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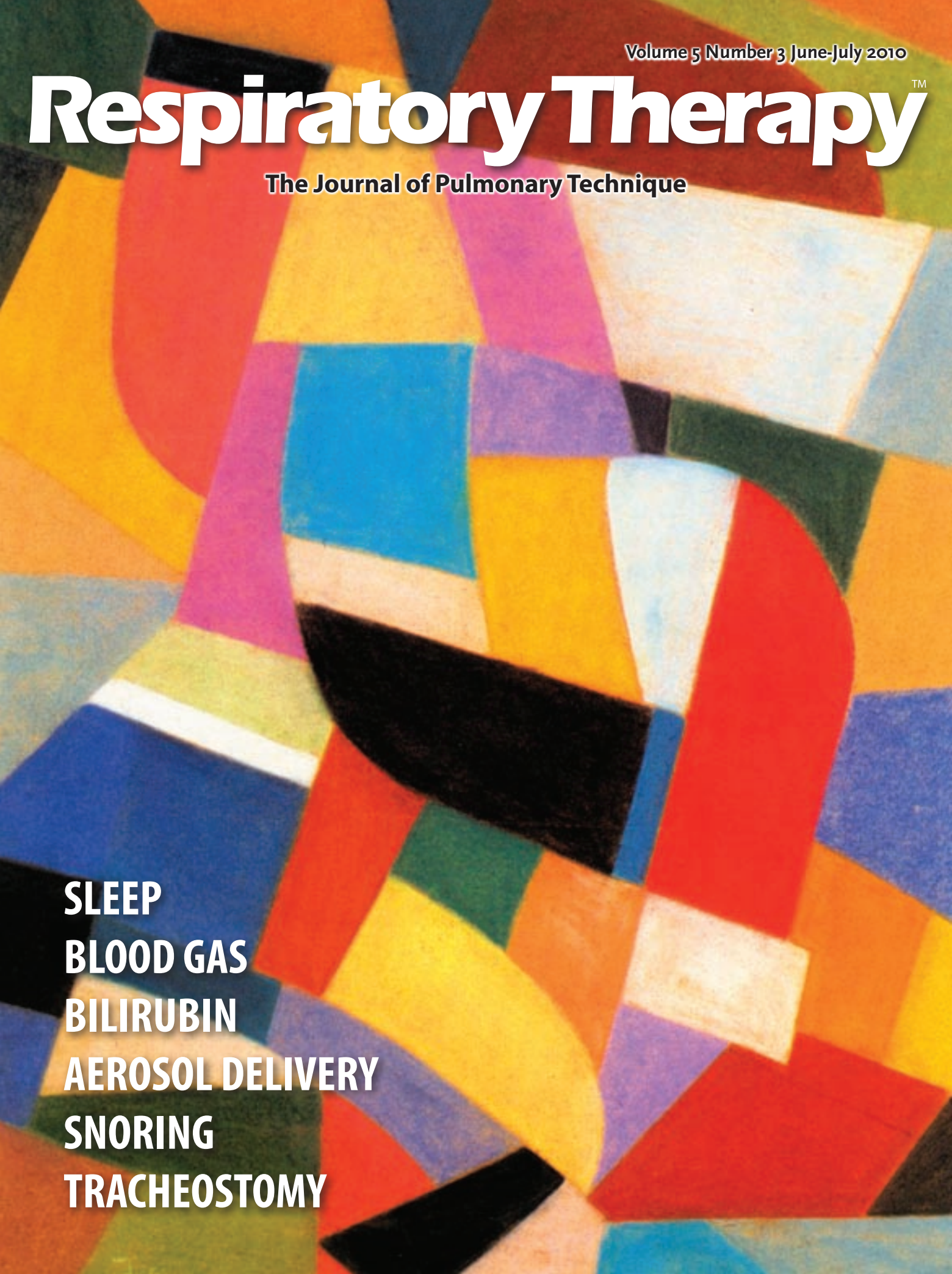
Respiratory Therapy™

