Chronic obstructive pulmonary disease: an overview of pathology and pathogenesis. In: Chronic Obstructive Pulmonary Disease: Pathogenesis to Treatment. Novartis Foundation Symposium 234; (John Wiley and Sons, New York, 2001). pp. 4-19.

6 Rogers DF. Mucus pathophysiology in COPD: differences to asthma, and pharmacotherapy. Monaldi Arch Chest Dis. 2000 Aug; 55(4): 324-32. Review.

7 Cella BR. Current thoughts regarding treatment of chronic obstructive pulmonary disease. Med Clin N Am. 1996; 80:589-609.

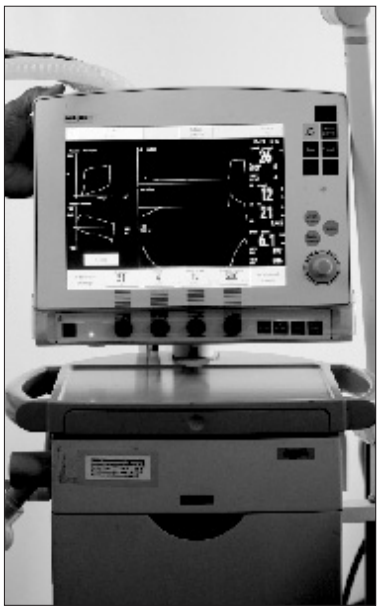
8 Rodriguez-Roisin R, MacNee W. Pathophysiology of chronic obstructive pulmonary disease. In: Management of Chronic Obstructive Pulmonary Disease, European Respiratory Monographs Vol. 3 (7), Postma DS, Siafakas NM, eds. U.K.: ERS Journals Ltd, 1998.
9 Barnes, PJ. Potential novel therapies for chronic obstructive pulmonary disease. In: Chronic Obstructive Pulmonary Disease: Pathogenesis to Treatment. Novartis Foundation Symposium 234; (John Wiley and Sons, New York, 2001). PP. 255-267.
10 Rennard SI, Farmer SG. COPD in 2001: a major challenge for medicine, the pharmaceutical industry and society. Chest 2002, 113S-115S.
11 Takisima T, Shimura S. Airway hypersecretion in bronchial asthma and chronic obstructive pulmonary disease. In: Airway Secretion: physiological bases for the control of mucous hypersecretion. Takisima T, Shimura S., eds. Lung Biology in Health and Disease, Vol. 72 (Marcel Dekker, New York 1994). pp. 527-578.
12 Chodosh S. Sputum production and chronic bronchitis. In: Airway Secretion: Physiological Bases for the Control of Mucous Hypersecretion. Takishema T, Shimira S, eds. (Lung Biology in Health and Disease, Vol 72; Marcel Dekker, Inc., New York 1994). pp. 579-628.
13 Fletcher C, Peto R. The natural history of chronic airflow obstruction. Br Med J. 1977; 1 (6077): 1645-1648.
14 Peto R, Speizer FE, Cochrane AL, et al. The relevance in adults of air-flow, but not of mucus hypersecretion, to mortality from chronic obstructive lung disease. Results from 20 years of prospective observation. Am Rev Respir Dis. 1983 Sep; 128(3):491-500.
15 Lange P, Nyboe J, Appleyard M, et al. Relation of ventilatory impairment and chronic mucus hypersecretion to mortality from obstructive lung disease and from all causes. Thorax 1990; 45 (8): 579-585.
16 Sherman CB, Xu X, Speizer FE, et al. Longitudinal lung function decline in subjects with respiratory symptoms. Am Rev Respir Dis 1992; 146: 855-859.
17 Prescott E, Lange P, Vestbo J. Mucus hypersecretion identified as significant predictor of COPD-related death with pulmonary infection. Eur Respir J 1995; 8 (8): 1333-1338.
18 Vestbo J, Prescott E, Lange P. Chronic mucus hypersecretion in patients with COPD associated with increased FEV1 decline and increased risk of hospitalizations. Am J Respir Crit Care Med 1996; 153: 1530-1535.
19 Lange P, Vestbo J, Nyboe J. [Risk factors of death and hospitalization due to pneumonia. Results from the Osterbro Study.] Ugeskr Laeger 1997; 10: 159 (7): 956-959.
20 Miravitlles M, Guerro T, Mayordomo C. Factors associated with increased risk of exacerbation and hospital admission in a cohort of ambulatory COPD patients; a multiple logistic regression analysis. The EOLO Study Group. Respiration 2000; 67 (56): 495-501.
21 Cilia and Mucus: From Development to Respiratory Disease. Matthias Salathe, Ed., (Marcel Dekker, Inc., New York, NY, 2001).
22 Cilia, Mucus, and Mucociliary Interactions. Feb 27-Mar 4, 2005; Buellton, CA., (Richard Boucher and Matthias Salathe, Chairs). http://www. grc.uri.edu/programs/2005/cilia.htm
23 King M, Rubin BK. Rheology of airway mucus: relationship with clearance function. In: Airway Secretion in Health and Disease: Physiological Bases for the Control of Mucous Hypersecretion, Takishma T and Shimura S, eds. (Marcel Dekker, Inc., New York, 1994), 283-314.
24 Fabbri LM, Hurd SS. Global strategy for the diagnosis, management and prevention of COPD: 2003 update. Eur Respir J 2003; 22: 1-2.
25 Patel IS, Vlahos I, Wilkinson TM, Lloyd-Owen SJ, Donaldson GC, Wilks M, Reznek RH, Wedzicha JA. Bronchiectasis, exacerbation indices, and inflammation in chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2004 Aug 15; 170(4):400-7.
26 Seemungal TA, Donaldson GC, Paul EA, Bestall JC, Jeffries DJ, Wedzicha JA. Effect of exacerbation on quality of life in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 1998; 157: 1418-1422.
27 Seemungal TA, Donaldson GC, Bhowmik A, Jeffries DJ, Wedzicha JA. Time course and recovery of exacerbations in patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med. 2000; 161: 1608-1613.
28 O'Brian C, Guest PJ, Hill SL, Stockly RA. Physiological and radiological characterization of patients diagnosed with chronic obstructive pulmonary disease in primary care. Thorax 2000; 55: 635-642.
29 Yankaskas JR, Marshall BC, Sufian B, Simon RH, Rodman D. Cystic fibrosis adult care: consensus conference report. Chest 2004; 125:1 S -39S.
30 Bush A, Cole PJ, Hariri M, et al. Primary ciliary dyskinesia: diagnosis and standards of care. Eur Respir J 1998; 12: 982-988.
31 Rogers DF. Mucoactive drugs for asthma and COPD: any place in therapy? Expert Opin Invest Drugs 2002; 11 (1): 15-35.
32 Poole PJ, Black PN. Mucolytic agents for chronic bronchitis (Cochrane Review). In; The Cochrane Library, Issue 2. Cochrane Database Syst Rev 2000: URL: www.update-software.com.
33 McCory DC, Brown C, Gelfand SE, et al. Management of acute exacerbations of COPD: a summary and appraisal of published evidence. Chest 2001; 119: 1190-1209.
34 Bateman JR, Newman SP, Daunt KM, Pavia D, Clarke SW. Regional lung clearance of excessive bronchial secretions during chest physiotherapy in patients with stable chronic airways obstruction. Lancet. 1979; 1 (8111):294-297.
35 Bateman JR, Newman SP, Daunt KM, Sheahan NF, Pavia D, Clarke SW. Is cough as effective as chest physiotherapy in removal of excessive tracheobronchial secretions? Thorax. 1981; 36:683-687.
36 Gallon A. Evaluation of chest percussion in the treatment of patients with copious sputum production. Respir Med. 1991; 85:45-51.
37 Bradley JM, Moran FM, Stuart Elborn J. Evidence for physical therapies (airway clearance and physical training) in cystic fibrosis: An overview of five Cochrane systematic reviews. Respir Med. 2006; 100:191-201.
38 Holland AE, Button BM. Is there a role for airway clearance techniques in chronic obstructive pulmonary disease? Chron Respir Dis 2006; 3: 83-91.
39 Bendig DW, Seilheimer DK, Wagner ML, Ferry GD, Barrison GM. Complications of gastroesophageal reflux in adult cystic fibrosis patients. J R Soc Med 1998; 91 (1): 7-9.
40 Button BM, Heine RG, Catto-Smith AG, Olinsky A, Phelen PD, Ditchfield MR, Story I. Chest physiotherapy in infants with cystic fibrosis: To tip or not to tip? A five-year study. Pediatr Pulmonol 2003; 35 (3): 208-213.
41 Vandenplas Y, Dietrich A, Blecker U, Lanciers S, Deneyer M. Esophageal pH monitoring data during chest physiotherapy.

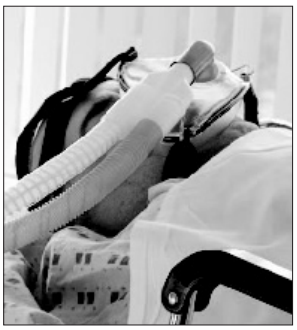
J Pediatr Gastroenterol Nutr 1991; 13:23-6.
42 Milla CE, Hansen LG, Weber A, Warwick WJ. High-frequency chest compression: effect of the third generation compression waveform. Biomed Instrum Technol. 2004; 38:322-328.
43 Kluft J, Beker L, Castagnino M, Gaiser J, Chaney H, Fink R. A comparison of bronchial drainage treatments in cystic fibrosis. Pediatr Pulmonol 1996; 22:271-274.
44 Braggion C, Cappelletti LM, Cornacchia M, Zanolla L, Mastella G. Short-term effects of three chest physiotherapy regimens in patients hospitalized for pulmonary exacerbations of cystic fibrosis: a cross-over randomized study. Pediatr Pulmonol 1995; 19:16-22.
45 Warwick WJ, Hansen LG. The long-term effect of high-frequency chest compression therapy on pulmonary complications of cystic fibrosis. Pediatr Pulmonol 1991; 11:265-271.
46 Perry RJ, Man GCW, Jones RL. Effects of positive-end expiratory pressure on oscillated flow rate during high-frequency chest compression. Chest 1998; 113 (4): 1028-1033.
47 Piquet J, Brochard L, Isabey D, De Cremoux H, Chang HK, Bignon J, Harf A. High frequency chest wall oscillation in patients with chronic airflow obstruction. Am Rev Respir Dis 1987; 136:1355-1359.
48 Rumbak MJ, Marchione VL, Kennedy TC, Rolfe MW. Ninety-day assessment of the effect of high-frequency chest wall oscillation (HFCWO) on exercise tolerance and quality of life of patients with chronic obstructive pulmonary disease. Chest 2001; 120:4(Suppl): 250S. (Presented at ACCP Chest Conference, November 2001).
49 Whitman J, Van Beusekom R, Olson S, Worm M, Indihar F. Preliminary evaluation of high-frequency chest compression for secretion clearance in mechanically ventilated patients. Respir Care 1993; 38:1081-1087.

Challenges In Critical Care: Geisinger Medical Center – Use of NIV in State-of-the-Art Care

For more than 90 years, Geisinger Medical Center in Danville, PA, has been known as the region's resource for the highest quality healthcare. Its physicians, all of whom are connected by a sophisticated electronic medical record system, practice in more than 75 medical specialties. Thanks to its highly regarded expertise and its use of the most advanced technology in the country, the most complex cases in Central and Northeastern Pennsylvania are often referred to the 437-bed medical center.

As one of the nation's top medical/surgical and Level 1 trauma centers with supplementary accreditation in pediatrics, Geisinger must have state-of-the-art equipment and procedures for acutely ill patients. For patients with acute respiratory illnesses, the hospital has a fleet of 45 SERVO-i ventilators. It recently upgraded its fleet to include software for noninvasive (NIV) functionality.





Top: Patient in facemask for noninvasive ventilation.

Left: SERVO-i in use at bedside.

The views, opinions, and assertions statged by Geisinger Medical Center staff members in this article are strictly those of the clinicians and administrators, and do not necessarily reflect the views of MAQUET. This article was provided by MAQUET.

NIV is a valuable treatment alternative for acute hyperapneic respiratory failure, particularly in patients with chronic obstructive pulmonary diseases (COPD). The hospital sees many COPD patients, particularly among its elderly patient population, says John Conrad, BS, RRT-NPS, RCP, Administrative Team Leader for Respiratory Care Services. Also, NIV can be effective in cardiogenic pulmonary edema (CPE) as well as during weaning, he says.

Noninvasive ventilation helps avoid some of the complications that can be associated with invasive ventilation, such as discomfort, infections and airway trauma. NIV can also shorten hospital stays for select patients, reducing their treatment costs, Conrad says.

Easy Monitoring

As a Respiratory Therapist, Mark Reffner, BS, RRT, RCP, finds the NIV option on the SERVO-i easy to employ. During NIV, the ventilator automatically adapts to variations in leakage to maintain the required pressure and positive end-expiratory pressure (PEEP) level, he says. The leakage percentage is one of the values displayed under trends, making it easier to make adjustments as needed. "It is possible, by measuring and adjusting during the same breath, to maintain the set pressure to the patient," he says.

Jennifer M. Small, RRT, RCP, Adult Critical Care Team Leader, finds that most patients tolerate NIV extremely well, especially if they are relaxed. To make patients comfortable, she often holds the facemask in place for a few minutes before strapping it on. The SERVO-i ventilator does not require any proprietary interface. Many masks and harnesses are available in several designs and materials, as patients have different facial contours.

To standardize care, Geisinger has adopted protocols for how supportive therapy is initiated, maintained, and discontinued to

Jennifer M. Small, RRT, RCP, Adult Critical Care Team Leader.

John Conrad, BS, RRT-NPS, Adminsitrative Team Leader for the Respiratory Care Services.

Mark Reffner, BS, RRT, RCP, Respiratory Therapist.

Respiratory therapist caring for patient on noninvasive ventilation with the SERVO-i.

alleviate a patient's work of breathing, and to ensure adequate oxygenation and ventilation. The overall goal of Geisinger's ventilator management protocol is to have all patients on mechanical ventilation for the shortest time possible. This helps reduce the incidence of Ventilator Associated Pneumonias (VAP), since patients who are intubated for more than 48 hours are more susceptible to VAP. Patients are assessed at least every four hours, and a wean is attempted based on the patient's tolerance and criteria listed in the Geisinger Ventilation Management Protocol.

Geisinger's protocol is based on the ARDSnet protocol, and was developed by its Pulmonary and Adult Critical Care physicians. The protocol allows therapists to use their knowledge and expertise to care for invasively and noninvasively mechanically ventilated patients. A section of its Respiratory Care Services Manual, Ventilated Management Protocol addresses noninvasive, positive pressure ventilation (NPPV). The RTs on staff are well respected, and work closely with physicians in finding the right settings and appropriate mode of ventilation for patients who need assistance breathing, Small says. Having the SERVO-i ventilators makes delivering the most appropriate, state-of-the-art care of each patient possible, she says.

Patient Comfort

A key advantage of the SERVO-i for Geisinger is that it has invasive and noninvasive capabilities in one machine, requiring less space in its patient rooms. "NIV has always been available, but on separate units," Conrad explains. "Space inside the patient rooms on the critical care floors can be an issue. With the bed and all the monitoring equipment, the IV poles, the cords and everything else, having one machine that can be used for invasive as well as noninvasive is a definite plus. You no longer have to push the invasive unit to the back or out of the room if you wish to switch modes."

Anecdotally, the hospital has found that because it now has NIV capabilities so readily available, it has reduced the number of patients it has had to reintubate. "We use NIV if you extubate a patient and he or she still needs some additional support," Reffner says. "You can use NIV to bridge the gap, and you end up not having to reinsert the endotracheal tube."

NIV is also useful for ventilated patients who must wait a few days for a follow-up surgical procedure, Reffner says. "You may extubate a patient but he or she is going to have to go back to surgery a few days later. You can put them on noninvasive ventilation and give them a little break periodically. A little time on the mask, a little time off the mask. They are more comfortable and don't have to have an endotracheal tube leading up to their second surgery."

Reffner has also seen patients weaned from mechanical ventilation earlier with an endotracheal tube, because the staff knows that NIV is there to support patients if needed when they are ready to extubate.

Cost Effective

The hospital also realizes cost savings from having NIV capabilities on its SERVO-i ventilator fleet. "In the past, we would be running so many NIVs that we had to rent machines," Conrad says. "Having the SERVO-i ventilators with NIV capabilities prevents us from needing to rent additional machines, which can be costly."

Because of the transport capabilities of the SERVO-i, patients who require NIV in the ER can be more easily transferred to the ICU if and when they are admitted. With the SERVO-i, their NIV can be maintained during transport, Reffner notes.

One of the reasons Geisinger purchased the SERVO-i ventilators was its evaluation team liked that the machines could be upgraded to meet its changing needs and advances in respiratory technology. Being able to upgrade to include NIV software has been a real plus. Says Conrad, it only confirms the original decision to choose the SERVO-i.

Excerpts from Geisinger Health System Mechanical Ventilation Protocol

Guidelines:

Patient Assessment:

1. Any acutely ill patient must be evaluated for adequacy of his/her native airway. Level of consciousness, respiratory pattern and rate, breath sounds, upper airway patency, secretion control, etc., are parameters to be assessed. A patent airway can be established by suctioning removal of foreign bodies, jaw thrust, chin lift, oropharyngeal airway, nasopharyngeal airway, and/or intubation. However, most critically ill patients require intubation.

   When intubation is done in emergent situations, the senior most person who possesses the necessary intubation skills should supervise and/or perform this procedure. For any patient requiring intubation, before intubation is attempted, a nasogastric tube should be inserted to empty gastric contents and/or cricoid pressure should be applied in order to minimize the risk of aspiration of these contents. Also, a patient's respiratory efforts should be controlled. This can be accomplished by oxygenating and hyperventilating a patient with a mask device attached to a supplemental oxygen source (usually FiO = 100%). An oral airway may help facilitate "bagging." Adequate sedation and topical anesthesia should be used prior to attempting intubation.

   Chemical paralysis may be needed, but only with the approval of a staff physician. When used, sedation should always precede paralysis and must be maintained while paralysis persists. Only after gastric contents have been evacuated and adequate airway control, oxygenation, and appropriate patient relaxation have been achieved should intubation be attempted. If a patient has been heavily sedated and/or paralyzed, mechanical ventilation will be necessary. After intubation, endotracheal tube placement can be confirmed by visibly checking the placement of the endotracheal tube (should be between the vocal cords), listening for bilateral breath sounds, looking for misting in the endotracheal tube, CO_2 detection, chest X-ray and/or bronchoscopy in some cases.

2. The adequacy of an acutely ill patient's respiratory activity needs to be assessed. Though arterial blood gases, pulse oximetry, and end-tidal CO_2 are commonly relied upon, they should not be the sole indicators of a patient's respiratory activity. Other indicators are a patient's rate, depth and pattern of respiratory activity, mental status, and overall 'comfort' level.

Guidelines:

NPPV (Non-Invasive Positive Pressure Ventilation)

1. Initiation of NPPV
   - **a.** In conjunction with section B: Patient Assessment, a spontaneously breathing patient with two of the following criteria may be a candidate for NPPV:
     - **1.** dyspnea
     - **2.** accessory muscle use
     - **3.** SaO < 90%
     - **4.** respiratory rate > 24 BPM
   - **b.** A patient with the following is not a candidate for NPPV:
     - **1.** respiratory arrest
     - **2.** uncontrolled arrhythmia
     - **3.** airway obstruction
     - **4.** inability to clear secretions
     - **5.** coma, uncooperative or claustrophobia
     - **6.** facial trauma
     - **7.** hypotension with systolic blood pressure < 90 mmHg
   - **c.** Initial settings include:
     - **1.** NIV-Pressure Support
     - **2.** Pressure Support Level = 10cmh20
     - **3.** PEEP = 4 cmh20
     - **4.** backup rate=8 BPM
     - **5.** inspiratory rise adjusted to patient comfort.

       Note: A comfortable, properly fitting mask should be chosen, too.
   - **d.** To adjust for optimal ventilation, increase PS in increments of 2 cm H_2O to relieve respiratory distress, and to adjust for inadequate oxygenation, increase PEEP (in increments of 2 cm H_2O) and/or FiO to achieve SaO ≥ 92%. *Note: Increases in PEEP will decrease PS. Therefore, PS may have to be increased to maintain desired ventilation.*

2. Discontinuation of NPPV
   - **a.** When precipitating cause(s) of respiratory failure is/are sufficiently resolved, when minimal NIV support (PS and PEEP) pressures are needed to maintain adequate patient comfort without signs/symptoms of respiratory distress, and when FiO < 65%, a trial off NPPV can be initiated. *Note: Minimal NIV support pressures are: PS = 10 cm H_2O and PEEP=4 cm H_2O.*

Identifying Autopeep by Examining the Flow and Pressure vs Time Waveforms

Tim France, BS, RRT, Clinical Support Specialist; Paul Garbarini, MS, RRT

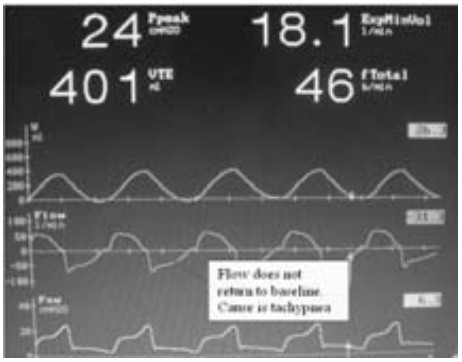
Unrecognized autopeep can be a potentially dangerous phenomenon, particularly in patients experiencing cardiopulmonary compromise. Autopeep results from dynamic pulmonary hyperinflation and is also referred to as "Intrinsic" PEEP (PEEPi). Extrinsic PEEP (PEEPe) is the set PEEP on the ventilator.

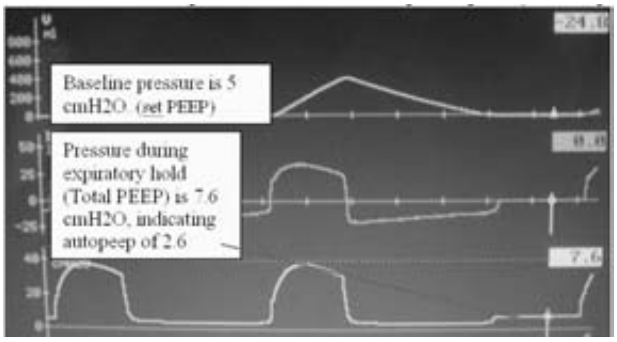
- PEEPi is an important parameter of respiratory mechanics, for several reasons[1]:
- PEEPi provides information on the amount of dynamic hyperinflation.
- PEEPi is to be summed to PEEPe in order to appreciate the real, total PEEP working on the respiratory system and on all the intrathoracic organs.
- PEEPi is to be taken into account in order to obtain a correct value for respiratory system static compliance. (Note, compliance measurements utilizing the LSF method on the Hamilton Galileo ventilator does not require correction for autopeep.)
- PEEPi is an inspiratory threshold load to be overcome by the patient inspiratory muscles at every patient-initiated breath, even when inspiration is mechanically assisted by the ventilator. Hence, PEEPi has important implications concerning the energetics of breathing.
- PEEPi is an additional elastic load to be overcome by the ventilator during passive ventilation. Hence, PEEPi contributes to the need for applying high inspiratory pressures in passively ventilated patients.

There are multiple situations in which autopeep can occur. In patients with obstructive pulmonary disease, high expiratory resistance and/or compliance can cause autopeep. Also, ventilator settings can cause autopeep if the I:E ratio does not allow enough time for exhalation. This becomes increasingly probable as the minute ventilation increases. Even if the "set" I:E ratio is adequate, any increase in rate due to patient spontaneous efforts changes the actual I:E ratio. Monitoring of the measured I:E ratio is recommended vs. the set I:E ratio.

A careful assessment of the flow and pressure waveforms can help clinicians identify and quantify autopeep. When using the flow waveform to examine autopeep, the expiratory portion of the waveform is assessed. Anytime a patient does not fully exhale there is autopeep. Incomplete exhalation is demonstrated by looking at the expiratory limb and assessing if flow returns to baseline (Fig 1).

As noted previously, this can happen because of two situations. The first is when a patient is tachynic and inverse ratio ventilation (IRV) occurs or even without an inverse I:E in the presence of increased resistance/& or compliance (whether due to intrinsic lung disease, ETT, HME etc.) The second is if ventilator settings are not allowing for complete exhalation. In both cases manipulating vent settings to either relieve tachypnea or increase expiratory time should decrease the autopeep. It should be noted that examining the flow waveform does not quantify the amount of autopeep; it only alerts the clinician that autopeep may be occurring.





The classic method to quantify the amount of autopeep is to examine the pressure waveform after performing an expiratory hold. If there is autopeep present an increase in baseline pressure will be seen during the expiratory hold (Fig 2).

Most ventilators have an expiratory hold feature to quantify autopeep, however this method is limited in that the patient must be passive. The Hamilton Galileo ventilator in addition to the classic expiratory hold technique, utilizes a computerized continuous analysis of flow, volume and pressure (a 'Least Square Fit' method) to measure autopeep in actively breathing patients.

1 Measurements of Respiratory Mechanics During Mechanical Ventilation, Giorgio A. Iotti, MD, Antonio Braschi, MD, 1999 ISBN 3-9521865-0-3.

Tim France is Clinical Support Specialist and Paul Garbarini is Clinical Application Manager, Hamilton Medical.

New Technology Offers New Opportunities: Continuous Bronchodilator Therapy During Mechanical Ventilation

James B. Fink, MS, RRT, FAARC

Introduction

Patients with severe exacerbations of asthma, refractory to standard dose and frequency of inhaled bronchodilators may benefit from continuous bronchodilator therapy (CBT). While CBT is commonly described in the literature for treatment of non-intubated patients little has been written about appropriate techniques for CBT during mechanical ventilation. Historically, lower respiratory tract deposition with standard nebulizers is diminished in mechanically-ventilated patients compared to ambulatory patients. Appropriate selection of techniques and devices can result in deposition and efficacy during mechanical ventilation that equals or exceeds delivery of aerosols in nonintubated spontaneously breathing patients. Multiple factors — including the type of aerosol generating device, particle size, placement in the ventilator circuit, circuit humidity, flow rates and duty cycle — influence the efficacy of aerosol delivery and deposition in mechanically-ventilated patients.

Use of CBT in spontaneously breathing patients should serve as a basis for similar application during mechanical ventilation.

The Need for Bronchodilator Resuscitation

Patients often arrive at the emergency department with severe exacerbation of asthma or acute bronchospasm. Many of these patients have been taking their beta agonist and failed to respond to standard doses prior to presenting in the ED or clinic. A common response is to order another nebulizer treatment with standard dose of bronchodilator, and if the patient continues to not respond, to ordering treatments at a high frequency until the patient responds. This strategy requires several hours of delay in giving the patient relief, and hours of additional staff time treating the patient.[1]

James Fink is Fellow Respiratory Science, Nektar, Inc, San Carlos, CA. He was previously an employee of Aerogen, Inc., and involved in the development of the Aeroneb vibrating mesh technology and its use in critical care settings.

Role of CBT

Several alternative strategies for bronchodilator resuscitation have been advocated including high dose MDI with holding chamber, administration of undiluted bronchodilators and high dose continuous nebulization. As we speak of high dose bronchodilator administration, it is important to remember that bronchodilators relieve symptoms such as severe airway obstruction, with the goal to provide the patient relief of their respiratory distress, with the greatest improvement in airflow in the shortest period of time and a minimum of toxic side effects, often while waiting for systemic anti-inflammatory agents to affect the underlying pathology. In the absence of symptom relief, the more severe patients become exhausted and require ventilatory support. This also exacerbates the challenges of aerosol delivery in that standard jet nebulizers are less effective during mechanical ventilation. Best methods for providing both intermittent and continuous bronchodilator therapy (CBT) during mechanical ventilation have not been well defined.

Clues to effective CBT during mechanical ventilation come from the literature describing CBT in non-ventilated patients. A standard SVN treatment with 2.5 mg of albuterol takes 10-15 minutes to administer. When the patient fails to respond, end on end treatments may be ordered until the patient "opens up". With severe exacerbation, a patient may receive up to 4-6 treatments in an hour, equivalent to a nebulizer nominal dose of 10-15 mg of albuterol in an hour. To be fair, the literature is mixed on the benefits of continuous vs high frequency intermittent nebulizer therapy.[1] The one clear benefit with CBT, is the decreased requirement for personnel at the bedside during adminmistration. And in the case of mechanical ventilation, the reduction of disruptions in mechanical ventilation required to periodically remove and fill the SVN jet nebulizers.

CBT in Non-ventilated Patients

Candidates for CBT are patients who, despite frequent beta-agonist treatments, remain in extremis with bronchospasm, dyspnea, cough, chest tightness, and diminished breath sounds.

Papo et al[2] described a method of continuous nebulization in which a harvard pump is adjusted to inject an albuterol/saline mixture into a SVN. A blender and humidifier were incorporated to control oxygen concentration with higher than ambient humidity. Papo found that continuous nebulization with pediatric patients compared to standard intermittent treatments with SVN reduced the duration of hospital stay ($p<0.04$), duration of therapy, therapist time ($p<0.001$) and provided greater reduction in asthma score within one hour of therapy. Moler et al[3] described an SVN system using an infusion pump to continuously fill the nebulizer, with a valved O_2 mask and reservoir bag (figure 1).

Large volume nebulizers such as the Heart (Westmed) or Hope (Band B) nebulizers have become commercially available to deliver CBT. A 20 ml bottle of albuterol solution is mixed with 180 ml of .09% NaCl with dose roughly regulation by changes in the flow rate driving the nebulizer (10 lpm [a] 10 mg/hr and 15 lpm [a]15 mg/hr). There is great variability in flow rate between individual nebulizers of the same model, so dosing can vary a great deal.[4] During CBT patients are commonly placed in monitored beds with EKG and pulse oximetry. If treatment extends beyond 3 hours, serum K^+ should be monitored, with repetition q 4h. Linn et al[5] studied the effects of such dosage levels and found minimal toxicity in treatment of acute exacerbation of asthma. The patient must be observed for adverse drug responses, including worsening tachycardia, palpitations, and vomiting. In these situations, the attending physician must be contacted immediately.

A positive response is indicated by an increase in PEFR of at least 10% after the first hour of therapy. The goal is to achieve a PEFR of at least 50% of predicted. For small children, improved oxygenation (oxyen saturation by pulse oximeter [Spo_2] >92% on room air) with evidence of decreased work of breathing indicates a favorable response. Once the patient "opens up," intermittent bronchodilator therapy can be resumed on a prm basis.

> If you accept the premise that all of these methods of high dose administration of albuterol have similar clinical effectiveness and safety, the choice of method should be based on other criteria such as disruption of mechanical ventilation, infection risk and personnel time.

CBT During Mechanical Ventilation

Many patients undergoing mechanical ventilation receive aerosolized medications, with variable effects.[6] In cases in which bronchospasm does not resolve with standard intermittent bronchodilator therapy CBT has been initiated. To date, this has been most commonly relied on jet SVNs, with a port to allow infusion of broncodilator into the nebulizer from an IV type infusion pump. This allows refilling of the nebulizer without removing it from the ventilator circuit and interruption of PEEP or ventilation. Although in vitro models demonstrate up to 40% higher aerosol delivery in a dry ventilator circuit, the risks of increased airway irritability and bronchospasm associated with administering cold dry gas through an endotracheal tube has been well established. When performing CBT, do not turn off humidification. Heat moisture exchangers (HMEs) act as a barrier to aerosol, and should be removed from between the nebulizer and the patient airway.

Table 1: Factors affecting respiratory tract deposition during mechanical ventilation

Physicochemical properties of medication
Aerosol generating characteristics of delivery device
Delivery device position in circuit
Mechanical ventilator settings
Ventilator circuitry and endotracheal tube
Relative humidity of inspired air
Airway Anatomy

Use of SVN During Mechanical Ventilation

Aerosol administered by common jet SVNs to intubated patients receiving mechanical ventilation tends to be deposited mainly in the tubing of the ventilator circuit and expiratory limb or filter. Under normal conditions with heated humidification and standard jet nebulizers, pulmonary deposition ranges between 1.5% and 3.0%.(ref: Egan chapter) When nebulizer output, humidity level, tidal volume, flow, and I:E ratio are optimized, deposition can increase to as much as 15%. There are several disadvantages with SVN use during mechanical ventilation in that they add additional flow through the circuit.

The addition of gas flow into the ventilator circuit may change parameters of flow and delivered volumes requiring changes to ventilator parameters and alarm settings both during and after nebulization. The smaller the patient, the greater the impact of this additional flow into the ventilator circuit where 6 L/min of additional gas flow can more than double tidal volumes and inspiratory pressures, placing the patient at risk. Perhaps the greatest risk is the tendency for condensate and secretions to drain into the nebulizer reservoir, contaminating medication being delivered to the lungs. It is not uncommon for a nebulizer with 3 mL of drug to run for 30 minutes and be found to contain 4 mL of fluid. This additional fluid is contaminated condensate which is then aerosolized and delivered to the lungs of the patient.

Use of a VM Nebulizer During Mechanical Ventilation

The Aeorneb Pro and Solo (Aerogen) are vibrating mesh (VM) nebulizers with a small plate that contains 1,000 funnel shaped apertures or holes. This plate (or mesh) is domed and attached to a washer. The mesh is vibrated by a piezo ceramic element that is also attached to the washer, moving the plate up and down by about 1 micron at 128kHz (or $1/10^{th}$ the frequency of an ultrasonic nebulizer). Liquid medication is extruded or pumped through the narrow end of the apertures, about 3 micron in diameter, creating very small, consistent particles. These apertures are so narrow, that gas from the ventilator does not leak out during ventilation (even with heliox) and liquid placed in the reservoir does not leak through the holes unless the nebulizer is actuated. The allows the VM nebulizer to be refilled without removal from the ventilator circuit or interruption of ventilation. The VM does not add gas into the ventilator circuit, so no changes in ventilator parameters occur, even in neonates.

The Aeroneb Pro is a multi-patient, autoclavable VM nebulizer, designed to deliver aerosol for periods of 15 or 30 minutes. The

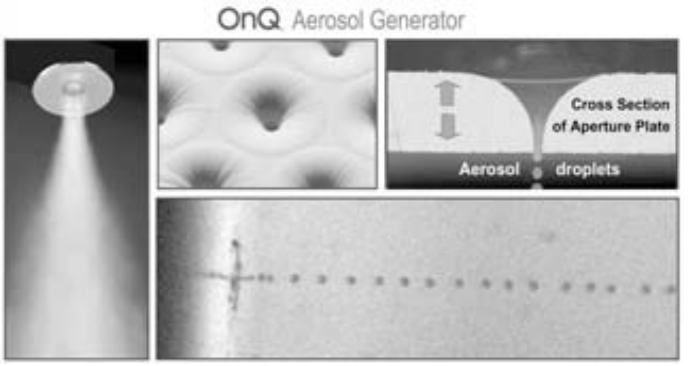


Figure 1: OnQ vibrating mesh technology. The Aerogen OnQ aerosol generator (left) with a microscopic view of tapered apertures (upper middle), and cross section of apertures (upper right). High speed microscopic photograph of aerosol generated from a single aperture (lower right).

Aeroneb Pro has been shown to deliver between 10-20% of nominal dose past the endotracheal tube during mechanical ventilation of both adults and infants without the addition of gas into the ventilator circuit. The low residual drug volume and small particle size are associated with higher efficiency. The Aeroneb Pro can be operated properly in the ventilator circuit for up to one week without requiring removal from the circuit for cleaning. The nebulizer reservoir can be opened without interrupting ventilation, even with heliox administration.

The Aeroneb Solo is a single patient use disposable nebulizer that can be operated continuously for CBE. The inlet port as an adapter that can be attached to a standard IV infusion set, and connected to an infusion or syringe pump to allow filling of the nebulizer over extended periods of time. Testing with the nebulizer has shown that it has similar performance and efficiency as the Pro.

Unlike both jet and ultrasonic SVNs, the medication reservoir of Aerobeb Pro and Solo nebulizers is superior to (above) the ventilator tubing, reducing the risk of contamination from circuit condensate to the medication in the reservoir.

Figure 2: Aeroneb Solo Nebulizer

Use of CBT

In order to use any nebulizer for CBT during mechanical ventilation it is important the maximum rate infusion of medication into the nebulizer does not exceed the mimimum output rate of the nebulizer. Overflow of the nebulizer with SVNs obstruct the ventilator circuit and patient airway while compromising ability of the nebulizer to function, reducing drug delivery. With the vibrating mesh nebulizer, overflowing the reservoir does not affect the ventilator circuit or nebulizer function, but wastes medication and can be messy.

Table 2 - Comparison the Aeroneb Pro (continuous) and three common jet nebulizers during adult mechanical ventilation. Particle size, fine particle fraction, residual volume and dose of albuterol sulfate delivered to the distal tip of an 8.0mm endotracheal tube are shown.

Neb	MMAD ± GSD	FPF (<5μm)	Residual Volume (mL)	Dose (μg) Deposit	% Dose Deposit
AN Pro	2.1 ± 2.2	83.2%*	0.4 mL*	315 μg*	13%*
Salter	3.1 ± 2.4	62%	1.7 mL	19 μg	0.8%
Misty Ne	2.5 ± 2.1	73%	1.1 mL	68 μg	2.7%
PB Drop	2.7 ± 2.4	67%	1.3 mL	52 μg	2.1%

Nebulizer manufacturers should provide minimum output rates for their products under standard operating conditions, however individual units, even of the same type of nebulizer may vary. Nebulizer output rate can be quantified by placing a known volume of medication into the nebulizer reservoir, and noting the time from turning on the nebulizer and the point that aerosol is no longer produced.

SVNs have residual drug volumes as high as 1.5 mL, so larger volumes should be used for testing. Since SVNs begin to stutter and output decreases near the end of dose, output rates should be determined gravimetrically. For SVNs, weigh the loaded nebulizer prior to aerosol generation, run for one minute, weigh again and determine the difference in weight. For water or albuterol sulfate, 1mg is equivalent to 1 mL. This will provide the mL/min.

With the Aeroneb Solo, place a known volume of liquid in the nebulizer (100 µl, 0.5 ml or 3.0 ml). Measure time from beginning to end of aerosol generation. Output rate does not vary with dose volume and it is easy to determine when aerosol generation is complete since there is no period of sputtering, and aerosol output simply stops. Determine output by dividing dose volume by time of operation.

Once the minimum output rate of the nebulizer is determined, the rate of flow into the nebulizer should be determined by the amount of bronchodilator you wish to nebulize each hour (eg, 10, 15 or 30 mg/hour). Keep in mind that pulmonary deposition efficiency will vary between types of nebulizer and differences in ventilator parameters. Consequently, dose rate should be titrated based on patient response. For beta- agonists, changes in heart rate or presence of tremor suggest that the rate is too high and should be lowered.

Techniques for assessing the response to a bronchodilator in intubated patients undergoing mechanical ventilation differ from those used in the care of spontaneously breathing patients because (1) expiration is passive during mechanical ventilation, (2) forced expiratory values (PEFR, FVC, FEV_1) cannot normally be obtained. Additional techniques can be used for mechanically ventilated patients because (1) a change in the differences between peak and plateau pressures (the most reliable indicator of a change in airway resistance during continuous mechanical ventilation) can be measured, (2) automatic positive end-expiratory pressure (auto-PEEP) levels which may decrease in response to bronchodilators, and (3) breath-to-breath variations make measurements more reliable when the patient is not actively breathing with the ventilator.

References

1 Fink J, Dhand R. Bronchodilator resuscitation in the Emergency Department, Part 2: Dosing. Respir Care 2000.45:5: 497-510.

2 Papo MC, Frank J, Thompson AE. A propsective, randomized study of continuous versus intermittent nebulized albuterol for severe status asthmaticus in children, Crit Care Med 1993;21:1478-86.

3 Moler FW, Johnson CE, Van Leanen C, Paomissano JM, Nasr SZ, Akingbola O. Continuous versus intermittent nebulized terbutaline:plasma levels and effects. Am J Respir Crit Care Med 1995;151:602-6.

4 Fink JB. Aerosol device selection: evidence to practice. Respir Care 2000;45(7): 874-885.

5 Lin RY, Smith AJ, Hergenroeder. High serum albuterool levels and tachycardia in adult asthmatics treated with high-dose continuously aerosolized albuterol. Chest 1993; 103:221-5

6 Fink JB ,and Dhand R. Aerosol therapy in mechanically ventilated patients: recent advances and techniques. Seminars in Respir and Crit Care Med 2000; 21 (3): 183-201.

7 Fink JB. Aerosols in mechanical ventilation: a revolution in the making.
Respir Care. 2004 Jun;49(6):609-10.

8 Duarte AG, Fink JB, Dhand R. Inhalation therapy during mechanical ventilation.
Respir Care Clin N Am. 2001 Jun;7(2):233-60, vi. Review.

Inhalation Techniques and the In-Check-Dial Device

Laszlo Sandor

The latest medical devices for inhalation therapy can have a marked effect on techniques that ensure proper usage. According to H. Chrystyn, in the paper "Is inhalation rate important for a dry powder inhaler?"[1] "The fraction of the emitted dose from an inhaler that has the potential to be deposited into the lungs is known as the fine particle dose (also the respirable dose). During inhalation all dry powder inhalers require a force to be created inside the device so that a fine particle dose is generated from the formulation in the metering chamber." As Chrystyn explains, "This force is formed by the inhalation rate used together with the resistance (and hence design) inside an inhaler." Studies demonstrate that the respirable dose is related to the clinical effect, but that it's dependent on the inhalation rate applied: "For those dry powder inhalers that demonstrate significant flow-dependent dosage emission, it is important that patients use the most desirable rate that has been reported."

According to Gustaffson, et al, "If patients are unable to use their inhaler, drug delivery may be unsatisfactory and the patients may fail to benefit from the prescribed medication. It is important to consider whether patients can use all dry powder inhalers equally well. The many marketed dry powder inhalers reflect differences in design decisions that could affect lung deposition. Differences in lung deposition patterns could have clinical effects. Studies may show similar clinical effectiveness with [different] inhalers, because most products are used at the plateau phase of the dose-response curve, although there may be differences in the adverse event profile… The individual balance of features will govern the overall preference for one inhaler over others… [Inhaler devices] should be evaluated in real-life studies."[2]

Inhaled drug distribution depends on particle size and flow rates, and improper rates can lead to decreased drug delivery. However, the various devices deliver different flow rates and variable resistances, and inhaled medications also have differing flow rates and resistances. Therefore, it's vital that clinicians have a way to gauge and adjust for proper inhalation.

According to Ben Francisco, writing in Advanced Managers of Respiratory Care, "There's compelling evidence that inhalation instructions by healthcare professionals haven't met the needs of people who take medications intended for deposition into the lungs."[3] Francisco's study points out that researchers have reported low levels of competency based on performance among patients using inhaled medications, and that performance points to a high rate of procedural errors when using inhaled medications: "Researches concluded [that] many individuals don't generate an air stream that's sufficient for the resistance imposed by specific inhalation devices and for the aerodynamic properties of drugs delivered." The problem is endemic with both adult and child users.[4]

The corrective, Francisco noted, is to evaluate and thus improve inhalation techniques: "Reassessment and retraining are required for achieving and maintaining optimal proficiency." Says Francisco, "Use of a handheld, low-range inspiratory flow measurement device for training has been shown to result in optimal airstream characteristics for most clients."

In-Check-Dial

One device used to test flow-rate effectiveness is the In-Check Dial (Alliance Tech Medical, Bakersfield, CA). Chrystyn notes, "The In-Check-Dial is a simple and easy to use meter that can be used to measure the inhalation rate of patients when they use each of the commonly prescribed inhalers. This meter can be used to identify the most suitable inhaler for each individual." According to Amirav et al,[4] "Even among experienced patients, many young children may not generate optimal PIFs through high-resistance DPIs. When DPI treatment is considered for young children, some devices may be successfully introduced at a younger age. It may thus be important to measure PIF in children who use a DPI or in whom DPI use is contemplated. This evaluation can be easily undertaken in the clinic with the In-Check Dial device."

Laszlo Sandor is medical staff writer for Goldstein & Associates, Inc.

A recent study used the In-Check-Dial Device to evaluate the adequacy of inhalation techniques. The study, by Karen-Lynn Fiato et al,[5] evaluated 234 asthma clinic patients with severe airflow obstruction. For purposes of the study, an AeroChamber with the whistle opening occluded was attached to the In-Check-Dial. A Diskus mouthpiece was attached to an AeroChamber and then attached to the In-Check. These modifications to the In-Check allowed measurements of flowrates, with patients using the correct positioning of the AeroChamber and Diskus.

According to the study, all subjects were instructed in a series of breathing exercises which were measured using the In-Check-Dial. The In-Check was adapted to fit the AeroChamber on the "no resistance" setting. Resistance for the Diskus was determined by the hole in its mouthpiece, and the In-Check was set to no flow resistance.

Patients participated in initial and follow-up assessments at one, three, six months and a year. On each visit, subjects were asked to demonstrate their inhaler techniques, reinstructed, and re-measured for proper technique.

Reinforcing Improvement

Seventy percent of the subjects had a peak inspiratory flow rate higher than recommended when demonstrating their technique before reinstruction, while 13% demonstrated too-high flow rates, and 24% had a too low flow rate using the Diskus. After the follow-up visit, 41% of the patients still had a higher than recommended flow rate using the holding chamber, and only 3% demonstrated a lower rate. An overall improvement of 26% was noted in using the holding chamber technique. Twenty-four percent of the subjects demonstrated a lower than recommended flow rate with the Diskus, but a 9% improvement was seen for those inhaling too hard on the Diskus at their first visit.

Fiato et al noted that a drop in retention techniques over time was due to lack of technique reinforcement, but added that problems of varying flow rates and differing resistances added to the problem in that "many of the inhaled medications had differing flow rates and resistances, and more medications are being developed each day that might add to the confusion for patients… In addition, many of our patients have been misinformed or poorly instructed by other providers on [correct techniques.]" The reinforcement of training was seen as vital to maintaining proper technique.

As the study notes, "The greater the period of time between reinforcements [of technique], the greater the chance that an incorrect technique will be performed… A longer period of time between reevaluation and reinstruction led to a decrease in retention techniques. The subject's demonstration of correct flow rates for use of the holding chamber decreased with prolonged lapses in reinforcement time."

The authors concluded that the In-Check is "a useful tool to help healthcare providers in assessing and educating clients on proper inspiratory flow rates for [various devices]. Frequent reeducation and reinforcement are needed… to increase retention and demonstration of proper inhalation techniques… We need to be vigilant about making sure our clients can use them correctly."

References

1 Chrystyn H. Is inhalation rate important for a dry powder inhaler? Using the In-Check Dial to identify these rates. Respir Med 2003 Feb;97(2):181-7.

2 Gustafsson P, Taylor A, Zanen P, Chrystyn H. Can patients use all dry powder inhalers equally well? Intl J Clin Pract Suppl 2005 Dec; (149):13-8.

3 Ben Francisco, PhD, PNP, AE-C. Raising the Bar: The Association of Asthma Educators calls for improving inhalation instructions. Advance for Managers of Respiratory Care (2007) March; 18-21.

4 Amirav I, Newhouse MT, Mansour Y. Measurement of peak inspiratory flow with in-check dial device to simulate low-resistance (Diskus) and high-resistance (Turbohaler) dry powder inhalers in children with asthma. Pediatr Pulmonol 2005 May;39(5):447-51.

5 Karen-Lynn Fiato, ACNP; Gary K. Iwamoto, MD; Michelle S. Harkins, MD; Joseph Morelos, RRT. Monitoring Flow Rates and Retention of Inhalation Techniques Using the In-Check-Dial Device in Adult Asthmatics. Journal of Asthma 2007: 44:209-212.