The Journal of Pulmonary Technique



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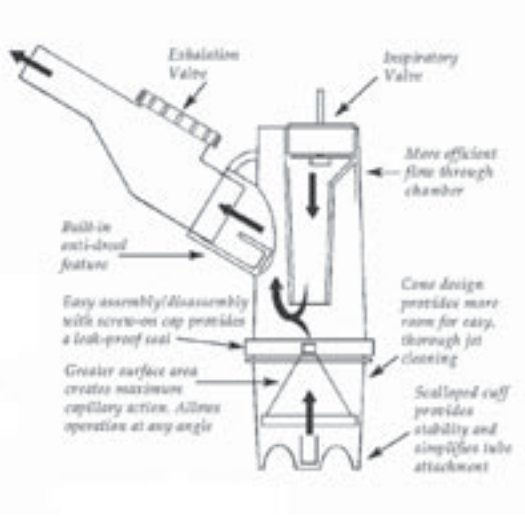

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The Journal of Pulmonary Technique

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Editorial

Read It And Reap

According to a report on the Huffington Post, "doctors, nurses and other health care workers are tapping into their inner Tolstoys to better connect with patients. They're meeting in monthly book clubs to discuss medical-themed literature. Humanities courses are now required in many medical schools. A hospital in Bangor, ME, hosted the first program in 1997. The idea has spread over the years to 25 states, including California, Florida, Massachusetts, Missouri, New York, Ohio and Virginia. Said Dr Robin Blake of the University of Missouri, 'One hundred years before Kubler-Ross identified the stages of dying, Tolstoy had it.' Dr Robin Blake, who runs a medical book club, notes that famous writers Camus, Faulkner, Flannery O'Connor and William Carlos Williams wrote in their fiction about medicine. Williams was a doctor, and O'Connor suffered from lupus." Blake says, in the HuffPost article, "In medical school, there was nothing of this, and I think that was a big omission." A Maine study revealed that participants in a literature program "reported greater empathy for patients and colleagues, higher cultural awareness, increased job satisfaction and improved interpersonal skills." Dr Abraham Verghese, a novelist and Stanford University professor, has founded the Center for Medical Humanities and Ethics at the University of Texas Health Science Center in San Antonio. He said, "There's a great hunger in clinical practice for discussions and explaining and reconciling the things you're seeing," he said. "It's as much about the physician as it is about the patient."

This is heartening news to me, insofar as in my other life, I teach fiction writing at UCLA. As such, here are some book recommendations, though not for the faint of heart: The Rise of Life on Earth by Joyce Carol Oates, about a murderous doctor and a victimized nurse (X rated); Louis Ferdinand Celini, Journey to the End of the Night, about a very bad doctor in Africa and France; The Benjamenta Institute, by Robert Walser, written by a guy who spent the last 20 years of his life in a mental institution; The Magic Mountain, by Thomas Mann, which takes place in a TB sanatorium; Wit (a play), by Margaret Edson, narrated by a woman with cancer; Do The Windows Open (short stories), by Julie Hecht, linked stories about a woman and her idiosyncratic doctor; and Darwin's Worms: On Life Stories And Death Stories, by Adam Phillips. I would also recommend a subscription to The Bellevue Literary Review, published by the NYU Langone Medical Center, the only journal of its kind. They also published a book of their "greatest hits." Finally, another excellent journal is Literature and Medicine, published by the Johns Hopkins University Press and also available through Project MUSE. So start reading.

Les Plesko, Editor

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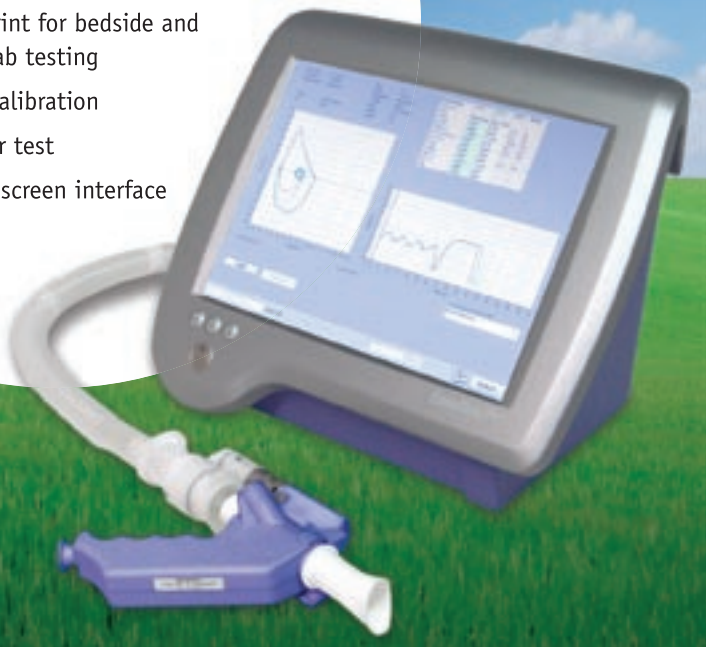