Gender and Respiratory Factors Associated With Dyspnea in Chronic Obstructive Pulmonary Disease

Juan P. de Torres, Ciro Casanova, Angela Montejo de Garcini, Armando Aguirre-Jaime and Bartolome R. Celli

Abstract

Rationale: We had shown that COPD women expressed more dyspnea than men for the same degree of airway obstruction.

Objectives: Evaluate gender differences in respiratory factors associated with dyspnea in COPD patients.

Methods: In a FEV_1% matched population of 100 men and women with COPD we measured: age, MMRC, FEV_1, FVC, TLC, IC/TLC, PaO_2, $PaCO_2$, D_{LCO}, P_{imax}, $P_{0.1}$, Ti/Ttot, BMI, ffmi, 6MWD and VAS scale before and after the test, the Charlson score and the SGRQ. We estimated the association between these parameters and MMRC scores. Multivariate analysis determined the independent strength of those associations.

Results: MMRC correlated with: BMI (men:-0.29, p = 0.04; women:-0.28, p = 0.05), ffmi (men:-0.39, p = 0.01), FEV_1% (men:-0.64, p < 0.001; women:-0.29, p = 0.04), FVC % (men:-0.45, p = 0.001; women:-0.33, p = 0.02), IC/TLC (men:-0.52, p < 0.001; women: -0.27, p = 0.05), PaO_2 (men:-0.59, p < 0.001), $PaCO_2$ (men:0.27, p = 0.05), D_{LCO} (men:-0.54, p < 0.001), $P_{0.1}/P_{imax}$ (men:0.46, p = 0.002; women:0.47, p = 0.005), dyspnea measured with the Visual Analog Scale before (men:0.37, p = 0.04; women:0.52, p = 0.004) and after 6MWD (men:0.52, p = 0.002; women:0.48, p = 0.004) and SGRQ total (men:0.50, p < 0.001; women:0.59, p < 0.001). Regression analysis showed that $P_{0.1}/P_{imax}$ in women ($r^2 = 0.30$) and BMI, DL_{CO}, PaO_2 and $P_{0.1}/P_{imax}$ in men ($r^2 = 0.81$) were the strongest predictors of MMRC scores.

Conclusion: In mild to severe COPD patients attending a pulmonary clinic, $P_{0.1}/P_{imax}$ was the unique predictor of MMRC scores only in women. Respiratory factors explain most of the variations of MMRC scores in men but not in women. Factors other than the respiratory ones should be included in the evaluation of dyspnea in women with COPD.

Authors de Torres, Casanova, de Garcini and Aguirre-Jaime are with the Respiratory Research Unit, Hospital Nuestra Sra de Candelaria, Tenerife, Spain. Celli is with the Pulmonary and Critical Care Division. Caritas-St. Elizabeth's Medical Center, Boston. The authors would like to acknowledge Jesús Villar MD for his invaluable contribution to the completion of this project. Reprinted from BioMed Central, Respiratory Research,

Background

The influence of gender on the expression of chronic obstructive pulmonary disease (COPD) has received limited attention.[1-3]

Dyspnea has been defined as the subjective experience of breathing discomfort consisting in qualitatively distinct sensations that vary in intensity and is derived from interactions among multiple physiological, psychological, social and environmental factors.[4] It is the most important symptom of COPD patients and the main determinant of their Quality of Life (QoL).[5]

In the United States, in the year 2000, more women died from COPD than men.[6] We have recently shown in a population of patients with COPD attending an outpatient clinic, that for the same degree of airway obstruction, women expressed more dyspnea than men at earlier stages of the disease.[7]

We therefore hypothesised that systematically studying and comparing different respiratory factors known to contribute to dyspnea in a population of men and women with COPD could help us identify those factors associated with the symptom. Knowledge of these factors, could aid us in the development of tailored strategies aimed at decreasing dyspnea in the female COPD population where this important symptom presents at younger age and earlier stages of the disease. To pursue our goal we called back our patients within the next year of the previous study.[7] At this new appointment we repeated the same original evaluation and also measured other important respiratory factors like the central drive ($P_{0.1}$), the inspiratory and expiratory maximal pressures (P_{imax}, P_{emax}), the inspiratory capacity to total lung capacity ratio (IC/TLC) and the breathing pattern (respiratory rate and Ti/Ttot).

Table 1: Clinical and physiologic characteristics of men and women participating in the study.

Clinical & Physiological Characteristics	Men* n = 50	Women* n = 50	p value
Age (years old)	67 ± 8	56 ± 11	<0.001
Pack years history	69 ± 27	48 ± 28	<0.001
MMRC (points)			
0 (%)	35 (70)	11 (22)	<0.001
1–4 (%)	15 (30)	35 (78)	<0.001
BMI (kg/m^2)	27 ± 4	27 ± 6	ns
BMI≤21(%)	5 (10%)	8 (16%)	ns
ffmi (kg/m^2)	18 ± 3	15 ± 2	<0.001
Charlson Score (points)	2 (2–3)	2(1–4)	ns
FEV_1 % of predicted	63 ± 17	63 ± 17	ns
FVC % of predicted	91 ± 18	92 ± 21	ns
FEV_1/FVC % of predicted	60 ± 12	60 ± 13	ns
FRC % of predicted	134 ± 38	134 ± 27	ns
TLC % of predicted	113 ± 21	114 ± 21	ns
IC/TLC (%)	36 ± 8	36 ± 7	ns
IC/TLC<0.25 (%)	6 (12)	4 (7)	ns
Respiratory rate	18 ± 4	19 ± 4	ns
Ti/Ttot	0,40 ± 0,06	0.41 ± 0.06	ns
PaO_2 (mmHg)	76 ± 12	76 ± 9	ns
$PaCO_2$ (mmHg)	41 ± 4	40 ± 4	ns
DLCO (%)	87 ± 30	72 ± 20	0.02
P_{imax} % of predicted	67 ± 22	50 ± 20	<0.001
$P_{0.1}$	0.27 ± 0.11	0.34 ± 0.19	<0.001
$P_{0.1}$ % of predicted	117 ± 12	155 ± 35	<0.001
$P_{0.1}/P_{imax}$	0.04 ± 0.02	0.06 ± 0.05	<0.001
6MWD (meters)	522 ± 90	461 ± 85	0.001
IC/TLC post 6MWD(Lt)	0.31 ± 0.09	0.31 ± 0.08	ns
VAS pre 6MWD (cm)	1 ± 1	3 ± 2	0.05
VAS post 6MWD (cm)	3 ± 2	5 ± 2	0.005

mean ± SD or median(25^{th}–75^{th} percentiles) depending on scale measurement and sample distribution; ns = statistically non significant.

Methods

This FEV_1% case series study, recruited men and post-menopausal women with COPD attending an outpatient clinic at Hospital Universitario Ntra Sra de Candelaria; a tertiary public university hospital in Spain from January 2000 to December 2005. Patients with all degree of airflow severity were included if they had smoked 20 pack years and had a post-bronchodilator FEV_1/FVC of <0.7 after 400 micrograms of inhaled albuterol. Patients were excluded if they had a history of asthma, had a history of bronchiectasis, tuberculosis or other confounding diseases. We decided to include only those patients with airway obstruction, therefore patients with GOLD stage 0 were not included. The patients were clinically stable (no exacerbation for at least 2 months) at the time of the evaluation and were part of the BODE international multicenter study.[8] The Ethical Committee of the Hospital approved the study and all patients signed the informed consent.

We evaluated the following parameters in the study sample: age, BMI (weight in kilograms divided by height in meters^2), ffmi was determined using the bioelectrical impedance Bodystat (Isle of Man, British Isles) and dividing the free fat mass weight in kilograms by height in meters^2, pulmonary function tests (FEV_1, FVC, TLC, IC/TLC, FRC, D_{LCO}), resting arterial blood gases (PaO_2, $PaCO_2$), dyspnea by the Modified Medical Research Council scale (MMRC)[9] and by the Visual Analog Scale (VAS)[10] immediately before and after the 6-minute walk distance (6MWD test),[11] maximal inspiratory pressures (P_{imax}), breathing pattern (respiratory rate, Ti/Ttot, mouth occlusion pressure ($P_{0.1}$), and presence of comorbidities by the Charlson scale.[12]

Pulmonary Function Tests: Postbronchodilator FEV_1 % of predicted, FVC % of predicted and FEV_1/FVC, IC, TLC, FRC, D_{LCO} values were determined using the European Community for Steel and Coal for Spain as reference values[13] and using a Jaegger 920 MasterLab® Body Box. Inspiratory Capacity was measured immediately before (the best of 3 manoeuvres) and after the 6MWD as previously described.[14] From the lung volume measurements we also determined their IC/TLC ratio.

P_{imax} and breathing pattern measurements

P_{imax} was measured in sitting position after 15 minutes of rest from FRC using the technique and predictive values of Black and Hyatt.[15] Breathing pattern was measured also in sitting position after 15 minutes of rest and having carefully explained the manoeuvre to obtain and an appropriate measurement. We measured respiratory rate, inspiratory time (Ti), expiratory time (Te) and total breathing time (Ttot).

Respiratory drive measurements: The measurement of mouth occlusion pressure ($P_{0.1}$) was performed following the recommendations of Burki et al.[16] To better reflect the central respiratory output of our patients, we calculated the $P_{0.1}/P_{imax}$ index as we have previously reported.[17]

Data processing: We describe each variable using mean ± SD or median (25^{th} percentile – 75^{th} percentile) depending on their distribution. A multivariate regression analysis with MMRC

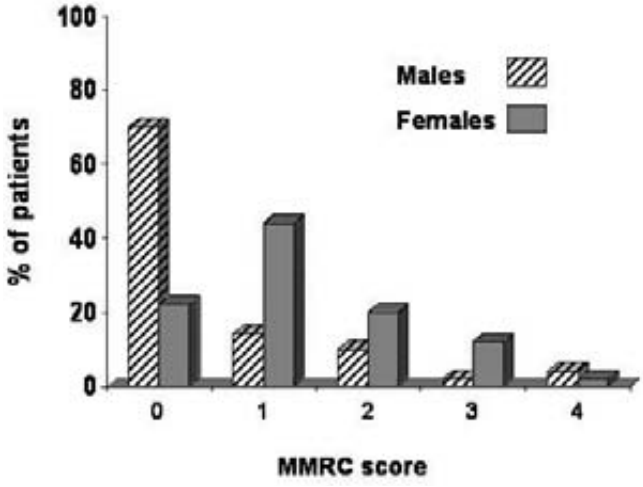


Figure 1
Distribution of MMRC score in COPD men and women. p < 0.05 for the comparison between men and women MRC scores.

score as the dependent variable and those parameters that were shown to be different between men and female as predictors of its changes was performed. We tested correlations between the MMRC score and the study parameters by non-parametric Spearman's rank or tau-b Kendall's linear correlations coefficients because of the ordinal nature of MMRC scales. We then performed a multiple linear regression analysis with MMRC score as the dependent variable and those factors and parameters that shown statistical significant correlation with it (Men: BMI, FEV_1%, IC/TLC, DLCO, PaO2 and $P_{0.1}/P_{imax}$; Women: BMI, FEV_1%, IC/TLC and $P_{0.1}/P_{imax}$). A p value = 0.05 was considered statistical significant. The analysis was performed with the statistical package SPSS® version 12, Chicago, IL, USA.

We describe the matching method as follows: we took our matched patients from an initial sample of 116 males and 59 females with COPD; we were able to matched every female patient with a male with FEV_1 % of predicted ± 2%; when more than one male matched, we randomly chosen the patient to be included in the final sample, being blind to the rest of the evaluated parameters.

Results

We were able to match 56 men and 56 women. Four men and six women did not appropriately complete the tests or dropped out of the study. The patients were white of European descent. When enrolled 48% of them were still smoking. Using the GOLD staging system,[18] there were the same number of men and women at each stage, distributed as follows: stage I: 25%, stage II: 52%, stage III: 17% and stage IV: 3%.

Table 1 shows the comparison of clinical and physiological characteristics of the population. Compared with men, women were younger, smoked less, expressed more dyspnea as shown in figure 1, had the same BMI but lower ffmi, a lower diffusion capacity, a higher respiratory center output and walked less in the 6MWD. As expected for an FEV_1% matched population no differences were found in the other respiratory parameters.

The multivariate regression analysis with MMRC score as the dependent variable confirmed that only gender (B coefficient: 0.4; 95% CI: 0.1 to 0.8; p = 0.04), age (0.02; 0.007 to 0.032; p = 0.004), p0.1 (1.79; 0.19 to 3.38; p = 0.03) and DLCO (-0.01; -0.02 to -0.007) explained its variations.

Table 2 shows the correlation coefficients between MMRC scores and the studied parameters that reached statistical signification at 0.05 levels. Correlation was found in men with: BMI, FEV_1%, IC/TLC, DLCO, $PaCO_2$ and PaO_2, $P_{0.1}/P_{imax}$, VAS before and after the 6MWD and QoL and in women: BMI, FEV_1%, IC/TLC,, $P_{0.1}/P_{imax}$, VAS before and after the 6MWD and QoL. IC/TLC after the 6MWD correlated with dyspnea after the test in men (-0.36, p = 0.04) and women (-0.40, p = 0.03). No statistically significant correlation was found between MMRC and age or pack year history for women.

A multiple regression analysis with MMRC as dependent variable and all factors that significantly correlated with it that represent each domain are shown in Table 3. The $P_{0.1}/P_{imax}$ in women and BMI, DLCO, PaO_2 and $P_{0.1}/P_{imax}$ in men had the strongest independent associations with MMRC scores.

Discussion

To our knowledge this is the first study exclusively designed to study differences in respiratory factors associated to dyspnea in a population sample of men and women with COPD and equivalent degree of airway obstruction. The most important

Table 2: Correlation coefficients of factors that showed significant correlations with the functional dyspnea score as determined with the Modified Medical Research Council scale.

Clinical and Physiological Parameter	Correlation coefficient*	
	Men	Women
BMI	-0.29	-0.28
ffmi	-0.39	ns
FEV_1 %	-0.64	-0.45
FVC %	-0.45	-0.33
IC/TLC	-0.52	-0.27
DLCO	-0.54	ns
PaO_2	-0.59	ns
$PaCO_2$	0.27	ns
$P_{0.1}/P_{imax}$	0.47	0.46
VAS pre 6MWD	0.37	0.52
VAS post 6MWD	0.52	0.48

Estimated by Spearman's rank or tau-b Kendall linear correlation coefficients; ns = stastistically non significant

Table 3: Multiple linear regression with functional MMRC score as dependent variable and those parameters with significant correlation with it. Men included: BMI, FEV_1%, IC/TLC, DLCO, PaO2 and $P_{0.1}/P_{imax}$; Women included: BMI, FEV_1%, IC/TLC and $P_{0.1}/P_{imax}$.

	Parameter	Regression Coefficient	95% CI	p-Value
Men $r^2 = 0.81$	**BMI**	-0.70	-0.23 to -0.09	0.001
	DLCO	0.32	0.001 to 0.02	0.037
	PaO_2	-0.78	-0.08 to -0.05	<0.001
	$P_{0.1}/P_{imax}$	0.20	0.16 to 21.6	0.047
Women $r^2 = 0.30$	**$P_{0.1}/P_{imax}$**	0.57	4.9 to 17.1	0.001

findings are: 1. $P_{0.1}/P_{imax}$ correlate with MMRC scores in both genders, but was the unique predictor of its scores only in women. 2. Respiratory factors explain most of the variations in MMRC scores in males but not in women with COPD.

Dyspnea is one of the leading symptoms and sometimes the only one affecting patients suffering from COPD. Functional dyspnea has been shown to be a strong predictor of survival,[8,19] and an important treatable symptom of the disease.[20] The development of dyspnea in patients with COPD is multifactorial and has been shown to be related to the degree of airway obstruction, pulmonary gas exchange abnormalities, nutritional status, inspiratory muscle strength, lung hyperinflation, respiratory central output, psychological as well as socio-cultural factors.[4]

We[7] and others[21] have reported that compared with men, women with COPD report more functional dyspnea for the same degree of airway obstruction. In our initial study we observed that dyspnea appears at earlier stages of the disease in women than in men. In an attempt to find explanations for that observation, we decide to explore the possible association of several of the main respiratory factors thought to be responsible for dyspnea in patients with COPD. We chose patients with mild to severe COPD because this is the group where dyspnea appears to develop earlier in women.[7]

Marin et al have previously determined that central respiratory output is an important factor in the genesis of the dyspnea sensation in patients with severe COPD.[22] Interestingly, in the present study we found that compared with men, women with similar FEV_1%, FVC%, TLC%, PaO_2, $PaCO_2$ and IC/TLC ratio have a higher central respiratory drive. In the multivariate analysis the $P_{0.1}/P_{imax}$ was the only independent respiratory factor associated with MMRC scores in women. This is even more important considering that all of our patients were postmenopausal, normoxyemic, normocapnic, well nourished and with a good exercise capacity at the early stages of the disease. Knowing the important stimulant effect that progesterone has on the respiratory center[23] the post menopausal state makes our findings in these patients even more important as lower levels of progesterone tend to decrease the output of the respiratory drive. The exact reason for this association remains unexplored. However, post-menopausal women may manifest unique changes in their physiological responses compared with pre-menopausal women. Indeed, post-menopausal women have less reactive pulmonary vasculature and therefore may develop dyspnea at lower levels of physiological stress compared with pre-menopausal women.[24] New studies addressing these and other mechanisms should provide important useful information.

In our study we also found that the degree of airway obstruction measured by the FEV_1 and FVC significantly correlated with MMRC score as previously reported by Bestall et al.[25] However, the association between the degree of airway obstruction and degree dyspnea was not strong enough to be retained in the regression analysis models of both men and women. This could be partially explained by the fact that our COPD group is composed mainly of mild to moderate patients, and probably in these stages airway obstruction does not play an important role in the development of dyspnea.

Lung hyperinflation is one of the most important factors related to the development of dyspnea in patients with COPD. It is associated with exertional dyspnea[26] and has also been shown to be an important independent predictor of survival.[27] We found that lung hyperinflation measured by the IC/TLC ratio was associated with functional dyspnea to a similar degree in both genders. We also confirmed in our patients that the degree of air trapped on exertion correlates with the degree dyspnea developed, implying that lung hyperinflation plays an important limiting factor in their activities of daily living.

The importance of arterial levels of O_2 and CO_2 in the development of dyspnea in COPD patients is well known.[4] Not surprisingly, their levels as well as the diffusion capacity correlated well with MMRC scores in the male COPD population. Indeed, O'Donnell et al[28] previously reported significant correlation between D_{LCO} and dyspnea rating in a population of severely dyspneic COPD patients, even though that the exact physiopathological mechanism is not well described. Interestingly, none of these parameters correlated with MMRC scores in the female patients, implying that probably this is not the most important reason why women with COPD have dyspnea.

Dyspnea has been also associated with the degree of malnutrition specially affecting the respiratory muscles.[29] We confirmed this in our COPD population where we observed an inverse relationship between BMI and MMRC (r = -0.26) similar to that described by Sahebjami et al.[29] This association was not strong enough to remain in the regression model for women, probably implying that malnutrition is not as important in women at these stages of the disease, even considering that they have a lower exercise capacity and Pimax than men with COPD.

We also observed that MMRC and VAS before 6MWD had a strong correlation confirming the face validity of our data and reproducing recent data from Oga et al in a sample of 143 men with COPD.[30] Furthermore, the VAS after 6MWD also correlated with MMRC, implying that the degree of dypnea developed after an exercise test is similar to the one perceived in their activities

of daily living as measured by the MMRC, a finding that is similar to that reported by Gallego et al.[31]

Very important information is obtained when we analyse the respiratory factors retained in the multivariate regression models for MMRC scores in men and women. The various respiratory factors associated with dyspnea such as nutritional status, carbon monoxide diffusion capacity, level of oxygenation and central respiratory output are responsible for 81% of the variation of MMRC scores in men with COPD. In contrast, we found that the single best predictor of MMRC scores in women, is the central respiratory output but only explaining 30% of its variation. This important finding indicates the need to evaluate novel factors to explain the genesis of dyspnea in women with mild to moderate COPD. Perhaps non respiratory factors such as anxiety, depression or coping mechanisms may play an important role in the perception of dyspnea in women. We support our hypothesis considering that anxiety and depression are highly prevalent in women with COPD and has been shown to be tightly associated with their degree of dyspnea[32] and knowing that men and women with COPD have different coping mechanisms.[33] Our findings also support the findings of Lapperre et al[34] who have suggested that COPD is a heterogeneous disease in terms of its clinical and physiological presentation.

Our study has several limitations. First, the findings here presented should be restricted to a population with similar characteristics of ours, namely men and women with mild to moderate COPD attending an outpatient clinic. It would be interesting to know if these findings are reproducible in populations of severe to very severe COPD patients. We speculate that probably in this group, lung hyperinflation may play a more important role. Second, we did not evaluate anxiety or depression as possible factors associated with dyspnea, but the goal of the study was to only explore the relationship of respiratory factors and dyspnea.

In conclusion, the central respiratory output is associated with functional dyspnea in both men and women with mild to severe COPD who attend an outpatient clinic. The central output was the single best predictor of MMRC scores only in women. Respiratory factors explained most of the variations of MMRC scores in men but not in women. We propose that other factors should be systematically explored in the evaluation of causes of dyspnea in women with COPD. Further studies in women of different age and severity of airflow obstruction are needed to confirm the importance of our findings.

References

1 Xu X, Li B, Wang L: Gender difference in smoking effects on adult pulmonary function. Eur Respir J 1994, 7:477-483.

2 Leidy NK, Traver G: Psychophysiologic factors contributing to functional performance in people with COPD: are there gender differences? Research in Nursing and Health 1995, 18:535-546.

3 Becklane MR, Kauffmann F: Gender differences in airway behaviour over the human life span. Thorax 1999, 54:1119-1138.

4 ATS official statement. Dyspnea. Mechanisms, Assessment, and Management: A Consensus Statement. Am J Respir Crit Care Med 1999, 159:321-340.

5 Gonzalez E, Herrejon A, Inchaurraga I, Blanquer R: Determinants of health-related quality of life in patients with pulmonary emphysema. Respir Med 2005, 99:638-644.

6 Mannino DM, Homa DM, Akinbami LJ, Ford ES, Redd SC: Chronic Pulmonary Disease Surveillance- United States, 1971–2000. MMWR 2002, 51:SS6.

7 de Torres JP, Casanova C, Hernandez C, Abreu J, Aguirre-Jaime A, Celli BR: Gender and COPD in patients attending a pulmonary clinic. Chest 2005, 128:2012-2016.

8 Celli BR, Cote CG, Marin JM, Casanova C, Montes de Oca M, Mendez RA, Pinto-Plata V, Cabral HJ: The body mass index, airflow obstruction, dyspnea and exercise capacity index in chronic obstructive pulmonary disease. N Engl J Med 2004, 350:1005-1012.

9 Brooks SM: Surveillance for respiratory hazards. ATS News 1982, 8:12-16.

10 Gift AG: Validation of a vertical visual analogue scale as a measure of clinical dyspnea. Rehabil Nurs 1989, 14:323-325.

11 ATS Statement: Guidelines for the Six-Minute Walk Test. Am J Respir Crit Care Med 2002, 166:111-117.

12 Charlson M, Szatrowski TP, Peterson J, Gold G: Validation of a combined comorbility index. J Clin Epidemiol 1994, 47:1245-1251.

13 Quanjer PH: Standardized lung function testing. Report of the Working Party for the European Community for Steel and Coal. Bull Eur Physiopath Respir 1983, 19(supp 5):22-27.

14 Marin JM, Carrizo SJ, Gascon M, Sanchez A, Gallego B, Celli BR: Inspiratory capacity, dynamic hyperinflation, breathlessness, and exercise performance during the 6-minute-walk test in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 2001, 163:1395-1399.

15 Black LF, Hyatt RE: Maximal respiratory pressures: normal values and relationship to age and sex. Am Rev Respir Dis 1969, 9:696-702.

16 Burki NK, Mitchell LK, Chaudhary BA, Zechman FW: Measurement of mouth occlusion pressure as an index of respiratory centre output in man. Clin Sci Mol Med 1977, 53:117-123.

17 de Torres JP, Talamo C, Aguirre-Jaime A, Rassulo J, Celli B: Electromyographic validation of the pressure-time index: a noninvasive assessment of inspiratory muscle load. Respir Med 2003, 97:1006-1013.

18 Pauwels RA, Buist AS, Calverley PM, jenkins CR, Hurd SS, GOLD Scientific Committee: Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. NHLBI/WHO Global Initiative for Chronic Obstructive Lung Disease (GOLD) Workshop summary. Am J Respir Crit Care Med 2001, 163:1256-1276.

19 Nishimura K, Izumi T, Tsukino M, Oga T: Dyspnea is a better predictor of 5-year survival than airway obstruction in patients with COPD. Chest 2002, 121:1434-1440.

20 Calverley PM, Walker P: Chronic obstructive pulmonary disease. Lancet 2003, 27;362:1053-1061.

21 PAARC. Group Coopératif: Pollution atmosphérique et affections respiratoires chroniques ou á répétition. Bull Eur Physiopathol Respir 1982, 18:87-99.

22 Marin JM, Montes de Oca M, Rassulo J, Celli BR: Ventilatory drive at rest and perception of exertional dyspnea in severe COPD. Chest 1999, 115:1293-1300.

23 Kimura H, Tatsumi K, Kunitomo F, Okita S, Tojima H, Kouchiyama S, Masuyama S, Shinozaki T, Honda Y, Kuriyama T: Progesterone therapy for sleep apnea syndrome evaluated by occlusion pressure responses to exogenous loading. Am Rev Respir Dis 1989, 139:1198-1206.

24 Parker TA, Afshar S, Kinsella JP, Grover TR, Gebb S, Geraci

M, Shaul PW, Cryer CM, Abman SH: Effects of chronic estrogen-receptor blockade on ovine perinatal pulmonary circulation. Am J Physiol Heart Circ Physiol 2001, 281:H1005-14.
25 Bestall JC, Paul EA, Garrod R, Garnham R, Jones PW, Wedzicha JA: Usefulness of the Medical Research Council (MRC) dyspnoea scale as a measure of disability in patients with chronic obstructive pulmonary disease. Thorax 1999, 54:581-586.
26 O'Donnell DE: Ventilatory limitations in chronic obstructive pulmonary disease. Med Sci Sports Exerc 2001, 33:S647-55.
27 Casanova C, Cote C, de Torres JP, Aguirre-jaime A, Marin JM, Pinto-Plata V, Celli BR: The Inspiratory to Total Lung Capacity Ratio Predicts Mortality in Patients with COPD. Am J Respir Crit Care Med 2004, 171:591-597.
28 O'Donnell DE, Webb KA: Breathless in patients with severe chronic airflow limitation. Physiologic correlations. Chest 1992, 102:824-831.
29 Sahebjami H, Sathianpitayakul E: Influence of Body Weight on the Severity of Dyspnea in Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med 2000, 161:886-890.
30 Oga T, Nishimura K, Tsukino M, Hajiro T, Mishima M: Dypnea with activities of daily living versus peak dypsnea during exercise in male patients with COPD. Respir Med 2006, 100:965-71.
31 Gallego MC, Samaniego J, Alonso J, Sanchez A, Carrizo S, Marin JM: Dyspnea in COPD: relation to the MRC scale with dyspnea induced by walking and cardiopulmonary stress testing. Arch Bronconeumol 2002, 38:112-116.
32 Di Marco F, Verga M, Reggente M, Maria Casanova F, Santus P, Blasi F, Allegra L, Centanni S: Anxiety and depression in COPD patients: The roles of gender and disease severity. Respir Med 2006, 100:1767-74.
33 Ninot G, Fortes M, Poulain M, Brun A, Desplan J, Prefaut C, Varray A: Gender difference in coping strategies among patients enrolled in an inpatient rehabilitation program. Heart Lung 2006, 35:130-136.
34 Lapperre TS, Snoeck-Stroband JB, Gosman MM, Stolk J, Sont JK, Jansen DF, Kerstjens HA, Postma DS, Sterk PJ, Groningen and Leiden Universities Corticosteroids in Obstructive Lung Disease Study Group: Dissociation of lung function and airway inflammation in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 2004, 170:499-504.

Clinical Presentation and Predictors of Outcome in Patients With Severe Acute Exacerbation of Chronic Obstructive Pulmonary Disease Requiring Admission to Intensive Care Unit

Alladi Mohan, Raya Premanand, Lebaka Narayana Reddy, Mangu H Rao, Surendra K Sharma, Ranjit Kamity and Srinivas Bollineni

Introduction

Background: Severe acute exacerbation of chronic obstructive pulmonary disease (AE-COPD) is a common reason for emergency room (ER) visit about which little has been documented from India.

Methods: Prospective study of the clinical presentation and predictors of outcome in 116 patients presenting with severe AE-COPD requiring admission to the medical intensive care unit between January 2000 and December 2004.

Results: Their mean age was 62.1 ± 9.8 years. There were 102 males. Mean duration of COPD was 7.2 ± 5.8 years. All males were smokers (22.3 ± 11.2 pack years); 35.2% smoked cigarettes and 64.8% smoked bidis. All women were exposed to domestic fuel. Associated co-morbid illnesses were present in 81 patients (69.8%); 53(45.7%) had one co-morbid illness and the remaining 28 (54.3%) had two or more co-morbid illnesses. Evidence of past pulmonary tuberculosis (PTB) was present in 28.4% patients; 5 patients who also had type II diabetes mellitus had active PTB. Arterial blood gas analysis revealed respiratory failure in 40 (33.8%) patients (type I 17.5% and type II 82.5%). Invasive mechanical ventilation was required in 18 patients. Sixteen (13.7%) patients died. Stepwise multivariate logistic regression analysis revealed need for invasive ventilation (OR 45.809, 95%CI 607.46 to 3.009;$p < 0.001$); presence of co-morbid illness (OR 0.126, 95%CI 0.428 to 0.037;$p < 0.01$) and hypercapnia (OR 0.114, 95%CI 1.324 to 0.010;$p < 0.05$) were predictors of death.

Conclusion: Co-morbid conditions and metabolic abnormalities render the diagnosis of AE-COPD difficult and also contribute to mortality. High prevalence of past PTB and active PTB in patients with AE-COPD suggests an intriguing relationship between smoking, PTB and COPD which merits further study.

Authors Mohan and Bollineni are with the Division of Pulmonary and Critical Care Medicine, Department of Medicine; Premanand, Reddy, and Kamity are with the Department of Tuberculosis and Respiratory Diseases; Rao is with the Department of Anesthesiology, Sri Venkateswara Institute of Medical Sciences, Tirupati; and Sharma is with the Division of Pulmonary and Critical Care Medicine, Department of Medicine, All India Institute of Medical Sciences, New Delhi, India.

Background

Chronic obstructive pulmonary disease (COPD), a common, costly and preventable disease and is the fourth leading cause of death globally.[1,2] Internationally there is a substantial variation in death rate due to COPD possibly reflecting smoking behaviour, type and processing of tobacco, pollution, climate, and genetic factors. Given the fact that there is an increasing tendency to abuse tobacco,[3-6] prevalence of COPD is expected to increase in the years to come. Acute exacerbation of COPD (AE-COPD) is a common cause of emergency room (ER) visits and is a major cause of morbidity and mortality. Following an acute exacerbation, majority of the patients experience a temporary or permanent decrease in the quality of life.[7] Moreover, more than half the patients discharged with AE-COPD often require re-admission in the subsequent six months.[7] Thus, the economic and social burden of AE-COPD are extremely high.[1] The great variability in the course of AE-COPD even in patients with similar degree of pulmonary impairment renders the prediction of the outcome in a given patient very difficult. Most studies have tried to correlate impairment in both respiratory and non-respiratory physiology with the course and progression of the AE-COPD with inconclusive results.

Though AE-COPD is a common reason for ER visits, little has been documented about this problem from India. Furthermore, even less data are available from India regarding the prevalence, precipitating factors and predictors of prognosis in patients with AE-COPD. Even from the developed world, while there are many published studies regarding the prognostic factors among patients with AE-COPD who are ambulatory, few studies have examined the prognostic factors in patients with severe AE-COPD who visit the ER and little is known regarding the long-term prognosis of patients with AE-COPD.[8] Keeping these factors in mind, the present study was designed to prospectively

Table 1: Demographic characteristics and co-morbid conditions in 116 patients with acute exacerbation of chronic obstructive pulmonary disease admitted to the medical intensive care unit

Age (years) (mean ± SD)	62.1 ± 9.8
Gender	
Male	102
Female	14
Smoking (all males)	22.3 ± 11.2 pack years
Duration of symptoms (years) (mean ± SD)	7.6 ± 5.2
*COPD, GOLD stage**	
Moderate [No. (%)]	25 (21.6)
Severe [No. (%)]	55 (47.4)
Very severe [No. (%)]	36 (31.0)
Co-morbid conditions	
Hypertension [No. (%)]	40 (34.5)
Alcoholism [No. (%)]	38 (32.8)
Type II diabetes mellitus [No. (%)]	36 (31.0) †
Past pulmonary tuberculosis [No. (%)]	33 (28.4) ‡
Coronary artery disease [No. (%)]	12 (10.3)
Chronic renal failure [No. (%)]	10 (08.6)
Number of co-morbid illnesses	
0 [No. (%)]	35 (30.2)
1 [No. (%)]	53 (45.7)
2 [No. (%)]	18 (15.5)
3 [No. (%)]	07 (06.0)
4 [No. (%)]	03 (02.6)

GOLD = Global Initiative for Chronic Obstructive Lung Disease (reference 1)
COPD = chronic obstructive pulmonary disease
* In all patients post-bronchodilator forced expiratory volume in one second (FEV_1)/forced vital capacity (FVC) was ≤ 0.7. Moderately severe COPD, FEV_1 = 50 – 80% predicted; severe COPD, FEV_1 = 30 – 50% predicted; very severe COPD = <30% predicted (reference 1)
† 3 patients had diabetic ketoacidosis and 5 patients had active pulmonary tuberculosis
‡ Clinical and radiographic evidence of past tuberculosis was present
More than one co-morbid conditions were present in several patients

study the clinical presentation and predictors of outcome in patients with AE-COPD requiring admission to the intensive care unit (ICU).

Methods

During the period January 2000 to December 2004, 914 patients were diagnosed to have COPD and were treated and followed-up from the Medicine Out-patient Department and Chest Clinic of our tertiary care referral centre. During the study period, 314 of them presented to our ER with AE-COPD. Of these 314 patients, after initial stabilisation and management in the ER, 116 were admitted to the medical ICU; 18 were discharged from the ER; and the remaining 180 were admitted to the acute medical care unit and the medical wards of the hospital. The predictors for mortality were studied in the 116 patients who were admitted to the medical ICU. Patients in whom the primary cause of ER visit was bronchiectasis, interstitial lung disease, acute severe bronchial asthma, pulmonary edema or pulmonary embolism were excluded from the study. The study was approved by the institutional ethics committee.

In all of them, pulmonary function testing was done using Morgan Transfer Test Benchmark PFT System (Morgan Scientific, Inc. Haverhill, MA, USA) at the time of the initial out-patient visit and COPD was diagnosed based on the criteria laid down by the American Thoracic Society (ATS)[8] and post-bronchodilator forced expiratory volume in the first second to forced vital capacity (FEV_1/FVC) ratio less than or equal to 0.7 was documented in all of them confirming the presence of airflow limitation that is not fully reversible. They were all receiving a combination of various bronchodilators and anticholinergic agents.

AE-COPD was diagnosed if all of the following criteria were present at the time of ER visit: (i) recent rapid worsening of dyspnoea; (ii) increase in sputum purulence; and (iii) increase in sputum volume. Patients were eligible for only a single enrollment in this study. Hospital admissions during the study period subsequent to the index admission were not considered in the analysis.

In all of them, a detailed history was taken and a thorough physical examination was done. These details were recorded in a predesigned proforma. From the smoking history, number of "pack years" was computed in cigarette smokers from the average number of cigarettes smoked per day, one pack year being smoking of 20 cigarettes per day for one year. Since the net weight of tobacco in a bidi (150 to 240 mg) is about one-fourth that in a cigarette,[9,10] in bidi smokers, "cigarette equivalent pack years" were computed. This was arrived at by dividing the "pack years" calculated on the basis of smoking bidis by four.[9,10] History of exposure to domestic fuel was recorded in female patients who were non-smokers.

At admission, in all the patients full haemogram, serum biochemistry; urine analysis were performed. Sputum and blood culture examination were performed to identify the etiological cause. Other diagnostic investigations related to the co-morbid illnesses and for monitoring the treatment were performed where they were required. Depending upon the clinical condition of the patient, bed side portable or postero-anterior view chest radiograph were performed at admission. In all the patients, 12-lead electrocardiogram (ECG) and echocardiography were performed within 24 hours of admission after initial stabilisation. Cor-pulmonale was diagnosed if there

Table 2: Clinical presentation in 116 patients with acute exacerbation of chronic obstructive pulmonary disease admitted to the medical intensive care unit

Variable	%
Symptoms	
Cough	100
Increased sputum volume	100
Increased sputum purulence	100
Recent rapid worsening of dyspnea	100
Accessory muscle use	60.3
Inability to complete a full sentence while talking	60.3
Pedal edema	19.8
Fever	29.3
Altered sensorium	12.9
Upper respiratory infection	08.6
Gastroesophageal reflux	07.8
Signs	
Wheezing	100
Respiratory rate > 24/min	94.0
Crepitations	56.0
Cyanosis	33.6
Heart rate > 100/min	25.0
Elevated JVP	12.9
Systolic BP < 90 mm Hg	03.4

JVP = jugular venous pulse

was ECG (p-pulmonale; right axis deviation; right ventricular hypertrophy) and echocardiographic evidence of right ventricular hypertrophy/dilatation. Two ml of heparinised blood sample was procured for arterial blood gas (ABG) analysis from the radial artery and was transported to the laboratory immediately for processing. ABG analysis was done using AVL Compact 2 (Radiometer, Denmark) analyzer.

Oxygen was administered through a standard dual-prong nasal cannula or face mask. When hypercapnia was a concern, oxygen was delivered through a Venturi mask (maintaining a fixed ratio of oxygen to room air). The oxygen therapy was guided by the ABG report and oxygen saturation (SaO_2) measured using a pulse oximeter. Initially, salbutamol (as frequently as 5 mg every 15 minutes to every 8 hours) and ipratropium bromide (as frequently as 0.5 mg every 15 minutes to 0.5 mg every 8 hours) were administered through an ultrasonic nebuliser. If the aerosol therapy proved inadequate, intravenous aminophylline was administered using a constant volume infusion pump. They received injectable corticosteroids (hydrocortisone/methyl prednisolone) for 72 hours following which oral prednisolone was administered in a dosage 0.75 mg/kg body weight for a subsequent period of seven more days. Pharmacological treatment was optimized based on the clinical response. Empirical antibiotic treatment was initiated as appropriate in 104 patients (89.6%) and the antibiotic choice was further modified basing on the culture and sensitivity report.

Criteria for intubation were not standardized, and noninvasive ventilation was infrequently utilized at our hospital during the period of study. Endotracheal intubation and assisted mechanical ventilation were initiated when pharmacologic and other non-ventilatory treatments failed to reverse clinically significant respiratory failure. Indications for initiating invasive mechanical ventilation included any of the following: severe dyspnea with use of accessory muscles and paradoxical abdominal motion;. severe acidosis (pH < 7.25) and hypercapnia ($PaCO_2$ > 60 mmHg); life-threatening hypoxaemia [arterial oxygen tension (PaO_2)/inspiratory oxygen fraction (FIO_2) < 200 mmHg)]; tachypnoea (>35 breaths/min); respiratory arrest; somnolence, impaired mental status; presence of co-morbid illness; and presence of other complications. The associated co-

Table 3: Laboratory abnormalities in 116 patients with acute exacerbation of chronic obstructive pulmonary disease admitted to the medical intensive care unit

Variable	%
Polycythemia (PCV >54% in men, >49% in women)	32.8
Leukocytosis [(>12 × 10^3/mm^3), (>12 × 10^9/l)]	64.7
Neutrophilia [(> 70%), (> 0.7)]	77.6
Elevated ESR (>20 mm at the end of the first hour)	64.7
Hypoalbuminemia [(< 3.5 g/dl), (< 35 g/dl)]	19.0
Hyponatremia [serum sodium < 120 meq/l, (< 120 mmol/l)]	16.4
Hypokalemia [serum potassium < 3.5 meq/l, (< 3.5 mmol/l)]	16.4
Hyperbilirubinemia [(>1.2 mg/dl), (> 20.5 µmol/l)]	06.0
Elevated transaminases [>50 IU/l]	22.4
Elevated blood urea [(>50 mg/dl), (>17.9 mmol/l)]	45.7
Elevated serum creatinine [(>1.5 mg/dl), (> 132.6 µmol/l)]	19.0

ESR = erythrocyte sedimentation rate

Table 4: Predictors of outcome in 116 patients with severe acute exacerbation of chronic obstructive pulmonary disease requiring admission to the intensive care unit: univariate sensitivity analysis

Variable	χ^2	p-value
Presence of co-morbid illness	1.673	0.0196
Altered consciousness	3.65	0.056
Presence of tachycardia	9.605	0.002
Peripheral edema	1.9	0.168
Hypoalbuminemia	4.3	0.038
Elevated transaminases	4.2	0.035
Acidosis	10.257	0.001
Arterial hypoxemia	4.999	0.025
Hypercapnia	2.189	0.139
Presence of new infiltrates on the chest radiograph	5.24	0.017
Need for invasive ventilation	16.178	0.0001

morbid illnesses were monitored and treated appropriately. Criteria for discharge from hospital included patients clinically and ABG wise stable for 24 hours; inhaled ,2-agonist therapy is required no more frequently than every 4 hours; patient is able to eat and sleep without frequent awakening by dyspnea.[1]

Statistical Analysis

Variables following normal distribution were summarized by mean and standard deviation. The association between two categorical variables was evaluated by $^{-2}$ test or Fisher's exact test as appropriate. Student's 't' test (for normally distributed variables) was used to compare the difference in mean values in the two groups for quantitative variables. To determine various predictors of death following hospitalization for AE-COPD, the analysis was performed in two stages. For this purpose the quantitative variables were categorized. Variables showing statistically significant association with the outcome (death during in-hospital stay) at $p < 0.20$, were considered as candidate variables for inclusion in the multivariate model. Stepwise multivariate logistic regression was performed with the potential candidate variables as the co-variates. SYSTAT version 7.0 (SPSS Inc., Chicago, USA) was used for data analysis. All the statistical tests performed were two tailed; $p < 0.05$ was considered as statistically significant.

Results

The mean age of the patients was 62.1 ± 9.8 years (Table 1); there were 102 males. Their demographic parameters, smoking history, COPD staging based on pulmonary function testing done prior to the present episode of ER visit as per the Global Initiative for Chronic Obstructive Lung Disease (GOLD) staging[1] and details regarding co-morbid conditions are depicted in Table 1. Majority of the males (64.8%) smoked bidis. All women gave a history of exposure to domestic fuel such as dried cow dung cakes, wood, dried coconut shells, crop residues and grass.

Evidence of past pulmonary TB was present in 28.4% patients presenting with AE-COPD requiring admission into the medical ICU (n = 116). In five of these patients who also had type II diabetes mellitus, sputum smear-positive pulmonary TB was diagnosed at the time of presenting to the ER with AE-COPD. Three patients with type II diabetes mellitus also had diabetic ketoacidosis. On comparing the prevalence of past pulmonary tuberculosis (TB) among the 314 patients with AE-COPD (116 patients with AE-COPD who were admitted to the medical ICU, the 198 patients who presented to the ER, but who did not require admission into the medical ICU) and the remaining 600 patients who were on follow-up but who did not develop AE-COPD, it was found that patients with past pulmonary TB were more likely to suffer from AE-COPD than those who did not have pulmonary TB (61 of 314 vs. 24 of 600; $^{-2} = 56.343$, $p < 0.001$).

Table 2 depicts the clinical presentation of AE-COPD. All the 15 of the 116 (12.9%) patients with altered sensorium manifested one or more metabolic abnormalities [hyponatremia (n = 9); hypokalemia (n = 7); hyperbilirubinemia (n = 3); elevated transaminases (n = 12) elevated blood urea (n = 11); and elevated serum creatinine (n = 3)] or type II respiratory failure and carbon dioxide retention (n = 11). Cor-pulmonale was present in 23 (19.8%) patients.

Chest radiograph revealed infiltrates in 48 (41.4%) patients; 33 had evidence of past pulmonary TB; 5 patients were diagnosed to have sputum smear-positive pulmonary TB; in the remaining 10 patients, focal parenchymal infiltrates without air-bronchogram, suggestive of lower respiratory tract infection were present and all these 10 patients had negative sputum and blood culture. None of the five patients with AE-COPD who had active pulmonary TB (n = 5) had any symptom or sign suggestive of active TB when they last presented to the out-patient department/chest clinic for follow-up. Furthermore, they also did not have any past history of TB. Pulmonary TB was diagnosed in them only at the time of the ER visit with AE-COPD.

Laboratory abnormalities at initial presentation are shown in Table 3. ABG analysis revealed respiratory failure in 40 (33.8%) patients; 7 (17.5%) manifested type I and 33 (82.5%) patients manifested type II respiratory failure. Bacterial isolates were grown in 25 (21.6%) patients; in 11 (44%) patients, more than one pathogen was isolated. Of these isolates, S. pneumoniae (42.9%) and Klebsiella sp (35.7%) were the most common bacteria isolated.

There was no statistically significant difference in the clinical presentation and laboratory abnormalities between smokers of bidi and cigarette. Invasive mechanical ventilation was required in 18 (15.5%) patients. Overall, 16 (13.7%) patients died. This included patients requiring mechanical ventilation (n = 8), patients who had type II diabetes mellitus and diabetic ketoacidosis (n = 3); type II diabetes mellitus and active pulmonary TB (n = 5) at presentation. The mean duration of in-hospital stay was 6.8 ± 6.6 days.

Table 5: Predictors of death in 116 patients with severe acute exacerbation of chronic obstructive pulmonary disease requiring admission to the intensive care unit: stepwise multivariate logistic regression analysis

Variable	Odds ratio	95% Confidence intervals	p-value
Need for invasive ventilation	45.809	607.46 to 3.009	$p < 0.001$
Presence of co-morbid illness	0.126	0.428 to 0.037	$p < 0.01$
Hypercapnia	0.114	1.324 to 0.010	$p < 0.05$

The predictors of in-hospital death in patients with AE-COPD as per univariate sensitivity analysis and stepwise multivariate logistic regression analysis are shown in Tables 4 and 5 respectively. Type of smoking (cigarette vs. bidi) did not influence the outcome (death). Stepwise multivariate logistic regression analysis revealed need for invasive ventilation ($p < 0.001$); presence of co-morbid illness ($p < 0.01$) and hypercapnia ($p < 0.05$) were predictors of death.

Discussion

Reliable epidemiological data regarding the burden of AE-COPD in the ER are lacking from India. Even less is known regarding the clinical presentation and outcome of AE-COPD in a predominantly bidi smoking population similar to the patients included in the present study. Observations from the present study indicate that patients with AE-COPD had one or more co-morbid conditions and metabolic abnormalities at presentation. High prevalence of past pulmonary TB was observed and active pulmonary TB was identified to be an important infective cause of AE-COPD.