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News

☐ June-July 2010

PUBLISH YOUR RESEARCH

BMC Research Notes, at BioMed Central, was launched with the aim of reducing the loss suffered by science (and the potential for publication bias) when sound research goes unpublished. Since the journal focuses on short reports, small-scale confirmatory studies, negative results, incremental updates to previous work and data-driven publications, BMC originally envisaged that the vast majority of articles published would be short, but authors told BMC about the frustrating process of journal submission and rejection. As such, BMC changed its format and is allowing longer articles, but still encourages brevity. Authors whose work is not accepted for publication in other, more selective, journals published by BioMed Central may be offered the opportunity to publish in BMC Research Notes. Contact BioMed Central.

BITE DOWN

Head & Face Medicine reports on the correlation between stress, stress-coping and sleep bruxism. In the article, stress is discussed as a potential factor in the development of sleep bruxism (SB). The aim of the study at Heinrich Heine University in Dusseldorf was to investigate whether specific stress-factors correlate with SB activity. Sixty-nine subjects, of which 48 were SB-patients, completed three questionnaires assessing different stress parameters and stress-coping strategies, a short questionnaire for recognition of stress-factors, a questionnaire for recuperation and strain and a stress-coping questionnaire. The diagnosis of SB was based on the clinical criteria of the American Academy of Sleep Medicine. The degree of SB activity was measured by the Bruxcore Bruxism Monitoring Device (BBMD, Bruxcore, Boston, MA), worn for five consecutive nights and analyzed using a computer-based method. Significant correlations were found for daily problems, trouble at work, fatigue, physical problems, and the coping strategy "escape." The researchers found that subjects with high SB activity tended to feel more stressed at work and in their daily life, which was conjectured to possibly influence their physical state. These subjects also seemed to deal with stress in a negative way. For the whole paper, see "Correlation Between Stress, Stress-Coping and Current Sleep Bruxism," by Maria Giraki, et al, Head & Face Medicine, BioMed Central.

EAT A FRUIT

The natural chemicals from blackcurrants may help asthma sufferers, according to a study by Plant & Food Research, New Zealand. Researchers found that a compound from a New Zealand blackcurrant may reduce lung inflammation. Fruit consumption of all kinds has been shown to reduce symptoms in allergy-induced asthma but this research is the first to give insights into the mechanism. The component epigallocatechin, an antioxidant, is found in blackcurrants. Selective compounds found in fruit and vegetables may work together with the body's natural defenses to suppress long-term lung inflammation.

RACE AND ASTHMA

Black Africans, Indians and Bangladeshis have a similar or lower prevalence of asthma than white children, while black Caribbean and mixed black Caribbean/white boys are more likely to have asthma, according to researchers at the UK's Medical Research Council. The study used data taken from 51 London schools to investigate a random selection of 11-13 year olds. The final sample for analysis included 1,219 children of various ethnicities. The researchers said social and environmental factors may influence risk of asthma. They found that a family history of asthma and psychological well-being were consistent correlates for asthma regardless of ethnicity. Less than six years of residence in the UK had a protective effect for black Caribbeans and black Africans, possibly reflecting continuing protection from early life exposures in their home countries. A gender difference was observed for Indians and Bangladeshis, with less asthma in girls than boys.

P4P

The ATS has released an official policy statement of pay-for-performance in pulmonary, critical care and sleep medicine. In its statement the ATS said it "endorses P4P when such programs explicitly link reimbursement to the quality of healthcare provided… If appropriately implemented, [these programs] can align payor and provider incentives to improve patient care. [The ATS] P4P document is in concert with the overall moral and ethical framework of the ATS… Most current systems provide financial incentives to clinicians for providing care based on the patients' diagnoses, the complexity of work they do and the time they are involved. P4P offers an alternative and complementary approach that places more emphasis on the outcome, or quality of care, rather than the quantity of patients seen." The ATS said that financial incentives in P4P programs are designed to create an economic stimulus for quality improvement and adoption of evidence-based practices and to correct the negative consequences of reimbursement schemes that link payment to the volume or complexity of services, rather than the quality. However, the ATS noted, P4P may also create disincentives for healthcare providers to take on complex or difficult cases, particularly where well-known racial, socio-economic or gender disparities in outcomes exist.