Bidi smoking is more common in lower and middle income groups especially those residing in smaller towns, and rural areas of India as bidis are cheaper than cigarettes. Furthermore, bidi smoking is considered to cause about two to three times greater nicotine and tar inhalation than do conventional cigarettes, due to the poor combustibility of the bidi and greater puff frequency needed to keep the bidi alight.[11] All these factors may exaggerate the health risks associated with bidi smoke. The burden of tobacco use is shifting from developed to developing countries and it is generally believed that smoking habit is on the rise in India.[5,12] Therefore, the prevalence of COPD is expected to increase in the years to come and AE-COPD is likely to be an important reason for ER visits in India.

Clinical presentation of AE-COPD observed in the present study (Table 2) was similar to that reported from studies reported from other parts of the world.[7, 13-18] Several causes can contribute to altered sensorium in patients with AE-COPD. These include, type II respiratory failure and carbon dioxide narcosis, metabolic abnormalities such as dyselectrolytemia, uremia and hepatic function derangement among others. As these can be corrected, an active attempt must be made to identify them when patients present to the ER with AE-COPD. This is important in developing countries like India because, majority of the patients with AE-COPD seek emergency care at primary health centres, district hospitals and general hospitals where facilities for round-the-clock laboratory monitoring are seldom available. Unless these factors, that are often correctable, are specifically sought and checked, they may be missed. Thus, these factors not only confuse the diagnosis but also contribute to mortality.

Majority of the patients in the present study had co-morbid conditions (n = 53; 45.7%) (Table 1) and presence of co-morbid factors was a predictor of death (Table 5) in these patients. Co-morbid conditions can be a confusing factor when assessing a patient with AE-COPD, as they themselves can cause respiratory symptoms.[19] Furthermore, the co-morbid conditions can trigger AE-COPD and their presence has been considered to be a predictor of poor outcome in several studies.[19] In the present study, patients who presented with AE-COPD who also had type II diabetes mellitus and diabetic ketoacidosis (n = 3); type II diabetes mellitus and active pulmonary TB (n = 5) died suggesting that complications related co-morbid conditions also contribute to the morbidity and mortality. Therefore, accurate assessment of co-morbid conditions and institution of specific treatment aimed against them should also help in reducing the mortality in patients with AE-COPD.

In the present study, compared with those who did not develop AE-COPD, past history of pulmonary TB was more frequently documented in patients presenting to the ER with AE-COPD ($p < 0.001$). Furthermore, 28.4% patients with AE-COPD admitted to the medical ICU had evidence of past pulmonary TB and all males among them were chronic smokers (Table 1). In a survey of 60000 men aged 20 to 50 years,[20] a definite correlation between the incidence of pulmonary TB and smoking has been documented. Gajalakshmi et al[21] observed that, among urban men, the death rates from medical causes of ever smokers were double those of never smokers. Of this excess mortality among smokers, a third involved respiratory disease, chiefly TB (risk ratio ever to never smoked = 4.5) suggesting that smoking per se increased the incidence of clinical TB. It has been suggested that nicotine turns off the production of tumor necrosis factor-alpha (TNF-·) by the macrophages in the lungs, and since TNF-· is crucial for the maintenance of the latent state within macrophages, reactivation may occur rendering the patient more susceptible to the development of progressive disease from latent M. tuberculosis infection.[22] Treated pulmonary TB is an important cause of COPD[23] and has been reported in 41%[24] to 68%[25] patients treated for pulmonary TB. Smoking seems to increase the incidence of TB and prevalence of COPD is high where smoking is highly prevalent. Cavitation, extensive fibrosis, bulla formation and bronchiectasis have been implicated in the genesis of COPD caused by destroyed lung due to treated pulmonary TB. Thus, in areas such as India where pulmonary TB is highly endemic and smoking is on the rise, the prevalence of COPD is expected to increase and severe AE-COPD would become a significant cause of morbidity and mortality in the ER. This intriguing relationship between smoking, pulmonary TB and COPD merits further study.

Five patients presenting with AE-COPD had type II diabetes mellitus and sputum smear-positive pulmonary TB. In the studies published from the west, there are scant references to active pulmonary TB as an infective cause of AE-COPD at the time of presentation to the ER.[7,13-18,26] This observation is particularly relevant to countries where TB is highly endemic. Patients with open TB in whom the diagnosis of TB is not

considered due to low threshold of suspicion constitute a health hazard not only to the treating physicians in the ER, but also to the nursing and paramedical personnel. These observations merit further evaluation.

Lack of uniform definition of AE-COPD hampers international comparisons and the evolution of uniform diagnostic testing and treatment guidelines.[19] Furthermore, initial evaluation of a patient in the ER in the guidelines issued by several international organisations are also different.[27,28] The recently published Indian guidelines deal with AE-COPD only briefly.[29] Guidelines for the initial diagnostic evaluation of AE-COPD should facilitate differentiating AE-COPD from other conditions which can mimic it such as congestive heart failure, pneumothorax, pleural effusion, pulmonary embolism and arrhythmias. With the evolution of a consensus definition,[19] these differences are likely to be resolved.

Several studies have attempted to identify the predictors of poor outcome in patients with AE-COPD.[7,13-18,26] However, there has been no such study published from India to the best of our knowledge. Acute respiratory failure is a common reason for admission into the ICU in patients with AE-COPD. [7,13-18,26] We also observed that need for mechanical ventilation was associated with a poor prognosis (Table 5). The study was carried out at our tertiary care teaching institute with facilities for invasive monitoring and assisted mechanical ventilation. These facilities are not widely available and affordable in most of the Rayalaseema area of Andhra Pradesh and majority of patients needing assisted ventilation are referred here often, late in the course of their disease. This could be the reason for the high prevalence of respiratory failure in these patients. In order to cope up with the expected increase in the burden of AE-COPD, there is a pressing need for making tertiary care facilities widely available and affordable in developing countries like India.

In conclusion, in addition to the host genetic factors, smoking behaviour, accessibility to health care and presence of co-morbid conditions contribute to morbidity and mortality due to AE-COPD. Correction of metabolic abnormalities such as dyselectrolytemia and judicious use of empirical antimicrobial treatment will also help in reducing the mortality. Large scale nationwide multicentric studies are required to clarify these issues and evolve consensus guidelines. Further research is required to clarify the association between pulmonary TB and COPD.

References

1 Global Initiative for Chronic Obstructive Lung Disease: Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. Updated 2005. Executive Summary. [http://www.goldcopd.org/Guidelineitem.asp?l1=2&l2=1&intId=996]. Accessed on 16 November 2006

2 Murray CJL, Lopez AD, editors: The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries and risk factors in 1990 and projected to 2020 Cambridge, MA: Harvard University Press; 1996.

3 Tobacco or Health: A Global Status Report. Country profiles by region. Southeast Asia. India [http://www.cdc.gov/tobacco/who/india.htm]. Accessed on 16 November 2006

4 Reddy KS, Perry CL, Stigler MH, Arora M: Differences in tobacco use among young people in urban India by sex, socioeconomic status, age, and school grade: assessment of baseline survey data. Lancet 2006, 367:589-594.

5 Jindal SK, Aggarwal AN, Chaudhry K, Chhabra SK, D'Souza GA, Gupta D, Katiyar SK, Kumar R, Shah B, Vijayan VK, Asthma Epidemiology Study Group: A multicentric study on epidemiology of chronic obstructive pulmonary disease and its relationship with tobacco smoking and environmental tobacco smoke exposure. Indian J Chest Dis Allied Sci 2006, 48:23-29 [http://medind.nic.in/iae/t06/i1/iaet06i1p23.pdf].

6 Snow V, Lascher S, Mottur-Pilson C, Joint Expert Panel on COPD of the American College of Chest Physicians and the American College of Physicians-American Society of Internal Medicine: The evidence base for the management of acute exacerbation of COPD. Clinical practice guideline, Part 1. Chest 2001, 119:1185-1189.

7 Connors AF Jr, Dawson NV, Thomas C, Harrell FE Jr, Desbiens N, Fulkerson WJ, Kussin P, Bellamy P, Goldman L, Knaus WA: Outcomes following acute exacerbation of severe chronic obstructive lung disease. The SUPPORT investigators (Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments). Am J Respir Crit Care Med 1996, 154:959-967.

8 American Thoracic Society: Standards for the diagnosis and care of patients with chronic obstructive pulmonary disease. Am J Respir Crit Care Med 1995, 152:S77-S121.

9 Malson JL, Sims K, Murty R, Pickworth WB: Comparison of the nicotine content of tobacco used in bidis and conventional cigarettes. Tobacco Control 2001, 10:181-183.

10 Malik SK: Chronic bronchitis in beedi smokers. Indian J Chest Dis 1974, 16:94-99.

11 Rahman M, Fukui T: Bidi smoking and health. Public Health 2000, 114:123-127.

12 Jindal SK, Aggarwal AN, Chaudhry K, Chhabra SK, D'Souza GA, Gupta D, Katiyar SK, Kumar R, Shah B, Vijayan VK, Asthma Epidemiology Study Group: Tobacco smoking in India: prevalence, quit-rates and respiratory morbidity. Indian J Chest Dis Allied Sci 2006, 48:37-42 [http://medind.nic.in/iae/t06/i1/iaet06i1p37.pdf].

13 Seneff MG, Wagner DP, Wagner RP, Zimmerman JE, Knaus WA: Hospital and 1 year survival of patients admitted to intensive care units with acute exacerbation of chronic obstructive pulmonary disease. JAMA 1995, 274:1852-1857.

14 Fuso L, Incalzi RA, Pistelli R, Muzzolon R, Valente S, Pagliari G, Gliozzi F, Ciappi G: Predicting mortality of patients hospitalized for acutely exacerbated chronic obstructive pulmonary disease. Am J Med 1995, 98:272-277.

15 Khilnani GC, Banga A, Sharma SK: Predictors of mortality of patients with acute respiratory failure secondary to chronic obstructive pulmonary disease admitted to an intensive care unit: a one year study. BMC Pulm Med 4:12. 2004 Nov 27

16 Portier F, Defouilloy C, Muir JF: Determinants of immediate survival among chronic respiratory insufficiency patients admitted to an intensive care unit for acute respiratory failure. A prospective multicenter study. The French Task Group for Acute Respiratory Failure in Chronic Respiratory insufficiency. Chest 1992, 101:204-210.

17 Nevins ML, Epstein SK: Predictors of outcome for patients with COPD requiring invasive mechanical ventilation. Chest 2001, 119:1840-1849.

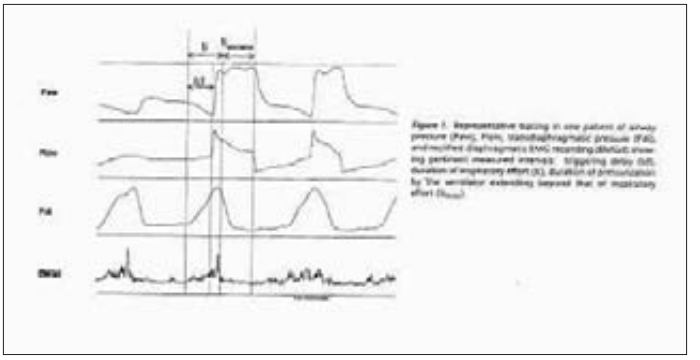
18 Gregoretti C, Squadrone V, Fogliati C, Olivieri C, Navalesi P: Transtracheal open ventilation in acute respiratory failure secondary to severe chronic obstructive pulmonary disease

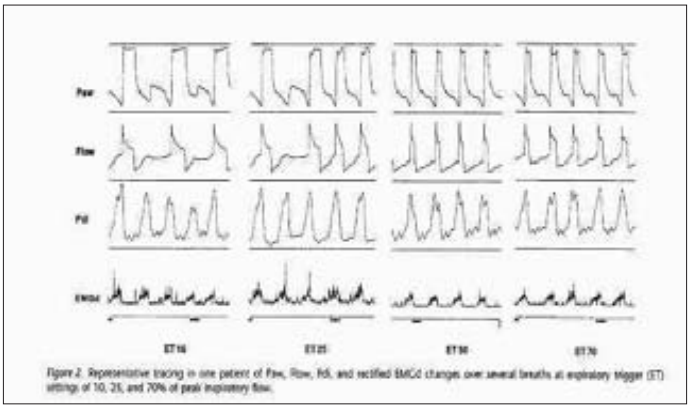
exacerbation. Am J Respir Crit Care Med 2006, 173:877-881. Epub 2006 Jan 19
19 Rodriguez-Roisin R: Toward a consensus definition for COPD exacerbations. Chest 2000, 117(5 Suppl 2):398S-401S.
20 Kolappan C, Gopi PG: Tobacco smoking and pulmonary tuberculosis. Thorax 2002, 57:964-966.
21 Gajalakshmi V, Peto R, Kanaka TS, Jha P: Smoking and mortality from tuberculosis and other diseases in India: retrospective study of 43000 adult male deaths and 35000 controls. Lancet 2003, 362:507-515.
22 Davies PD, Yew WW, Ganguly D, Davidow AL, Reichman LB, Dheda K, Rook GA: Smoking and tuberculosis: the epidemiological association and immunopathogenesis. Trans R Soc Trop Med Hyg 2006, 100:291-298. Epub 2005 Dec 1
23 Snider GL, Doctor L, Demas TA, Shaw AR: Obstructive airway disease in patients with treated pulmonary tuberculosis. Am Rev Respir Dis 1971, 103:625-640.
24 Hassan IS, Al-Jahdali HH: Obstructive airways disease in patients with significant post tuberculous lung scarring. Saudi Med J 2005, 26:1155-1157.
25 Willcox PA, Ferguson AD: Chronic obstructive airways disease following treated pulmonary tuberculosis. Respir Med 1989, 83:195-198.
26 Soler-Cataluna JJ, Martinez-Garcia MA, Roman Sanchez P, Salcedo E, Navarro M, Ochando R: Severe acute exacerbations and mortality in patients with chronic obstructive pulmonary disease. Thorax 2005, 60:925-931. Epub 2005 Jul 29
27 Celli BR, MacNee W, members of the ATS/ERS Task Force: Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. Eur Respir J 2004, 23:932-946.
28 National Institute for Clinical Excellence: Clinical Guideline 12 Chronic obstructive pulmonary disease Management of chronic obstructive pulmonary disease in adults in primary and secondary care 2004 [http://www.nice.org.uk/CG012NICEguideline]. London: National Institute for Clinical Excellence Accessed on 16 November 2006
29 Jindal SK, Gupta D, Aggarwal AN, WHO-Government of India Biennium (2002–2003) Programme: Guidelines for management of chronic obstructive pulmonary disease (COPD) in India: a guide for physicians (2003). Indian J Chest Dis Allied Sci 2004, 46:137-153

Cycling and Inspiratory Muscle Workload

Paul Garbarini, MS, RRT

In August 2005, the American Journal of Respiratory and Critical Care Medicine published a small study involving 10 patients with COPD and studied the effects of various expiratory trigger settings (flow termination criteria for cycling pressure support breaths into expiratory phase). The study, entitled "Impact of Expiratory Trigger Setting on Delayed Cycling and Inspiratory Muscle Workload", compared expiratory trigger settings at 10, 25, 50 and 70 percent of peak inspiratory flow.





The study was performed in the medical intensive care unit and measured continuous diaphragmatic EMG as well as esophageal and gastric pressures. The study concluded setting an expiratory trigger setting at a higher percentage of peak inspiratory flow in patients with obstructive disease during pressure support improved patient-ventilator synchrony and reduced inspiratory muscle effort. As a result of increasing ET from 10 to 70 percent of peak flow, a reduction in inspiratory time occurred which led to an increase in expiratory time which in turn led to a reduction in intrinsic peep and furthermore decreased inspiratory muscle effort and decreased the number of non-triggered breaths. Limitations were discussed and further studies are needed to solidify these results as well as look at whether an improved patient outcome occurs. Below are setting ranges for some of the high end ventilators today:

- Galileo Gold Setting Range: 5-60%
- Drager Evita 2 Setting Range: 250
- Newport Medical e500 Setting Range: 5-50%
- GE Centiva 5 Setting Range: 10-60%
- Servo-i Setting Range: 0-40%
- PB 840 Setting Range: 1-80%
- GE Engstrom Carestation Setting Range: 5-50%

PRODUCTS

GET COMFORTABLE

Contour Living, a leader in the ergonomic support and comfort industry, announced today the introduction of the CPAP Sleep Aid, specifically designed for sleep apnea sufferers who use Continuous Positive Airway Pressure (CPAP) masks to address their condition. The CPAP Sleep Aid's patented design features hollowed-out areas on each of the pillow's lower sides, which accommodate patients' CPAP mask and hose, alleviating mask pressure against the face to dramatically improve comfort and help prevent mask leaks. These pressure-free mask zones allow CPAP patients to sleep on either their left or right side, and even on their stomachs. The pillow is designed to help CPAP patients get the full benefit of their equipment without having to sacrifice their favorite sleeping positions. In addition to the pressure-free mask zones, the CPAP Sleep Aid has five additional design features specifically created for CPAP mask use. From ergonomically designed neck, head and shoulder support, to specifically molded spots for users' ears when sleeping on their sides, to inclined upper sides for forehead support to prevent rotating downward and crushing the mask and hose, the CPAP Sleep Aid addresses several key problems that interfere with CPAP patient compliance. It is designed to work with all major brands and styles of CPAP masks. Contact contourliving.com.

BREATHE EASY

Constructed to be small and unobtrusive, the new BreatheX Journey CPAP from VIASYS is powered by a rechargeable battery that will provide 11 hours of use at 10 cm H_2O. Providing CPAP pressures from 5 to 12 cm H_2O, the BreatheX Journey features a ramp and altitude compensation and includes a 72 inch hose, which allows the system to be positioned in the most comfortable or convenient position. Compact and mobile, the CPAP system is compatible with a range of masks and nasal pillow systems including The Advantage Series Nasal and Full Face Masks and SNAPP X Direct Nasal Interface, all of which are also made by VIASYS.

KEEP STILL

Iapyx Medical, a developer of innovative single-use medical devices, introduced its Stable-Line family of catheter stabilization products designed to minimize the risk of catheter-related bloodstream and urinary tract infections, two of the three most common hospital-acquired infections. With the launch of Stable-Line Arterial and Stable-Line Foley catheter stabilization devices, Iapyx Medical aims to combat the epidemic of hospital-acquired infections and improve patient care and clinician safety. The Stable-Line Arterial catheter stabilization device is designed to prevent inadvertent movement and dislodgment of arterial lines. Suture securement, the traditional means of arterial line securement, increases patients' risks of developing catheter-related bloodstream infections (CRSBI), which pose a significant mortality risk. Suture securement also puts healthcare workers at risk for needlestick injuries, which expose them to blood-borne pathogens including Hepatitis B, Hepatitis C, and HIV. The Stable-Line Arterial device mitigates these risks while addressing OSHA's recommendation for sutureless securement and meeting Infusion Nurses Society (INS) standards as a manufactured stabilization device. Without the use of invasive sutures or conventional strips of tape, the Stable-Line Arterial catheter stabilization device firmly grips the extension set to immobilize the catheter while permitting visual inspection and monitoring of the insertion site. Iapyx Medical also introduced the Stable-Line Foley catheter stabilization device, which addresses the infection risks, complications and discomfort associated with indwelling Foley (urinary) catheters. To secure Foley catheters, most critical care clinicians use tape and leg-straps, which are not only ineffective in securing the catheters but are inadequate defenses against urethral irritation, meatal erosion and accidental dislodgement. The Stable-Line Foley catheter stabilization device minimizes these complications by securing the catheter and reducing inadvertent movement. The device, designed with a releasable and rotating dead-bolt style locking mechanism, allows for patient movement while maintaining skin integrity. Iapyx Medical's products have been successfully adopted by hospitals nationwide, including Loma Linda University Medical Center. Contact iapyx.com.

TAKING OFF

Marking its official launch into the US emergency care market, Draeger Medical, Inc announces the first implementation of its newest ventilation system, the Oxylog 3000, at Lee County Medstar Flight Operations. Medstar, a division of Lee County Emergency Medical Services, serves as the primary air medical transport service for Lee County in Fort Myers, FL and is staffed with two critical care flight paramedics and an EMT/pilot. To ensure the best possible outcomes for patients before, during and after transportation, the aircraft is equipped with the latest Advanced Life Support (ALS) equipment—which now includes Draeger's Oxylog 3000. "Whether we're conducting scene missions or inter-facility transports we need to make sure our patients receive the best care possible," said Lt Michael G. Hamel, Operations Supervisor/Flight Paramedic. "In the testing phase, the Oxylog 3000 exceeded our expectations. Now in clinical use, the vent is performing flawlessly. The Oxylog 3000 allows our team the ability to provide ventilatory management to a wide spectrum of patients in a manner not previously available in our service. We're very pleased with the multi-parameter capabilities of Oxylog 3000 in the critical care environment—so much so that we've made a purchase for another one." Intended for the demanding emergency and transport environments, the Oxylog 3000 is ideal for supporting Medstar's rapid transport of high priority patients or critically ill and injured persons. Medstar's Hamel estimates that the ventilator could be used as many as fifty times per quarter, and in such a taxing environment the quality of design and construction needs to be of the highest caliber. Designed and manufactured with the same attention to detail and performance as Draeger's high-end Evita ICU ventilators, the Oxylog 3000 represents a significant advance in emergency and transport ventilation systems. Contact draeger.com.

A WINNER

Hill-Rom received the 2007 Medical Device Excellence Award from medical publisher Canon Communications for its Vest Airway Clearance System, Model 205. The award is the only one of its kind, bestowed for excellence in design and engineering features, including innovative use of material and enhanced patient benefits. The Vest uses high frequency chest wall oscillation technology to provide a consistent therapy as an alternative to CPT. It is designed for acute and long term care environments. Contact hillenbrand.com.

TWO FOR TWO

Maxtec Inc, Salt Lake City, UT, announced the release of its all

new OptiVenturi. This unique product offers Fisher & Paykel humidifier and OPTIFLOW users the ability to mix ambient air and oxygen without the need of piped medical grade air. This unit also includes Maxtec analyzer technology, providing 5,000 hours of battery life and a simple one touch calibration. The OptiVenturi is also equipped with a high-flow flow meter. Maxtec offers this product with either the MAX-250ESF fast response sensor, or the MAX-250E long life sensor. The company also announced the release of its new Pulsox-300i pulse oximeter from Konica Minolta Sensing. For years, the Pulsox-3 series provided for spot checking and recording heart rate and blood-oxygen saturation. Now, the Pulsox-300i offers more, with 300 hours of non-volatile data storage, 30 hours of battery life on one AAA battery and with connection to a PC via USB port for faster downloading and report printing. Contact Maxtec at (866) 4-maxtec, maxtecinc.com.

SPOTLIGHT ON PFT

JOIN THE ELITE

Medical Graphics Corporation, St Paul, MN, produces and markets the MedGraphics Elite Series Plethysmograph. Winner of the Medical Design Excellence Award, the Elite offers complete spirometry, diffusing capacity, lung volumes by nitrogen washout and/or plethysmography, and airway resistance in a networked or stand-along system. The Elite's unique "zero-clearance" door wraps around the system, allowing it to operate in small spaces while accommodating patients of all sizes, from pediatric to adult. The Elite's clear chamber improves patient comfort by providing an open field of vision, and makes testing accessible for all ambulatory and wheelchair-bound patients. Contact (800) 950-5597; medgraphics.com.

SCANNERS

Vida Diagnostics, Inc, makes and sells CT scan post-processing software designed for use by pulmonary professionals. Its primary product is Pulmonary Workstation *Plus* (PW+), a comprehensive software for viewing and analyzing pulmonary CT data. PW+ provides airway and lung density analysis tools that are used to evaluate emphysema, COPD and asthma patients. Tools include automatic airway segmentation and labeling, sub-voxel accuracy lumen and airway measurements, CT viewer with innovative 3D visualization, lobar histogram analysis, lobar 2D and 3D bullae analysis. Additional features include automatic vascular tree segmentation, patient database, manual editing, and exportable data. Contact vidadiagnostics.com.

ALL YOU NEED

MasterScreen PFT from VIASYS Respiratory Care is a powerful diagnostic system within the MasterScreen family, incorporating the standard lung function measurements, spirometry, lung volumes by helium equilibration, and single breath DLCO. MasterScreen PFT uses the latest ATS/ERS standards. Easily expand your testing capabilities to add even greater capabilities of body box, IOS, and Exercise. MasterScreen PFT quickly and efficiently measures diffusion capacity via the Single Breath Diffusion method. In addition to the Transfer Factor, further static lung volumes, such as FRC, RV and TLC can be determined by gas dilution. This includes CO_2 scrubbing and O_2 supply, controlled by the included O_2 sensor. Optionally, Diffusion Capacity can also be measured via the DCO Re-breathing Method (multiple breaths). Diffusion measurements can be used effectively whenever diffusion is suspected to be impaired, ie, mainly in patients suffering from pulmonary fibrosis or pulmonary emphysema. Indication of therapy, trend and assessment play a decisive role. To broaden your diagnostic spectrum, the system can be equipped with a Bodyplethysmography option and/or a CPX option. The **Vmax Encore PFT**, the third generation in the Vmax line, brings innovation, quality, and efficiency to your laboratory. Whether testing young children or adults, the Vmax Encore now makes collecting data fast, accurate, more reliable and easier than ever before. The mass flow sensor's automated circuitry is accurate and stable in all conditions, such as changing environmental conditions, and uses the exclusive Vmax Real-Time BTPS correction. The Vmax Encore enables you to obtain quality data with less effort for the patient. For example, our optional, fully integrated Impulse Oscillometry (IOS) collects reliable airways resistance data and bronchodilator response data with normal tidal breathing. Additionally, there is less effort on your part because of Encore's fast testing capability and low maintenance costs. Vmax Encore has extensive built-in QA to help ensure the highest quality data possible, including the latest ATS/ERS and NLHEP standards with real-time prompting. After the test has been completed, 100% of the Vmax Encore patient circuit can be disinfected: An industry first. Of course, a VIASYS MicroGard disposable filter should always be used. The **Vmax Encore PFT & Exercise** brings superior quality with less effort for both you and your patients. Vmax analyzers are accurate and stable over a wide range of uses – from screening patients to testing elite athletes, and from performing PFT tests to Exercise tests on the same system. Many tests, such as diffusing capacity and spirometry may be performed at rest, during exercise, and simultaneously with other measurements. Vmax Encore software is both flexible and easy-to-use, and incorporates the latest ATS/ERS and NLHEP standards with real-time prompting, and other extensive QA. VIASYS technical support uses the latest in technology to meet your post-sale needs, including our new VCare Connect, the latest in remote support solutions. Through the highly efficient Breath-by-Breath, Mixing Chamber, and Dilution modes, **Vmax Encore CPET** acquires and displays exercise and nutritional test data in a format that is easy to see and evaluate. Elevated oxygen testing, exercise diffusing capacity testing, CO_2 rebreathing, and exercise flow volume loops are also available. Automated or manual selection of anaerobic threshold (AT), automated slope calculation and the ability to overlay and trend previous tests are a few of the many features designed to provide maximum ease of use for the user. Vmax Encore is available as a stand alone CPET system or combined with a PFT into one system. A wide variety of external devices can easily interface with Vmax Encore—ECG's, automated blood pressure and SpO_2 monitors, treadmills and ergometers. The company's **Oxycon Mobile** is an accurate and reliable system that allows the determination of a subjects' metabolic response while exercising. Oxycon Mobile records the data breath-by-breath, based on the "Open System Approach." It is a light battery operated portable system that is mounted to the subjects' body via a comfortable vest. The Oxycon Mobile allows testing in all groups of persons; from children to adults and from patients to athletes. The breath-by-breath data is collected through a facemask or mouthpiece and is sent to a host computer system via wireless transmission (telemetry), making the device suitable for use in a non-laboratory environment. Fields of Application: sport and exercise, rehabilitation, work environment. The system may

also be used as a stationary device. Windows based software, including Spirometry, Flow-Volume program, on-line registration program for the transmitted data, evaluation software and reporting system. **Vmax Encore Nutritional Assessment** provides nutritional status for athletes wanting to increase performance, for those desiring to lose/gain weight, and for patients wanting a shorter hospital stay. Predicted equations (over 100 available) can only estimate, but the Vmax Encore accurately measures the critical parameters enhancing the ability to accurately feed athletes or patients. Vmax Encore offers breath by breath, mixing chamber and dilution testing modes and easily interfaces to ventilators and spontaneous breathing persons and can provide both macro and micro nutrient breakdown. Vmax Encore's compact design is well-suited for small spaces such as in the ICU, and the software automates the process to ensure reliable data each time. Whether using the Vmax Encore as a stand alone indirect calorimeter or adding it to an exercise or PFT system the Vmax Encore is proven to be cost effective. Contact viasyshealthcare.com, (800) 231-2466.

INSPIRED

nSpire Health introduces the Collins Eagle—Comprehensive Pulmonary Function Laboratory. Eagle's proprietary 4th generation sensor technology is proven at nearly twice the industry standards in the world's most demanding and comprehensive inhaled drug trials to date. Experience iFlow; new Flow Sensor Technology delivering <1% accuracy and repeatability, see smaller changes in lung function sooner. Autoflow Gas Delivery system offers ultra-low resistance and improves patient comfort and test compliance. Eagle exceeds industry standards, bringing you the most accurate pulmonary function testing at the lowest cost of operation. For more information contact (800) 574-7374, nspirehealth.com.

LINKING UP

VIASYS created VLink so that your pulmonary, caridopulmonary, neurology and sleep department diagnostic devices could all interface with your Hospital Information System (HIS) through one common gateway—Vlink! Vlink accepts orders from the hospital ADT program to populate the demographic fields in the patient's electronic medical record, thus saving time, reducing errors, saving costs and improving patient outcomes. By seamlessly connecting your diagnostic departments with the caregivers in your institution VIASYS helps you connect Health with Care. Contact viasyshealthcare.com.

EXECUTIVE PROFILES

Ambulatory Monitoring, Inc

Linda Tavolacci
Linda Tavolacci is Vice President, Ambulatory Monitoring, Inc.

Ambulatory Monitoring (AMI), located in Ardsley, NY, and headed by its president, Thomas Kazlausky, is a pioneer and innovator in ambulatory instrumentation. In addition to the Inductotrace inductive plethysmograph, the instrument of choice for respiratory monitoring throughout the world, its product line includes the PVT-192 Psychomotor Vigilance Task Monitor, the gold standard in reaction time measurement, and the Motionlogger Actigraph, the most sensitive and accurate actigraph on the market, providing an approximate 88% correlation to polysomnography.

AMI products provide a valuable adjunct means to aid in the diagnosis of sleep disorders, track treatment efficacy, and allow for an economical method of long-term follow-up.

To meet the challenge of a growing concern with regard to the effect of sleep deprivation on alertness and performance, AMI incorporated into its line of Motionloggers a quick and easy means to download recorded sleep data into the Air Force-developed Fatigue Avoidance Scheduling Tool (FAST program). It also developed an addition to its line of Motionlogger analysis software ActiFAST, which contains all the features of the user-friendly, well-known Action W-2 program and also provides an expression of performance based upon sleep equivalent to blood/alcohol level, providing clinicians an easy-to-comprehend means to express to patients the seriousness of sleep deprivation as it relates to cognitive ability. In addition, AMI has developed Palm Logger Software, which includes a sleep diary (with Stanford and Epworth sleepiness scales) and a low resolution reaction time measurement test.

AMI attempts to relate its R&D efforts toward the needs of customers and the public at large. For example, in response to concern over the increasing numbers of children diagnosed and pharmaceutically treated for Attention-Deficit Hyperactivity Disorder, AMI is currently embarking on federally-funded clinical site testing of a new Motionlogger device to measure a child's motor activity and use "feeding actigraphy," operant conditioning, and behavioral therapy as a treatment alternative. Moreover, in conjunction with a highly respected physician in the field, AMI currently provides a service that includes objective actigraphic data collection as one criterion in the diagnosis of ADHD. It is the aim of AMI to work closely with personal contacts and the medical community at large and gear its research and development efforts accordingly.

AMI attends numerous medical conventions annually as a means to educate healthcare professionals and clinicians with regard to the value of our products in sleep and sleep-related fields. AMI invites people to visit its website at ambulatory-monitoring.com to learn more about its line of instrumentation, and it is planning to host an actigraph information seminar sometime next year. AMI also provides CDs and DVDs to educate people on the use of its instrumentation.

AMI has taken an interest and role in obtaining the current Category III CPT Code for Actigraphy (#0089T), and it encourages all clinicians to diligently use this code in order that a fully-refundable actigraph Category I Code will evolve this year.

AMI is constantly striving to meet the needs of the sleep industry. It will soon be expanding its product line—striving to serve the medical community with state-of-the-art ambulatory monitoring equipment. On the horizon, for example, is development of a feedback Motionlogger to meet a growing concern in the sleep arena with regard to the interacting epidemic of sleep loss, obesity, and inactivity—particularly in American youth. This is an application of the Motionlogger

BuzzBee in which children are encouraged to be more active. Contact ambulatory-monitoring.com.

Ingen Technologies, Inc

Ingen Technologies, Inc develops and markets cutting-edge medical technologies designed to increase accuracy of medical care and prevent unnecessary medical costs associated with today's healthcare industry. Ingen is a medical device manufacturer that owns several US patents and has several patents pending in the US, Japan, European Communities and People's Republic of China. The company's Secure Balance product line and OxyView product line currently provide revenues for the company.

The company's flagship product is OxyView. An FDA registered and classified device, OxyView is a pneumatic gauge that provides visual monitoring of oxygen flow-rate for patients in the hospital, surgical room, outpatient therapy, nursing homes and emergency response facilities. It also provides a use with commercial aviation product manufacturers of oxygen delivery systems for pilots. This product enhances the safety, assurance and accuracy of patients being administered oxygen from any source. OxyView is a lightweight pneumatic gauge that is attached to the oxygen tubing just below the neck that displays the oxygen flow rate near the patient and the cannula; allowing instant verification of any leak or inaccuracy between the delivery source and the cannula.

OxyAlert, a second-generation design of the Company's BAFI product line that provides a low-oxygen safety warning device used on remote oxygen cylinders for patients, hospitals, commercial aircraft, military transport, and fire and safety equipment. OxyAlert technology uses digital sensing and RF frequency transfer so that caregivers can access a hand-held remote to monitor the actual oxygen level of any oxygen cylinder from a reasonable distance. OxyAlert increases safety and convenience for patients and clinical staff.

The Secure Balance product is a private-label product that includes a vestibular function testing system and balance therapy system. The Secure Balance program provides equipment, education and training of balance and fall prevention to physicians and clinicians worldwide.

"Our team of professionals has developed our medical products for the ever-increasing elderly population. Our products are superior to any of our competition and they allow for effective medical product availability to seniors, and at the same time the increasing senior population allows for a steady growth in sales and profits," said Scott Sand, CEO & Chairman of Ingen Technologies.

Ingen Technologies, Inc, a Georgia Corporation, was formed as a result of a reverse merger in March 2004 whereby Ingen became a publicly-owned company. Operations are conducted through a 100%-owned subsidiary, Ingen Technologies, Inc of Nevada, which has been in business since 1999 when Chairman/CEO Scott R. Sand founded it. The principal executive office is in Yucaipa, CA, northeast of Los Angeles.

Ingen has devised a business model with some very appealing operational and economic aspects. First, its core strength is obtaining intellectual property rights (owning patents and trademarks) to technologically advanced products, particularly with medical applications for the elderly portion of the population, among whom aging increases the incidence of balance and breathing disorders. Second, Ingen deliberately does not do any manufacturing in-house. Ingen avoids the necessary investment in, and headaches of, manufacturing. Third, in the case of both Secure Balance and the BAFI line, the sales function is, and will be, outsourced to organizations with existing marketing channels. Again, Ingen escapes the costly and time-consuming necessity of creating an internal sales force. There is a rational *quid pro quo*: Ingen gains immediate access to a productive marketing organization; the latter gains equally rapid access to an additional, and attractive, product to pour through its distribution pipeline. Thus, there are mutual—and major—economic efficiencies and timesaving, for both parties.

There is a real economic savvy to Ingen's approach in two particular respects. First, overhead expenses are sliced to a minimum: no internal manufacturing or selling. Therefore, a big chunk of any future incremental revenue growth would flow through the income statement to earnings. Second, in the future, Ingen is positioned to add other interesting technologies to its product portfolio, thereby boosting revenues and leveraging earnings. Contact imgen-tech.com.

Aerogen Ireland Limited

John Power
John Power is Managing Director, Aerogen Ireland Limited.

Describe your products and their unique features.
Having spent many years working in the design of critical care ventilators, I was struck by the limited performance of typical drug delivery options available for ventilator applications. My objective became the design and development of a significantly improved nebulizer for ventilator application which addresses the shortfall of traditional devices. The result of this quest was the 2002 launch of our Aeroneb Pro nebulizer, a nebulizer specifically developed for critical care patients receiving mechanical ventilation that offers caregivers the opportunity for improving drug delivery efficiency while at the same time, reducing drug and personnel costs associated with respiratory care in the hospital setting. Using OnQ micropump technology and unlike traditional nebulizers, the Aeroneb Pro adds no pressure or volume to ventilator circuits and minimizes drug waste by nebulizing virtually all medication. The Aeroneb Pro produces a fine particle, low velocity aerosol optimized for deep lung drug deposition. This autoclavable nebulizer enables multi-patient use in-line with mechanical ventilators.

The latest addition to our critical care nebulizer range, the Aeroneb Solo nebulizer, is a product line extension of the Aeroneb Pro nebulizer and was developed and designed in direct response to market need. The Aeroneb Solo offers the same aerosol characteristics that care givers have come to expect from the Aeroneb Pro. The Aeroneb Solo is a dual functional nebulizer, in addition to intermittent functionality; it also offers the caregiver the ability to conveniently continuously nebulize patients when powering the nebulizer with the Aeroneb

Pro-X controller. It can be used for intermittent therapy for up to 28 days and for continuous therapy, for up to 7 days, after which time it is disposed of. Its light weight and small size makes it attractive for use with pediatric and neonatal patients.

How do your products directly affect patient care?
The Aeroneb Pro and Aeroneb Solo nebulizers are very efficient, delivering up to four times the amount of medication inline verses a traditional small volume nebulizer. They incorporate Aerogen's OnQ micropump aerosol generator which produces an optimum, low velocity aerosol for deep lung drug delivery. The Aeroneb Pro is a reusable device with a warranty for one year whereas the Aeroneb Solo is a disposable device that offers the care giver the convenience and flexibility of either intermittent or continuous nebulization therapy depending on a patients needs. As the Aeroneb Pro and Aeroneb Solo do not require additional airflow to generate an aerosol, this makes these nebulizers ideal for use with neonatal patients whose airways are susceptible to increased airflow. They nebulize virtually all of the medication at an acceptable flow rate of approximately 0.4mL/minute.

What sets your products apart from others in the field?
The Aeroneb Pro and the Aeroneb Go nebulizers were both designed specifically with the care givers and patients' needs central to the design process. Both nebulizers incorporate Aerogen's OnQ Aerosol generator which utilizes our patented micropump technology to produce a high-quality aerosol with fine, low-velocity, consistently-sized particles. The OnQ aerosol generator does not heat or shear medications, thereby making it ideal for nebulizing a broad range of drugs including biological based drugs and suspensions.

Discuss your R&D process, including end-user input.
As an organization, Aerogen is fully committed to research and development with 30% of turnover re-invested into the R&D process. We operate a structured 5 stage R&D system to ensure a timely advance from new idea concept through validation and ultimately to market launch. Our product development process ensures continual updates and improvements are implemented in our portfolio of products. Both our research and development efforts are supported by a dedicated and experienced team of engineers and marketers.

What are your goals for R&D in the near future?
Our R&D goals are firmly rooted in responding to our customer's needs thereby ensuring that our respiratory care products enable best practice in associated patient care. We are also researching other applications for use of our micropump technology in other medical fields. Our activities will always remain centered on high value add technology applications that have greatest impact on the improvement of overall patient care where we will continue in our pursuit of leading edge innovation.

Discuss the role of critical care providers in developing and upgrading your products.
Feedback from critical care providers is the epicenter of our product development and design process. Without input from critical care providers we are effectively working in a vacuum. Being a marketing led organization, all our product upgrades and extensions have been introduced as a result of response to specific market needs. Although we are the experts in aerosol technology, we are not the experts in patient therapy, we rely on our critical care providers to help us here to ensure our products meet their clinical needs and expectations.

Talk about how you test and evaluate your product in actual day to day use.
We operate a strict quality policy within Aerogen to ensure our products are manufactured to the highest standards. We take our commitment to our quality policy, and ultimately to the patients on whom our products are used very seriously. Rigorous checks are performed on all incoming raw material, on our products at various intervals during the manufacturing process and on final product. Our Aeroneb Pro and Aeroneb Solo nebulizers are both FDA 510(k) cleared and CE marked.

What new technology do you see as having the greatest impact on your area of expertise?
The most significant looming advancement that will have the greatest impact on our field of expertise is the potential to deliver traditional systemic drugs via the pulmonary route. Inhaled insulin is a successful example of this trend, but we know of several other companies working on exciting programs ranging from pulmonary delivery of erythropoietin, human growth hormone, antibiotics, prostacyclin therapy to name but a few. These new applications will require highly efficient drug delivery with minimum waste of drug. We believe Aerogen's nebulizers, which deliver consistent repeatable doses, are well poised to meet such technology requirements.

Discuss the international scope of your testing/marketing/development efforts
Aerogen's R&D and testing facilities are based at our headquarters in Galway, Ireland. Our marketing activities are also based in Galway. We believe in co-location of R&D and marketing, however, marketing intelligence is acquired globally. Our products are available in over 50 countries worldwide through strategic partnerships set up with leading ventilation companies and through an independent distribution network.

Tell us how you utilize conferences, seminars and such to promote your product.
Aerogen exhibits at key international respiratory meetings including AARC, ISICEM, ESICM and ERS among others. We set out clear objectives that have to be reached at each exhibition. These range from significant events such as product launch, the search for new distributors and specific market intelligence gathering. Exhibiting at conferences and seminars is a great opportunity for meeting a high concentration of critical care providers in a short period of time. It's always an honor to listen to experiences of how existing users have been able to improve patient care through using our technology and it's always refreshing to demonstrate the products to someone who is unfamiliar with our technology and gauge their amazement as they see the aerosol being generated.

VENTILATION ROUNDTABLE

Dräger Medical, Inc.

Robyn Whalen, RN, BSN, MBA
Robyn Whalen is Director, Marketing Critical Care (Care Area Director), Dräger Medical, Inc.

What ventilation products do you currently offer?
Draeger Medical (DMI) offers ventilation products that support all patient categories—neonatal, pediatric and adult—without compromise in typical and advanced hospital settings. In addition to products for hospital use, DMI offers homecare ventilation solutions and a full line of emergency and transport ventilators for ambulance use.

How has technology changed over the past five years?
The healthcare industry strives to improve the quality of patient care while combating the rising costs of healthcare. At DMI, our overall goal has been to improve patient care in a cost-effective manner while increasing opportunities for increased throughput and revenue generating opportunities. DMI has introduced products that have changed the landscape of ventilator options by emphasizing advances such as open breathing systems, non-invasive ventilation and automated weaning protocols. All of these have the ability to improve the patient experience while reducing recovery time and ultimately decreasing costs.

What are the latest advances in technology that you have introduced?
In late 2005, DMI introduced the SmartCare option for the EvitaXL ventilator. SmartCare is a knowledge-based ventilation system developed to improve the efficiency and effectiveness of the weaning protocols. SmartCare automates the weaning process, based on the user's input, and uses continuously measured parameters and patient respiratory profiles. As the level of ventilator support is adjusted automatically, the patient's response and ability to adapt to each change in support is evaluated. Automating your weaning protocol can lead to reductions in the cost of care and improved resource utilization.

What type of training and customer support programs do you have in place?
DMI has 1,300 service engineers in more than 50 countries around the world available to help protect customers' financial investments and keep medical equipment operating at peak performance levels. This service is an amenity that ensures continuous efficiency of DMI's devices throughout their lifecycles. The experience gained from servicing thousands of devices on a daily basis helps DMI better understand specific customer needs. DMI helps customers make the most of their clinical resources by offering education and training tools that empower staff through learning modules in everything ranging from basic device training to process management.

What in terms of cost-savings/benefits does your technology bring?
DMI provides solutions that help clinicians offer the very best in patient care. By emphasizing constant innovation, seamless integration and comprehensive services, DMI is able to offer products that help improve the patient experience, process efficiencies and optimize care.

EMERGENCY PLANNING/DISASTER PREPAREDNESS ROUNDTABLE

eVent Medical

Stephen Tunnell, RRT
Stephen Tunnell is President and Chief Operating Officer, eVent Medical Inc.

By way of background, describe your products.
Our company is focused on meeting clinicians' needs in the area of ventilator care. In order to accomplish this, we have made it a priority to hire Respiratory Therapists so that their experiences and needs—as well as the needs of today's customers are captured and embodied into our ventilators. In the area of disaster preparedness, we have focused on the need to preserve life support in the absence of power or wall air. Our ventilators are equipped with internal compressors that can be operated by the internal battery for well over 2 hours. We also provide optional external batteries that can add as much as another 8 hours of operating time. We feel this has been a success based on letters and testimonials coming out of the Coastal and Gulf regions where they suffered from tornados and hurricanes. Additionally important is that our product provides this kind of lasting power while providing sophisticated, high-end proportional solenoid breath delivery featuring all the advanced methods of ventilation from infant to adult.

How can your company help an area stricken by a disaster or in an emergency situation?
Our products are designed to handle the rigors of the ICU, and that includes sometimes the disaster-stricken areas. Our ventilators are great in transport and in continuing to operate in the absence of power and wall air. Our technology can also accept lower pressured oxygen systems as a source gas which could be a necessity in a disaster.

What products does your company offer to assist in this type of effort?
We offer infant to adult ventilators that can be used invasively or non-invasively.

Has your company had any experiences with dealing with man-made or natural disaster situations?
Our ventilators were used in Thailand and Indonesia in the aftermath of the tsunami. Our products have been used in Miami and withstood the loss of hospital power and wall air. While caregivers were rushing around the unit to hand ventilate patients on our competitors' products, the light from our user interface helped illuminate the ICU and caregivers as to the practical value an eVent Inspiration ventilator brought to them during their times of need.

What contingency plans does your company have to boost production of your product in case of a disaster or emergency?
Our product is produced in an environment where our capacity to boost production exists. Further, it is our goal to keep a stock of finished product available for these sorts of situations.

What types of education do you provide, relevant to emergency services or disaster planning, for both your own personnel and for those using your products?
As mentioned previously, we employ medical professionals who are trained for these sorts of situations, and we support their continued education. For our customers, we have a number of educational venues where they can learn not only about our products but about clinical science.

Please visit our website event-medical.com and enter the ICU–Inspiration Clinical University.

What mechanisms relevant to your product are in place to assist hospitals, clinics, and users in the event of emergency use of you products?
The most important thing we can do as a manufacturer is to create an easy-to-use, intuitive ventilator. We are proud from the feedback about our products that we have met this challenge. In case of an emergency, you can always call our 24-hour hotline (888) 454-VENT (8368).

Discuss the role of critical care providers in research, development, and improvements and/or new applications of your products in emergencies and for disaster-preparedness.
As mentioned above, we not only hire clinicians but we insist on taking external clinician guidance and feedback on a worldwide basis.

Talk about how you test and/or evaluate your product in-house and in the field.
Our products are developed, tested and ultimately produced under a strict ISO 13485 and cGMP compliant design control system. Under this system, we employ clinical input from concept throughout design and into the finished product. In fact, we employ clinical testing as a key element of our product's release to the market.

Tell us about how you're promoting your product as it relates to emergency usage and applications.
We have an account executive and the marketing organization focused on identifying and liaising with key individuals in this discipline.