LUNG RECRUITMENT

The Yearbook of Intensive Care and Emergency Medicine reported on new and conventional strategies for lung recruitment in acute respiratory distress syndrome. According to the writers, "in patients with ALI/ARDS, considerable uncertainty remains regarding the appropriateness of recruitment maneuvers." The authors report that the most commonly used recruitment maneuver is the conventional sustained inflation, which may be associated with adverse effects. They point to new recruitment maneuvers that consider the level and duration of recruiting pressure and the pattern and frequency of its application. The new maneuvers include incremental increase in PEEP, limiting maximum inspiratory pressure; pressure-controlled ventilation with escalating PEEP and constant driving pressure; prolonged lower pressure with PEEP up to 15 cmH_2O

and end-inspiratory pauses for 7 seconds twice per minute for 15 minutes; intermittent sighs to reach a specific pressure in pressure control mode, and slow lengthy increase in inspiratory pressure up to 40 cmH_2O. The authors also posit the strategy of using variable controlled ventilation and assisted ventilation modes as alternatives for lung recruitment. The article can be viewed on BioMed Central, "New and conventional strategies for lung recruitment in acute respiratory distress syndrome," by Pelosi, et al, © 2010 Springer-Verlag Berlin Heidelberg 2010.

ALLIANCE

GlaxoSmithKline and Pfizer have made long-term commitments to supply new vaccines against pneumococcal disease. Supply may start as early as this year and at a fraction of the price charged in industrialized countries. The agreements were made possible thanks to the Advance Market Commitment (AMC) for pneumococcal disease, a financing mechanism piloted by the GAVI Alliance. The governments of Italy, the United Kingdom, Canada, Russia, Norway and the Bill & Melinda Gates Foundation committed $1.5 billion to launch the program. GAVI estimated that the introduction of suitable and affordable vaccines against the disease could save approximately 900,000 lives by 2015 and up to seven million lives by 2030. The two participating firms have committed to supply 30 million doses each, for ten years, at a charge of $3.50 per dose to be paid by GAVI and the countries using the vaccines.

CHESTY

Chest x-rays may play an important role in the diagnosis and treatment of H1N1 influenza by predicting which patients are likely to become sicker, according to a study at Tel Aviv Sourasky Medical Center. Researchers analyzed the chest x-rays of 97 patients with H1N1 and correlated the x-ray findings with adverse patient outcomes. The chest x-rays revealed abnormal findings for 39 of the patients, five of whom experienced adverse outcomes, including death or the need for mechanical ventilation. For the other 58 patients, chest x-ray findings were normal. The mean age of patients in the study was 40.4 years. Although a normal chest x-ray did not exclude the possibility of an adverse outcome, researchers said the study's findings can help physicians better identify high-risk H1N1 patients who require close monitoring.

TOO MUCH INFORMATION

Want to know all about hiccoughs? Christian Nordqvist, writing in Medical News Today, tells all. Some highlights: SDF, ie, singultus, ie hiccoughs, have no purpose. They usually go away on their own. One in 100,000 hiccoughers have bouts that may last for months. Home remedies include drinking water quickly, scaring the person, breathing into a paper bag, or swallowing something. Men are more likely to have longer bouts. Some surgical procedures can cause them, including anesthetic, endoscopy, and intubation. Underlying causes of hiccoughs that won't go away may be GERD, gastritis, bowel obstruction, tumor, pneumonia, eardrum irritation, pericarditis, heart attack, stroke, MS, Addison's disease, goiter, hyperglycemia, anorexia, meningitis, encephalitis, brain injury, electrolyte imbalance, kidney failure, and the use of benzodiazepines and corticosteroids. Testing may include X-rays, CT, MRI, ECGs or endiscopy. Ways to avoid hiccups are to avoid changes in temperature, don't drink alcohol or fizzy drinks and don't eat like a pig. The information above is copyright Medical News Today.