Newport Medical

Cindy Miller, RRT
Cindy Miller is Director Clinical Education, Downstream Product Manager, HT50, Newport Medical

By way of background, describe your product.
The 15 lb Newport HT50 is the only ventilator that offers a patented dual-piston driven gas generator, the most capable and flexible, yet gas and power efficient gas delivery system of its kind. This makes the HT50 both clinically proficient and robust so that it can meet the ventilation needs of the most critical patients, even in the most hostile environments. The HT50 offers full ventilation capabilities from rescue ventilation to long-term care to weaning. Yet, it is extremely portable. The internal battery can run a full-functioning (including the internal compressor) HT50 for up to 10 hours and takes only 5-7 hours to recharge from any 100-240 VAC or 12-30 VDC power source using a simple power cord. Newport offers external batteries to meet extended DC power requirements but the user can also employ batteries of their choice within the 12-30 VDC range. A standard car battery that might run another ventilator for five hours will run the HT50 for four or five times that long.

Some other facts about the Newport HT50 Ventilator:

- Made in the USA.
- Meets or exceeds all AARC Guidelines for Acquisition of Ventilators to Meet Demands for Pandemic Flu and Mass Casualty Incidents
- The easiest to use, most intuitive ventilator of its class
- Uses one, non-proprietary universal circuit for all patients (no need for patient-specific circuits)
- Provides the highest level of patient safety for all patients from pediatric to adult and the highest level of caregiver safety.

How can your company help an area stricken by a disaster or in an emergency situation?
We help our customers build a Total Solution Program that enables them to face any ventilation emergency with strength, consistency and confidence.

- From ground zero to hospital to alternate care site to home
- Meets AARC guidelines
- Internal (10) + External (8-15) battery = up to 25 hours use time
- Ventilates children and adults
- Enables seamless continuum of care
- Personalized Training and Education Programs**:** Multidimensional trainings for responders in all levels of the program; accredited training and education programs; advanced preparation of responders to use, maintain and service the HT50.
- Clinical and Technical Support Services: 24 hour hotline manned by extensively trained healthcare professionals; regional specialists to support customers on site; personal and internet options for FAQ's and troubleshooting.
- Customized, flexible purchasing programs allow our customers to secure the TOTAL number of ventilators they need.

We can provide the right product, training and support for superior clinical results.

Has your company had any experiences with dealing with man-made or natural disaster situations?
Newport has extensive experience in this area. The Newport HT50 was deployed throughout China during the SARS crisis. Newport embraced this challenge and exceeded the expectations of users and government agencies throughout the process. In fact, Newport received a beautifully framed Certificate of Appreciation from the Shanghai Red Cross, a branch of the Red Cross Society of China, in recognition of our donation of ventilators, "for Humanitarian Aid and Relief." We have also worked with many other government agencies to assist with the preparation and equipment procurement needed to plan appropriately for the possibility of natural disasters. Our HT50 is ideal for this application for many reasons, one of which is infection control. Questions have been raised about the safety of using portable ventilators in the treatment of patients with maladies such as SARS and Avian Flu since the air

Pandemic Flu
Disasters
Emergencies

Be Prepared
with the Newport HT50 Ventilator

The responsibility of ensuring preparedness for pandemic, disaster or mass casualty incidents is a duty we all take very seriously. The portable ventilator is an essential component of this preparedness.

The Newport HT50 Ventilator is perfectly suited for the treatment of those inflicted by respiratory illnesses or trauma. In fact, this product saved many lives in Asia during the SARS crisis.

The advantages of employing the HT50 for emergency situations go beyond product capabilities. Newport Medical Instruments' Total Solution Emergency Preparedness Program includes finance, delivery, service and training options customized to fit your needs. Our commitment to excellence ensures that your ventilators and your users will be ready to go when disaster strikes.

Be prepared. Contact Newport Medical Instruments today.

NEWPORT NMI

1620 Sunflower Ave., Costa Mesa, CA 92626
800.451.3111 www.ventilators.com
customers@ventilators.com

delivered to the patient is drawn in from the room rather than from a cylinder or piped-in air system. The concern is that if the virus is spread through the air and the ventilator draws in contaminated room air, it might contaminate the ventilator interior and possibly re-infect the patient or other patients in the same hospital environment.

The Newport HT50 Ventilator is uniquely equipped to prevent contaminated air from entering the ventilator. To protect against this possibility, the air inlet filter used in the HT50 was chosen because it is very effective in capturing bacteria and virus organisms. The HT50 inlet filter material has been tested to BFE (Bacterial Filtration Efficiency) and VFE (Virus Filtration Efficiency) standards. These are international standards to judge the efficiency of trapping bacteria and viral organisms. The HT50 filter material has a BFE efficiency rating of 99.7523 and a VFE efficiency rating of 99.6216. These tests were completed by independent national laboratories and show that the HT50 gas inlet filter material provides an extremely effective barrier to both bacteria and virus organisms.

Newport's CBRN adapter allows you to expand patient and caregiver protection by connecting any NATO-style Chemical-Biological-Radiological-Nerve Gas filter to the ventilator's gas intake port.

What contingency plans does your company have to boost production of your product in case of a disaster or emergency?
Newport employs a flexible production program which allows us to dramatically increase production and delivery of the HT50 Ventilator. Established minimum stores of components at the supplier level and at our facility and forecasted stores of finished ventilators allow us to be highly responsive with production and delivery schedules. Newport can effectively boost production by 400% within a very short lead time.

Newport has also created a strategic reserve program for HT50 Ventilators which would allow us to supply a significant number of additional units beyond the expanded production levels within hours from the time a need is identified in case of disaster or emergency.

What types of education do you provide, relevant to emergency services or disaster planning, for both your own personnel and for those using your products?
Newport is a strong believer in education for our employees and for our users. Newport employees attend monthly education classes which include disaster planning. It is also our practice to work side by side with our customers to help them plan for successful deployment of ventilators both in the hospital and in the field in the case of a disaster.

Newport's multidimensional clinical training programs include:

- Hands On "Train the Trainer" sessions at our customers' designated sites
- Newport's Interactive CD guides users through practicing their clinical skills with a virtual HT50. CD training includes a competency exam that is scored and can be printed out for training certifications. Easy guides for quick reference can be attached right to the ventilator.

Caregivers are very busy and finding time to train on new devices can be difficult and stressful. Newport's simple, accessible HT50 clinical training programs ensure that caregivers maintain their proficiency so that they can feel confident applying lifesaving ventilation skills during crisis situations.

Newport is both a BRN and AARC CME provider. We make it easy for licensed caregivers to obtain the contact hours needed to maintain credentialing. Newport's Technical Service and Maintenance programs certify personnel to perform functional tests, calibrate and maintain the HT50 so that they can keep equipment running at peak performance levels with extremely short turn around times.

What mechanisms relevant to your product are in place to assist hospitals, clinics, and users in the event of emergency use of your products?
- Newport has developed special "EP" (Emergency Preparedness) packaging that includes special training aids and quick guides packaged with each ventilator.
- When users have an urgent question, Newport is at their service 24-7! Our highly trained clinicians and technicians are available to assist hospitals, clinics, and users by phone, day or night via our 800 hotline.
- Less urgent clinical and technical questions about the HT50 are readily answered by phone or email. It's easy to access help through the Contact Us section of the Newport website, ventilators.com for telephone extensions and direct-link email.
- The Education section of the Newport website, ventilators.com, contains Clinical Bulletins that keep users updated on new clinical applications for HT50 and Q&A's that answer the most commonly asked questions.
- Newport is a clinically focused company. The president is a physician and Newport's nationwide network of clinical and sales specialists are all former healthcare professionals. We believe in providing support whenever the customer needs it, day or night, emergency situation or every day use.

Discuss the role of critical care providers in research, development, and improvements and/or new applications of your products in emergencies and for disaster-planning.
Newport partners with critical care providers to ensure that HT50 product development stays abreast with current and new ventilation requirements for patients affected by disasters. HT50 offers ICU-style ventilation, including noninvasive ventilation (with a non-vented mask) so that emergency caregivers are equipped with what they need to handle the full spectrum of patients. With that said, it should be noted that Newport also believes that the best ventilator for emergency use is one that is simple to use. Our keen focus on the needs of the emergency provider ensure that every design element of the HT50 Ventilator contributes to rather than detracts from simplicity of use.

Talk about how you test and/or evaluate your product in-house and in the field.
Newport makes only life support products and our testing and evaluation procedures reflect the seriousness of our charge.

- During the development phase, our design is tested by highly trained engineers, outside test houses, and qualified clinicians.
- After the safety and performance has been verified, clinical

validation ensures that the design meets the goals for the product.
- During production of the finished product, our comprehensive testing starts at the component level and continues throughout the manufacturing and completion of the finished goods to ensure that all aspects of the product meet our stringent quality standards.
- Additional beta-site field testing is performed to get real-world feedback prior to release to the general medical population.
- Following the sale of the product, post market surveillance ensures that we have a keen understanding of how the product is perceived by the end users. We continually evaluate our own testing processes to ensure that we meet or exceed our own quality standards.

Discuss your R&D process, including clinician and user input, both in terms of emergency and day-to-day applications.
Newport's research and development process includes a parallel investigation of new ideas along with new technologies. Newport works closely with physicians, respiratory therapists and other clinicians throughout the world to make sure that our product development follows the pathway of need while providing safe, reliable devices. Post-sale clinician input is facilitated through our post market surveillance program. These ideas are incorporated with the same earnest consideration as those gathered during the initial development process. Newport goes even one step further for emergency preparedness. We have an Emergency Preparedness Team which is dedicated to staying abreast of the product, education, packaging and delivery requirements associated with emergency response. In conclusion, we believe that the Newport HT50 is the ideal ventilator for emergency preparedness programs. Its size, ease of use and clinical capabilities ensure that first responders will have the proper equipment when faced with a disaster or emergency situation that requires respiratory support. Newport is committed to providing the highest quality of equipment and services that these unique conditions require.

Hamilton Medical, Inc

David Costa
David Costa is Vice President and COO, Hamilton Medical, Inc.

By the way of background, describe your product and its unique features, including the latest in product development and applications.
Intelligent Ventilation by Hamilton Medical, offers one very unique advantage in the event of an emergency or disaster. That unique advantage is automation. In the best of circumstances, there is a well recognized shortage of qualified healthcare professionals. In an emergency or disaster that shortage will be even more severe. It is bad enough that our clinical teams are pushed to the limit on a normal work day, but add the threat of contamination themselves, and you multiply the stress exponentially. Should a pandemic strike, the challenge will be getting healthcare workers to report for work, period.

Many have cited the need for more ventilators in the event of an emergency or pandemic. I believe that unless the ventilator that you select is a "force multiplier" by offering a "ventilation autopilot" you have wasted precious capital resources. In a recent New York Times article, the statement was made that, "Hospitals operating on thin profit margins, say they cannot afford to buy and store hundreds of units that may never be used. Cheaper alternatives can be deployed in a crisis, but doctors say they are grossly inadequate to deal with a flu pandemic." Hamilton Medical is the only ventilator company that offers a ventilator that can provide either a sedated or spontaneously breathing patient correct support without the need for constant supervision by a clinician. In an emergency situation, clinical teams will need to be caring for the casualties, not the equipment. Hamilton Medical also offers a simple and unique scavenging system that can filter expiratory gasses from infectious patients. Hamilton Medical responded in full force during the SARS outbreak in Asia, where this product was proven highly efficient. The Hamilton ventilators stay completely isolated from patient contamination. The scavenging system is completely disposable.

How can your company help an area stricken by a disaster or in an emergency situation?
Hamilton Medical is always available to assist anyone during a time of a disaster or emergency situation. If they don't ask, we will call. We are offering a very unique disaster/emergency program that allows health care facilities to participate in a shared ownership program of sorts. The Hamilton Emergency Life-support Program (HELP) allows a hospital to invest minimum dollars for access to a specific number of mechanical ventilators, clinical staff, and virtually everything needed to support the ventilator (including disposables). Participation in HELP allows the healthcare facility to leverage their available funds. In the event of an emergency or disaster, a complete Hamilton Medical team arrives to set-up, train and support the equipment during those initial hours or days of an emergency when the situation is the most tense. The hospital need not worry about stockpiling equipment. Hamilton Medical makes sure that the equipment is always in patient ready condition. Since training on Intelligent Ventilation is so simple, the team of Hamilton Medical Respiratory Care Professionals can get virtually anyone basic competency with the "ventilation autopilot" in very short order. This allows the hospital Respiratory Care Professionals to focus on the most critical tasks right away, without compromising patient safety with transport or portable ventilators that require manual ventilator settings and do not adapt to a dynamic patient.

What products does your company offer to assist in this type of effort?
HELP is only available to facilities that have taken the opportunity to sign up in advance. These customers are triaged by our disaster management team to top priority. All other response from Hamilton Medical is directed on a first come, first serve basis. HELP is a new initiative and will be expanded based upon interest from government, military and individual health care facilities.

Has you company had any experiences with dealing with man-made or natural disaster situations?
Yes. Two examples of Hamilton Medical's experience with dealing with man-made or natural disasters are the SARS outbreak in Asia (2003) and Hurricane Katrina (2005). HELP is a totally new initiative and has not yet been implemented in support of an emergency or disaster.

What contingency plans does your company have to boost production of your product in case of a disaster or emergency?
Hamilton Medical believes that the best way to address a disaster or emergency is to plan in advance. This is the main reason behind HELP. This allows for a no-hassle implementation of support on minimum notice. In the event of an unplanned demand for ventilators, Hamilton Medical is ready. We can increase our production five-fold in very short order and maintain that for several months. Hamilton Medical has set up a hierarchy of action that ensures existing Hamilton Medical customers are always served first before we address needs outside of the current owner group. We are obligated to those facilities that have been the leaders in incorporating Intelligent Ventilation. They are the ones who are changing the mechanical ventilation paradigm forever.

What types of education do you provide, relevant to emergency services or disaster planning, for both your own personnel and for those using your products?
Intelligent Ventilation from Hamilton Medical is the primary educational focus of the organization. When health care professionals realize how Intelligent Ventilation from Hamilton Medical benefits them, and more importantly the patient, we can have "next step" conversations like disaster planning and emergency preparedness. Intelligent Ventilation provides dramatic improvements in patient safety, staff efficiency, risk reduction and quality improvement. Hospitals that have interest in, or participate in the Hamilton Emergency Life-support Program (HELP) have the opportunity to receive specialized training and consulting services relevant to the scope of the program. This mission specific training provides the highest level of readiness to both parties.

What mechanisms relevant to your product are in place to assist hospitals, clinics and users in the event of emergency use of your products?
HELP redefines disaster preparedness for mechanical ventilators. The program is simple, and designed to address localized disasters and emergencies. In the event of a national pandemic or national emergency no one program can address all needs, but history has shown that regional emergency events are by far the most prevalent. Hamilton Medical makes a great many analogies with commercial aviation. As a former airline pilot, I learned early on that you cannot address emergencies correctly unless you train, evaluate and critique performance on a regular basis. Many times our first step with a Hamilton customer is product training. That is simply not enough. Hamilton Medical is now focused on Human Factors Training. Put simply, our role is not to teach clinical practice but to train correct interaction between the human operator and the ventilator itself. Common elements like a pre-flight check, crew briefing, procedures, flows and checklists are incorporated into this kind of training. Hamilton Medical's Human Factors Training is applicable to any facility that manages ventilators, regardless of manufacturer.

Discuss the role of critical care providers in research, development, and improvements and/or new applications of your products in emergencies and for disaster preparedness.
Hamilton Medical has implemented a comprehensive customer and clinical feedback system. Intelligent Ventilation is so dramatically changing the "clinical standard" that it demands that Hamilton Medical catalogue all feedback for analysis. Intelligent Ventilation is all about protecting the patient from harm due to mechanical ventilation. Intelligent Ventilation is also focused on making the ventilator as hassle-free as possible for the clinician as well. Those involved in serving the patient, need to be free from the limitations that medical instrumentation imposes on their already hectic day. In June, Hamilton Medical launched a new initiative to discuss the clinical issues around new technology's role in patient safety, staff efficiency and quality improvement. We are the first ventilator company in the world to do this. Hamilton is calling this new program the "Initiative for Patient Safety in Mechanical Ventilation." I consider it my personal mission to put together an industry consensus meeting on closed-loop control: impact on safety, efficiency and quality in critical care. I thank you for allowing me this opportunity to invite executives from other ventilator companies, clinicians in all fields of critical care practice, patients, healthcare executives and clinical associations and organizations to join me in putting together an un-biased consensus meeting on a paradigm whose time is already upon us. As an airline pilot who has always been one to "fly by hand," I can tell the readers that appropriate automation combined with better situational awareness and human factors analysis will benefit the patients that we all serve. An airline captain must follow strictly evidence-based procedures, protocols and report deviations to those established criteria. We fought these initiatives at first, but soon learned that this in no way limited our command authority, but by embracing this change, greatly improved safety for our passengers. There may be a reason why we adopted this more quickly in aviation. We are sitting in the same aircraft as our passengers! There is a huge benefit for the clinical team with Intelligent Ventilation and Hamilton is taking great care to educate our clinical experts (customers) of "what's in it for them as well!" It is our obligation in industry to separate gadgets and features from what makes the best sense for the patient, the clinician that dedicates themselves to the patient and the already strained healthcare system as a whole. Anyone with interest in moving ahead with this initiative, please contact me directly.

Talk about how you test and/or evaluate your product in-house and in the field.
Hamilton Medical does a majority of its initial product testing at top institutions in Europe and elsewhere. Our product development team is in Bonaduz, Switzerland. The evaluation of our devices is on-going and never stops. Information from users is constantly re-evaluated to determine the next step in the improvement process. This is a big reason for our high grades with industry watchdog groups. We are never satisfied with "good enough."

Discuss your R&D process, including clinician and user input, both in terms of emergency and day-to-day applications.
Intelligent Ventilation from Hamilton Medical will never have an "end point," so R&D continues every day. We are well along the road to a fully automated ventilator that allows the clinician to choose from several "autopilots" depending on the situation. Imagine a ventilator that can assess proper ventilation, oxygenation AND lung recruitment status. Imagine the RT now able to look only at caring for the patient, managing a dynamic and automatic system that protects that patient from harm while they perform the high level management functions that only a human can perform (looking at the big picture). Would

this be helpful and dare I say, required, in an emergency situation? You bet.

Tell us about how you're promoting your product as it relates to emergency usage and applications.
Intelligent Ventilation is perfect for emergency applications. We are currently developing our next step… the world's first portable ventilator with Intelligent Ventilation, due out in the near future. In the meantime, Hamilton Medical is focused on promoting Intelligent Ventilation; now, any ventilator with simply manual control or traditional waveforms is obsolete.

Pulmonetic Systems/ VIASYS Healthcare

Jim Homuth
Jim Homuth is Director of Marketing and Unified Preparedness Coordinator, Pulmonetic Systems/VIASYS Healthcare.

By way of background, describe your products.
Pulmonetic Systems' hallmark LTV Series ventilators are a result of dedication to quality and innovation. At the size of a laptop computer, these ventilators offer powerful features previously available only on standard-sized critical care ventilators. The LTV Series' unique miniaturization technology and advanced pneumatic design are combined, forming a self-contained ventilator capable of meeting the needs of the most challenging patient.

How can your company help an area stricken by a disaster or in an emergency situation?
Pulmonetic Systems/VIASYS Healthcare has over 30,000 LTV ventilators currently being used in the hospital, home, military, and transport applications. Intuitive controls allow the First Responder to deploy the system with minimal training, making the LTV series of ventilators the "pick-up-and-go" solution that can travel with the patients.

What products does your company offer to assist in this type of effort?
The LTV 1200 is the ideal ventilator for emergency planning and disaster preparedness. At a fraction of the size of comparably equipped systems, the LTV 1200 has the ability to adapt to changing respiratory needs. It is portable and easy to deploy in and out of the hospital environment.

Has your company had any experiences with dealing with made-made or natural disaster situations?
Pulmonetic Systems/VIASYS Healthcare has previous experience with supporting the relief efforts with hurricane Katrina. We were able to respond to this disastrous event within hours and ship out a total of 39 ventilators. We proved that we are amongst the best in the business of saving lives and are able to support all levels of medical emergencies 24 hours a day, 7 days a week.

What types of education do you provide, relevant to emergency services or disaster planning, for both your own personnel and for those using your products?
We have developed many educational tools that can be utilized. We have an emergency set-up card, a Go Pack, a Patient Interface Supplies Pack, as well as an educational CD to provide further information. We also have a CEU program.

What mechanisms relevant to your product are in place to assist hospitals, clinics, and users in the event of emergency use of your products?
The LTV Series of ventilators are small, lightweight critical care ventilators that support both invasive and non-invasive applications. It combines portability, impact-resistant construction, easy-to-read displays and comprehensive monitoring to patients as small as 5kg. Our product promotes healthcare safety and is able to operate from a diverse selection of power sources.

Talk about how you test and/or evaluate your product in-house and in the field.
From the design and development, to marketing and servicing its products, Pulmonetic Systems utilizes a progressive and rigorous quality system to ensure its commitment to offering products. This provides for better care for patients and a better value for the healthcare provider.

Tell us about how you're promoting your product as it relates to emergency usage and applications.
We have sold many ventilators all over the country and the world for emergency preparedness. We are currently working with several other states and countries to support their Emergency Preparedness/Disaster Planning efforts.

Respironics, Inc

Ulf Solback
Ulf Solback is the Vice President of Marketing for the Critical Care Business Unit of Respironics, Inc.

By way of background, describe your products.
Respironics revolutionized the noninvasive ventilation market with the release of the BiPAP VISION ventilator that automatically adjusts trigger sensitivity and cycling in response to leaks around the patient interface. We continue to reinforce our market position with new medical devices and patient interfaces that support our mission to provide lung protective solutions to avoid intubation and to safely liberate a mechanical ventilation patient from the ventilator as soon as possible. The new BiPAP FOCUS noninvasive ventilator is lightweight and portable with a battery back-up for moving patients within the hospital and it contains the Digital AutoTrak Sensitivity feature that made the VISION so popular. The ESPRIT Critical Care Ventilator offers a full range of ventilation options from infant to adult, invasive or noninvasive. Coupled with the $NICO_2$ Pulmonary Management System, the clinician is able to see the effects of mechanical ventilation long before they present as clinical challenges. The Cadence Self Breathing System has offered an alternative to traditional self breathing trials for many ventilator dependent patients.

Our capnography technology is not only available in stand-alone monitors and hand-held devices, but is licensed to other ventilator manufacturers around the world.

How can your company help an area stricken by a disaster or in an emergency situation?

Respironics provides comprehensive solutions to meet the challenging needs of disaster victims and health care providers. In the case of a protracted disaster, many patients will need to be treated outside of traditional medical facilities. Our invasive home ventilators and noninvasive BiPAP and CPAP devices will help to optimize patient care in these settings. As oxygen may need to be provided to these patients, Respironics offers a full line of oxygen concentrators and oxygen conserving devices. We also realize that the effects of a disaster can linger long after the initial danger has passed. For this reason, the Respironics Charitable Foundation was formed to assist the needs of disaster survivors and help them get their lives back on track.

What products does your company offer to assist in this type of effort?
The PLV invasive ventilator and the BiPAP VISION and BiPAP FOCUS noninvasive ventilators are the best options for use following a disaster. In fact, the PLV has such a low power draw it can operate through sources such as a car cigarette lighter or a 12-volt battery. In mass disaster scenarios, car batteries can be pulled and used to power the PLV. The Esprit Critical Care Ventilator which has a built-in centrifugal flow compressor and battery back up can be used to treat the more critical victims of a disaster. Respironics also offers the Millennium series oxygen concentrators, capable of providing up to 10 liters per minute of oxygen and able to operate in brown-out situations. The EverGo oxygen concentrator is portable and can operate for up to eight hours on internal battery. Portable hand-held pulse oximeters, EMS continuous positive pressure devices and a full line of noninvasive interfaces and breathing circuits round out a very comprehensive package.