VITAMIN D

Black children with asthma were significantly more likely to have low levels of vitamin D than healthy black kids in DC, according to a study by Children's National Medical Center. The study supports research that vitamin D plays a greater role in the body than just keeping bones healthy. Vitamin D deficiency has also been recently linked to a variety of non-bone related diseases including depression and autoimmune disorders. The study measured vitamin D in the blood of 85 black children with asthma and in 21 healthy black children. Researchers found that 86% of the children with asthma had insufficient levels of vitamin D, while only 19% of non-asthmatics had these low levels.

SIT DOWN AND EAT!

Kids who have asthma, who typically suffer from separation anxiety, should partake in regular family mealtimes, according to a study at the University of Illinois. Researchers said supportive interaction during family mealtimes helps increase a child's sense of security and eases separation anxiety symptoms, thereby improving lung function. In the study, 63 kids with persistent asthma completed questionnaires and were interviewed about their physical and mental health, including an assessment for separation anxiety. Within a week of the lab visit, a family meal was recorded on video camera. The children's medication use was monitored electronically throughout the study. The researchers found a relatively strong relationship between compromised lung function and separation anxiety symptoms.

DON'T BLOW IT

Washing out your nose with a spray or salt water won't reduce sinus infections, but may reduce symptoms, according to a study at the University of Queensland, Australia. The researchers said nasal irrigation with saline may be mildly beneficial to some patients, though the existing evidence was too limited to recommend it as a standard treatment. Saltwater washes have long been a part of ayurvedic care, a traditional medicine used on the Indian subcontinent. Saline sprays and nose irrigators like the neti pot, used to pour water through the nostrils, have been showing up more often in Western culture. Saline nasal washes could flush out excessive mucus. The studies referenced by the researchers included 618 participants worldwide. Other studies have shown that people with chronic sinus symptoms might be able to prevent flare-ups with regular saline washes.

IMMUNITY

Researchers at the University of Pennsylvania School of Veterinary Medicine discovered a previously unidentified cell population that may fight off parasitic infections but may also cause a harmful immune responses that can lead to allergies and asthma. Multipotent progenitor cells, or MPP, appear to be activated in the context of allergies or infection with parasitic worms and may be one of the earliest cellular events in the developing immune response. The research could benefit developing countries still dealing with parasitic worm infections and industrialized environments where immune responses can run amok, leading to a higher prevalence of allergies and asthma.

DRUG RESISTANT

Justin Tse of Hamilton Medical reports on strains of drug-resistant H1N1. In the United States, the H1N1 virus, also known as Swine flu, was first confirmed by the CDC on April 15th, 2009. This virus was originally referred to as "swine flu" because laboratory testing showed that many of the genes in the virus

were very similar to influenza viruses that normally occur in pigs (swine) in North America. But further study has shown that the 2009 H1N1 is very different from what normally circulates in North American pigs. It has two genes from flu viruses that normally circulate in pigs in Europe and Asia and bird (avian) genes and human genes. By June of 2009, every state had reported cases of H1N1. The symptoms of novel H1N1 flu virus in people are similar to the symptoms of seasonal flu, although vomiting and diarrhea has been reported more commonly with H1N1 flu infection than is typical for seasonal flu. Reported symptoms of H1N1 are listed below.

Table: Symptoms of hospitalized novel H1N1 patients

Symptom	Number (%)
Fever*	249 (93%)
Cough	223 (83%)
Shortness of breath	145 (54%)
Fatigue/Weakness	108 (40%)
Chills	99 (37%)
Myalgias	96 (36%)
Rhinorrhea	96 (36%)
Sore Throat	84 (31%)
Headache	83 (31%)
Vomiting	78 (29%)
Wheezing	64 (24%)
Diarrhea	64 (24%)

The US Department of Health and Human Services National Institutes of Health (NIH) News release dated March 26 reported 2 cases of drug resistant H1N1. Two patients undergoing treatment for H1N1 developed drug resistance after less than 2 weeks of treatment. Matthew J. Memoli, MD and Jeffery K. Taubenberger, MD, PhD, observed that these two patients demonstrated resistance to Tamiflu while one patient also showed resistance to another antiviral drug treatment undergoing experimental trials. "While the emergence of drug-resistant influenza virus is not in itself surprising, these cases demonstrate that resistant strains can emerge after only a brief period of drug therapy," said NIAID Director Anthony S. Fauci, MD, "We have a limited number of drugs available for treating influenza and these findings provide additional urgency to efforts to develop antivirals that attack influenza virus in novel ways." For more information on H1N1 Flu and the reported cases above, see the documents 2009 H1N1 FLU ("Swine Flu") and you, at cdc.gov, Flu: Novel H1N1 Flu: Facts and Figures, at www.3.niaid.nih.gov, and NIH News, March 26, US Dept of Health and Human Services, nih.gov/news. The above report is by Justin Tse, RRT-NPS, Clinical Support Specialist, Hamilton Medical, Inc.