Has your company had any experiences with dealing with man-made or natural disaster situations?
Yes, we assisted the national effort after the 9/11 tragedy as well as provided products and support during the relief campaign after hurricanes Katrina and Rita. During the SARS outbreak in Asia, Respironics supplied ventilators to China and Korea.

What contingency plans does your company have to boost production of your product in case of a disaster or emergency?
Our manufacturing facilities maintain a buffer inventory of product that can be drawn upon in the case of a disaster or emergency. We also maintain the capability of boosting production levels as needed by increasing the number of labor shifts per day and per week.

What types of education do you provide, relevant to emergency services or disaster planning, for both your own personnel and for those using your products?
Respironics formed a Pandemic Preparedness Committee to develop a plan to ensure business continuance in the event of a global breakout. A website and training materials are available to all Respironics employees on how to prepare and respond to a pandemic. We are also working on a business continuance plan in case of bioterrorism or natural disasters. Respironics products come with a Quick Setup Guide that provides easy to follow instructions on how to operate the equipment and how to select an appropriate size patient interface. Educational materials include protocol flowcharts for the application of noninvasive ventilation, a mask selection poster, and interactive training CDs for the BiPAP Vision, BiPAP Focus, Esprit Ventilator, Cadence, $NICO_2$ and emergency transport products. These training CDs are also available on Respironics educational website, elearning.respironics.com. Respironics is also creating product user guides directed toward non-medical personnel and working directly with local hospitals to train their employees on the proper use of Respironics' products.

What mechanisms relevant to your product are in place to assist hospitals, clinics, and users in the event of emergency use of your products?
With the Respi-Link System, software upgrades can be made to a number of our products over the Internet without the product having to leave the facility or the need for a technician to visit the hospital. This could be very important in an emergency situation where access to the hospital may not be possible.

In addition to a large hospital sales force, Respironics also employs the largest clinical specialist group in the critical care industry. These highly trained Respiratory Therapists interact with hospital personnel on a local level and would be the first line of clinical support in the event of an emergency.

Discuss the role of critical care providers in research, development, and improvements and/or new applications of your products in emergencies and for disaster-preparedness.
Respironics invests a sizable portion of its revenue in Research and Development to ensure we keep a viable pipeline of new products and services entering the respiratory care market. Our efforts to find better solutions for patients and care givers in general goes hand in hand with our efforts to address the need for disaster preparedness and to meet the needs of natural and man-made disaster victims.

Talk about how you test and/or evaluate your products in-house and in the field.
Our medical devices undergo rigorous verification and validation testing prior to evaluation in a clinical setting through customer preference testing. Clinicians using the products provide feedback to the design teams for validation of intended use and for recommendations for product improvements.

Discuss your R&D process, including clinician and user input, both in terms of emergency and day-to-day applications.
Respironics has a structured development process that includes feasibility, input, design, qualification and release stages. Clinician and user recommendations are obtained from the input through design and qualification phases. Final design validation is accomplished utilizing both simulated and actual use testing.

Tell us about how you're promoting your product as it relates to emergency usage and applications.
The Critical Care Corporate Sales Department maintains contact with governmental boards and elected officials to keep them informed about our products and services. We also receive information regarding public tenders for disaster preparedness equipment.

B&B Medical Technologies

David Thompson, Beth Keifer
David Thompson is President and Beth Keifer, RRT, is Vice President, Sales and Marketing, B&B Medical Technologies.

Being prepared means being equipped for any kind of emergency, be it hurricane, earthquake, manmade disaster or medical pandemic. However for the sake of this discussion we will be addressing the needs of the healthcare provider in the event of a medical disaster of great proportions. Worldwide, healthcare providers are being asked to prepare a plan for management of a probable flu pandemic. This plan will require that resources be in place to allow hospital facilities to manage the incoming patient load in the most expeditious manner and still maintain "normal" patient loads.

Recent disasters have shown the importance of ready access to appropriate resources necessary for rapid response teams. "Resources" is a collective term for people, machines, products and services. If one or all resources are not available, healthcare providers will have difficulty delivering optimal care. It is estimated that during a flu pandemic approximately 30% of healthcare providers will be absent from hospitals and that skilled clinicians will be available only in limited numbers. This will impact how healthcare providers support the patient load. As well, healthcare providers will have to determine best care at the right time and will need to implement strategies that will provide products that are easy to use, pre-packaged, and fit a variety of patient populations. As projected, statistics predict approximately 15 to 35% of the population will be infected with the flu and 7.5% of those infected will require invasive ventilatory support.

Disaster preparedness requires all team members to have the essential tools at hand. In the early phase of respiratory distress, both rescue and continuous nebulization therapy may be the primary treatment modality or may be used as a critical adjunct therapy combined with other pharmacological agents. The Omni-Max Nebulizer is uniquely designed for rescue therapy providing optimal medication nebulization combined with a built-in system for rescue Heliox gas delivery. The Omni-Max Nebulizer is packaged as a kit that includes aerosol delivery tubing and mask (adult or pediatric application) to eliminate the need to gather supplies when the patient is critical and time is of the essence.

The gold standard HOPE Nebulizer kits provide additional resources for delivery of continuous nebulization therapy with supplemental gas therapy, ie, Heliox therapy for both rescue and delivery of long term therapy. The ease of use and pre-packaged kit with aerosol delivery tubing and mask (adult or pediatric application) provide the tools indicated to support the patient and provide the clinician potential resources to impact overall patient care.

For the 7.5% of patients who will require invasive support, one of the necessary steps to support ventilation is the ability to secure the primary artificial airway. In 2005, the AHA adopted guidelines that recommend the use of precut, commercial tapes for securing endotracheal tubes during resuscitation. The B&B ET Tapes comply with the new AHA guidelines recommending the use of a commercial device for "securing the endotracheal tube for preventing accidental tube disconnects when compared with traditional methods of securing; i.e. tape". B&B's products fulfill these guidelines and provide the clinician the solution for securing protective airways during an emergency of any proportion.

B&B's airway management product line offers a complete package for rapid access to stabilizing the airway. The "all-in-one package" solution provides the tools necessary for the clinician to rapidly secure the endotracheal tube. The B&B products take into account the need for patient comfort with our selection of materials used to manufacture our products. All the B&B products are latex free and hypoallergenic.

For more than 25 years, B & B Medical Technologies has been the leader in the development of specialty airway management devices for infants, pediatrics and adults. B&B's Bite Blocks, StabilTube, and ET Tapes are the industry's standard bearers for most practitioners for their quick ease-of-use in a complete pre-packaged form. B&B products are designed for easy, one person application, helping to minimize risk of accidental disconnects and unplanned extubations. B&B's StabilTube, LockTite, E.T.Tape for Adults and Infants and Bite Block products provide clinicians simple solutions for comfortably securing the endotracheal tube, prevention of ventilator disconnects and a convenient answer to prevent ET tube biting.

The value of B&B products is in the economic design, manufacturing processes and time savings provided by a packaged product ready for use when the clinician needs it most. B&B products provide efficient solutions to allow the clinician the ability to provide patient- focused care in the emergency department and by first responders in the field. Our convenient kits are both time and cost saving. With the simplicity and ease of use of the B&B specialty airway management devices, we have found that multimedia tools, such as educational CDs and DVDs with tutorials provide a consistent method for training today's healthcare practitioners. These tutorials are developed with input from B&B's team of clinical consultants who provide the educational support tools needed by the clinician. On the CD, each B&B product is identified with a separate training module. Each module provides a visual display of the applicable training material along with an audio portion to allow the clinician to view the material at the clinicians' own speed. A basic competency program has been developed as an adjunct to the product CD with a focus on application of each product. As part of the B&B Value Add program, Policy and Procedure Protocols that focus on patient care are provided to the hospital clinical education department. Clinical, technical and educational materials are available upon request and many of the support documents can be downloaded from the B&B Medical Technologies website at bandb-medical.com. B & B Medical Technologies' products are readily available through national distribution partners and are housed in local warehouses that provide coverage for all 50 states and Puerto Rico. B & B Medical Technologies' responsive team, network of distribution partners and local warehousing will enable quick response to practitioners' needs in the event of a disaster. With company headquarters in California, B&B Medical Technologies is continually alert to the unique needs of responding when disasters occur. Providing quality products under all circumstances is imperative. All B&B Medical

Technologies products have been designed with the critical care clinician in mind. Respiratory Therapists, Nurses and Physicians have always been instrumental in clinical testing, and practitioners are involved from the onset of product concept through final release. The critical care clinician is an integral part of the B & B strategy for delivery of care.

Versamed, Inc

Kevin Plihal
Kevin Plihal is VP Marketing and Bus Development for VersaMed, Inc.

By way of background, describe your product.
The iVent201 was designed for portability using turbine technology in a case 1/3 the size of a traditional ICU ventilator but having the ICU level features and functionality. An IBW quick start feature and built-in color screen with extensive monitoring capabilities allows the clinician to keep an eye on what has transpired over the last 72 hours (both graphical and alpha numeric data are stored in the ventilator), when treating numerous patients in "MASH" type settings. In addition, the ventilator now has built in SpO2 monitoring capability. This allows disaster planners to deploy a single device which will not only provide information about the patient's respiratory status but will also provide heart rate and pulse oximetry in a package that is compact and portable.

How can your company help an area stricken by a disaster or in an emergency situation?
Versamed has established a nationwide clinical network of specialists who can train institutions or individuals in the use of the iVent201. Training (including competency testing) can be done on site, via our web based Total E Support System (TESS) or via our interactive training CD. Additionally, VersaMed maintains a separate stockpile of product and consumables should a disaster arise requiring immediate supply delivery. In association with our nationwide distributor partner, Tri-Anim, we can provision for many contingencies including warehousing, supply depots and service.

What products does your company offer to assist in this type of effort?
Versamed supplies the iVent201 Disaster Preparedness Model which is a ruggedized version of the already rugged iVent201 that is deployed by many militaries, EMS agencies and hospitals throughout the world. Versamed supplies an array of accessories that will allow the ventilator to be used with car batteries, adapters for standard single limb patient circuits, low flow O_2 adapters and high flow oxygen concentrators that allow rapid deployment of ventilation anytime, anywhere. Lastly, the iVent201 is the only turbine ventilator that protects the patient through the use of a CBRN Filter which allows the ventilator to be brought to hazardous environments and will provide air that is filtered of chemical, biological, radiological or nuclear particles for up to 90 minutes by the use of an adapter that fits a standard NATO gas mask filter (40mm thread).

Has your company had any experiences with dealing with man-made or natural disaster situations?
The iVent201 is the chosen ventilator for Carolina's Med-1 mobile hospital (Dr. Tom Blackwell) that was deployed to handle the disaster needs of hurricane Katrina. The iVent201 was chosen to evacuate bombing victims from Kenya. The US, Canadian and New Zealand armed forces, the Israeli Defense Force and Ministry of Health have all chosen the iVent201 for military and civil use during both war and emergency situations. The iVent201 was deployed in Pakistan for use following their devastating earthquake.

What contingency plans does your company have to boot production of your product in case of a disaster or emergency?
VersaMed has worked with its suppliers to hold additional components in stock such that production of iVents can be ramped up exponentially should the need arise (double within 90 days).

What types of education do you provide, relevant to emergency services or disaster planning for both your own personnel and for those using your products?
Versamed offers many methods of training and education including:

A training CD with step by step instruction, a quick start guide developed in conjunction with New York City's Department of Health, Web based training, and on site clinical inservices and competency testing. Train the trainer programs are also available for regional stockpile members. The company also offers factory-based technician training for preventative maintenance and high level repair work.

What mechanisms relevant to your product are in place to assist hospitals, clinics, and users in the event of emergency use of your products?
Versamed is currently working with the City of New York Department of Health to train users at disaster preparedness study institutions in the use of the iVent201. This interaction has led to the production of our Disaster Quick Start Guide which is basically a guided checkbox pictorial sequence of instructions on how to set up a ventilator for deployment in an emergency. Little or no understanding of language is required as the pictures tell most of the story. Versamed has deployed a stored stockpile of ventilators with a number of cities and states for deployment to local hospitals should the need ever arise. However, each locality may have different requirements for disaster preparedness. How should each ventilator be stockpiled to insure it is available and reliable when taken out of a box during an emergency? New York City has required that Versamed deploy two ventilators to each of NYC's study hospitals in preparation for a large deployment. While we currently offer various solutions for emergencies, we anticipate learning a great deal more about disaster preparedness practices during New York City's study. There are over 200 current users (comprising over 1000 RTs) in the United States already trained on the use of the iVent201. Because the iVent201 is a product that addresses the average patient's needs so ideally, it is becoming a ubiquitous ventilator. The iVent201 lets healthcare staff greet the patient in the ER with NIV and transport them, intubated or not, with the same patient circuit to their next stop in the hospital, MRI the OR or the ICU. Versamed's US distribution partner is Tri-Anim. They have over 100 of the most professional sales personnel trained on the use of the iVent201. We are extremely proud to have been chosen as a partner by Tri-Anim.

Discuss the role of critical care providers in research, development, and improvements and/or new applications of your products in emergencies and for disaster-preparedness.
All of our emergency and disaster preparedness features are derived from research and consultation with globally recognized critical care providers. It is clinical practice that dictates the function of a medical device and therefore we design what we are told is needed by our clinical associates.

Talk about how you test and/or evaluate your product in-house and in the field.
Specifications are provided by clinical users, and from these specs we derive our testing which allows us to determine if we've done the right thing. We then provide products to these users to get feedback on whether actual practice bears out our results. We also rely on evaluations done by external entities such as the US Armed Forces.

Discuss your R&D process, including clinician and user input, both in terms of emergency and day to day applications.
R&D begins after our sales and marketing/ product development specialists consult with medical experts, clinicians and opinion leaders. As an example, a leading clinician at Jackson Memorial Hospital asked for SpO_2 to augment patient monitoring in emergencies. Another leading research facility is helping make use of this data to automate ventilator settings. The beauty of the iVent is that its software platform allows continuous improvements and product enhancements (by download), based on field and expert feedback.

Tell us about how you're promoting your product as it relates to emergency usage and applications.
Versamed participates in nationwide disaster preparedness conferences and meets with state stockpile selection committees meetings to help them assess their level of preparation and ensure they have adequate stockpiles of ventilators, oxygen sources and the appropriate consumable components to care for any number of expected casualties. We even established a separate section on our website with special information on our disaster preparedness package, selection guidelines and e-training opportunities. In addition, we can be reached via our dedicated disaster preparedness email address, stockpile@versamed.com.

VORTRAN Medical Technology, Inc.

Jody McCarthy
Jody McCarthy is Director, Sales & Marketing, VORTRAN Medical Technology, Inc.

By way of background, describe your product(s) and its unique features, including the latest advances in product development and applications.
VORTRAN Medical manufactures and markets a patented line of fully automatic disposable respiratory devices for patients in the hospital and other market segments (EMS, post acute and home care). Our latest advances in product development and

applications have provided for efficient gas consumption, Positive End Expiratory Pressure (PEEP) valve and an intrinsic alarm system for the VORTRAN Automatic Resuscitator (VAR).

How can your company help an area stricken by a disaster or in an emergency situation?
VORTRAN is able to help an area stricken by disaster or in an emergency situation by marketing our products to emergency service agencies and critical care providers. The VAR and E-vent Case products provide an inexpensive ventilation solution for any Mass Casualty Incident (MCI), whether man-made, natural or bio-terrorism type disasters. The VAR, being single patient and disposable, eliminates cross-infectivity, contamination and equipment sterilization issues.

What products does your company offer to assist in this type of effort?
The E-vent case is organized for rapid deployment and provides ventilatory support for seven patients simultaneously with the 7-port manifold. Connecting the manifold to a single gas source such as wall connection, "H" tank, or even medical grade air compressors provides maximum clinical performance during an initial emergency medical response.

Has your company had any experiences with dealing with man-made or natural disaster situations?
Our experiences dealing with man-made, natural or bio-terrorism type disaster situations have been through end-user communication, before and after the disaster situations occur. We recognized, through communication with the end-user, the value and resourcefulness of the VAR and E-vent Case.

What contingency plans does your company have to boost production of your product in case of a disaster or emergency?
Our contingency plans for boosting production of our VAR and E-vent Case have remained the same since the 9-11 terrorist disaster situation. We continually monitor our raw materials, finished goods, stocking levels of our dealers, and follow up with pending business. With this daily plan, we have been able to meet the demand and be prepared for future production.

What types of education do you provide, relevant to emergency services or disaster planning, for both your own personnel and for those using your products?
Because of the interest and widespread use of our VAR for disaster preparedness and pandemic influenza, we have recognized the need for education and training. The three types of education and training we provide relevant to emergency services or disaster planning are: the interactive CD-ROM, which contains a multimedia presentation for a PC platform and includes instructional video, brochure and user guide in a PDF format for all VORTRAN products. Second is an online Educational Module Sponsorship for free CEUs. The program provides one contract hour of online continuing education at no charge to medical professionals, at accessce.com/courses.aspx. The course title is, "Gas Powered VORTRAN Automatic Resuscitator (VAR) for Short Term, Emergency Ventilation." Third is the VORTRAN website. We maintain an informative website at VORTRAN.com with up-to-date information on clinical research and outcome, product brochure and user guide in a PDF format.

What mechanisms relevant to your product are in place to assist hospitals, clinics and users in the event of emergency use of your products?
The VORTRAN mechanisms in place relevant to our VAR and E-vent Case product to assist hospitals, clinics and users in the event of the emergency use of our products is through annual training, daily utilization in transports, MRI/CT applications, publications, and our network of dealers. The hospitals, clinics and users have created and adopted emergency response protocols providing a comfort level for use.

Discuss the role of critical care providers in research, development, and improvements and/or new applications of your products in emergencies and for disaster-preparedness.
The role of critical care providers provides key communication links for defining goals in improved product development. VORTRAN's processing program includes tracking and recording critical care provider comments, suggestions and complaint information that is continually analyzed for identification of corrective action if necessary and product improvement. For example, critical care providers commented that the VAR gas consumption was more than they realized would be needed to drive the pneumatic device and that an FiO_2 delivery option of 100% or 50% would be beneficial, as not all patients require 100% FiO_2. VORTRAN launched the VAR RCM Model providing gas conservation utilizing the 50% FiO_2 delivery option. Other comments included addressing the pediatric patient population for disaster preparedness. VORTRAN launched the VAR-Plus PCM Model for patient body mass of 10 kg and above. This model can be used on both pediatric and adult patients as well as provide for the FiO_2 delivery options.

Talk about how you test and/or evaluate your product in-house and in the field.
The testing and evaluation process of the VORTRAN products line for in-house and field use is an integral part of our commitment for continuous process improvement. Clinical trials with established standards and measurements ensures the level of quality customers expect for product performance and features.

Discuss your R&D process, including clinician and user input, both in terms of emergency and day-to-day applications.
The R&D process for our team of mechanical engineers as it relates to disaster preparedness and day-to-day application provides for clinician and user input, patient safety, and clinician comfort level. An affordable price tag allows us to assist in public health emergencies and natural disasters in addition to meeting the demand for ventilator surge capacity.

Tell us about how you're promoting your product as it relates to emergency usage and applications.
VORTRAN promotes our VAR and E-vent Case products through various avenues such as tradeshows, on-site visit and training, publication advertising and our network of specialty dealer representatives.

new Innovation from Compumedics

COMPUMEDICS™
'Defining *Life's* Signals'

compumedics ProFusion PSG 3™

by

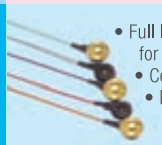
Custom built for you.

Compumedics is excited to announce our latest innovation in Sleep Diagnostics: **ProFusion PSG 3**. Compumedics brings an unparalleled level of configurability for every person that interacts with the software. The **MyWorkspace**™ concept allows individualized custom views and application specific tools to make every task efficient, simple and yes, even a pleasure to use. Tools for the technologist, scorer, physician, administrator and even the IT department have all been integrated into **ProFusion PSG 3**, available only from Compumedics. With **ProFusion PSG 3** and **MyWorkspace**™ however your current software works, everything you ever wanted your software to do, and whatever question you want answered **- Compumedics has a solution.**

compumedics ProFusion PSG 3 Featuring **MyWorkspace**™

More Compumedics innovative products:

NeuroMedical Supplies
Consumables: EEG, PSG, Research and TCD



- Full line of accessories for Sleep & EEG
- Competitive pricing
- Monthly specials

PSG/Sleep Diagnostics
Profusion neXus

- Total lab management
- Data & document control
- Increases overall efficiency

EEG/Neurodiagnostics
Siesta: Wireless EEG & PSG

- Wireless freedom
- 32 Data Channels
- EEG and PSG applications

Brain Research
QuikCell: Liquid Electrode Delivery system

- Fast preparation
- Increased patient/ subject comfort
- Fast easy clean up

AC922 Issue 4

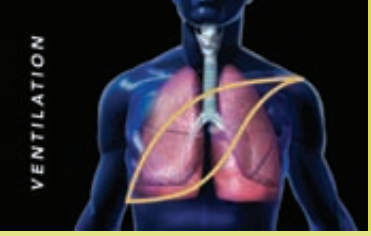
Since 1987, Compumedics Limited has emerged as a world leader in the design, manufacture, and sales of diagnostic sleep, neurophysiology, research and transcranial Doppler systems. Compumedics design expertise in the area of portable physiologic recorders and wireless data transmission is just one reason for our continued double digit growth in the USA year after year. Compumedics is improving people's lives through innovative products, exceptional service and a full range of consumables and accessories brought to you by dedicated people who care.

United States Australia Germany **www.compumedics.com**

For more information please contact:

Headquarters, Compumedics Limited, Australia:
30-40 Flockhart Street
Abbotsford VIC 3067
Australia
Tel: +61 3 8420 7300
Fax: +61 3 8420 7399
Free Call: 1800 651 751

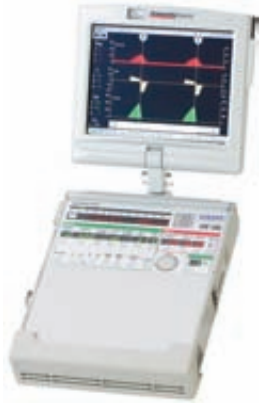
Compumedics USA Ltd:
7850 Paseo del Norte
El Paso
Texas 79912
Toll Free: 1 877 717 3975
Fax: 1 915 845 2965



Experience the Freedom of Portable ICU Ventilation

Unified Preparedness Begins with the LTV
Introducing the LTV® 1200

In busy hospitals where clinical resources are stretched, the LTV 1200 ventilator offers ease of use and versatility to help ensure optimal patient care across clinical settings. Whether in the ICU, PICU, ED or Patient Transport, the LTV 1200 has the flexibility to adapt to changing respiratory needs, for patients as small as 5kg, providing invasive and non-invasive modes of ventilation. At a fraction of the size of comparably equipped systems, the LTV 1200 moves seamlessly with the patient. Experience why the LTV Series has become the ventilation platform chosen by clinicians worldwide.



For more information on the LTV 1200 and unified preparedness applications, please contact a Customer Care Representative at 1-800-754-1914.

VIASYS® HEALTHCARE
Excellence For Life

Pulmonetic Systems

Pulmonetic Systems is a division of VIASYS Healthcare, Inc.
www.viasyshealthcare.com • www.pulmonetic.com

cobas®

Life needs answers

Now you won't have to do backflips to meet regulatory compliance.

Why? Because the **cobas b** 221 blood gas analyzer:

- ☑ Is the only analyzer with FDA 510(k) clearance for pleural fluid pH testing
- ☑ Provides innovative and reliable IT solutions for remote control, patient data management and QC reporting
- ☑ Features an extensive, labor-saving AutoQC® module with automatic lot-to-lot comparisons
- ☑ Offers eQAP, online CEU programs and remote troubleshooting capability

To find out more, contact your Roche Diagnostics representative or call 800-428-5076.

Roche Diagnostics

http://us.labsystems.roche.com