CHEST REPORTS

The journal Chest has reported: Pregnant women with asthma who smoke have an increased risk for asthma symptoms and fetal growth abnormalities… Airway obstruction may be the cause of reduced lung function in World Trade Center (WTC) rescue workers from the New York City Fire Department… Psychological disorders like anxiety and depression are twice as prevalent among adults with asthma than the general population. See the journal Chest for more info.

EAB ANNOUNCED

Respiratory Therapy's European edition, debuting in September, has lined up its Editorial Advisory Board, with members from Spain, Belgium, Italy, Slovakia, Turkey, the UK, Brazil, Greece, and Israel. EAB members are with departments of pediatrics, ICUs, physio and occupational therapy, rehabilitation, and include clinicians and researchers. For more information, please contact us at s.gold4@verizon.net.

NEWS FEATURE

Electronic Medical Records and BMDI

Paul Garbarini, MS, RRT

Paul Garbarini is Clinical Applications Manager, Hamilton Medical, Inc.

Most hospitals have used some form of computerized documentation for many years. Often, the first applications were directed towards capturing billing for services. More recently, comprehensive EMRs (Electronic Medical Records) are focused on electronic documentation of all aspects of patient care. These systems have been shown to improve workflow, reduce transcription errors and improve patient care and safety. In order to completely transition to an EMR, it is necessary to integrate biomedical devices into the EMR. This is referred to as BMDI or Bio-Medical Device Integration; the prime example being mechanical ventilators. Virtually all current generation ventilators have the option to output settings, monitored parameters and alarms in digital format. Unfortunately, it's not a matter of simply plugging the ventilator into the EMR. There has to be a "middleware" to allow the ventilator or other device to communicate or "handshake" with the EMR.

This can be in the form of software and/or a hardware interface. Many ICU patient monitoring systems are compatible with ventilators. They contain a driver that allows communication with the ventilator. An analogy would be hooking up a printer to your computer. The computer operating systems (eg Windows XP, Vista, etc) upon detecting the printer can only communicate with the printer if a software driver specific to that device (or class of device) is installed. ICU patient monitors have limited capabilities in the number and type of devices they can support. A more comprehensive solution is a software/hardware solution that can integrate virtually all devices into the EMR. Think of this as a universal hub that interfaces a variety of devices into the EMR. An analogy would be a hub into which you could interface your computer with your printer, scanner, digital camera, internet modem etc. It doesn't matter what type or brand of device you need to interface.

One leading company in this field is Capsule, which has partnered with numerous manufacturers to provide a vendor neutral solution, including Hamilton Medical.

The Sentara Healthcare System in Norfolk, Virginia, has implemented the CapsuleTech system allowing it to integrate over 500 medical devices into their EMR, including over 150 ventilators. A free webinar hosted by Raphael L. Aquino, MS, Sentara IT Integration Manager, is available at: http://capsuletech.com/medical-device-applications-webinars.htm.

Additionally, the journal Patient Safety and Quality HealthCare

features an article by M Aquino on Sentara's medical device integration. The on-line article Sentara Supports Its Commitment to High Quality Care and Patient Safety with Biomedical Device Integrations is available at: http://www.psqh.com/marchapril-2010/449-trends-sentara-supports-its-commitment-to-high-quality-care-and-patient-safety-with-biomedical-device-integration-.html.

PRODUCTS

SAFE

The Joint Advisory Committees of the FDA recently discussed the design of post-marketing safety studies for long-acting beta-agonist (LABA)-containing products in the US, including Symbicort (budesonide/formoterol fumarate dihydrate). Its manufacturer, AstraZeneca, said the company was confident in the positive benefit-risk profile of Symbicort in asthma as demonstrated by extensive clinical data and patient experience, and supported ongoing scientific discussion to address any outstanding questions regarding the use of combination LABA and inhaled corticosteroid products for the treatment of asthma. Contact symbicort.com.

SALE

Vortran Medical Technology 1 is having a Customer Appreciation Sale: Buy 1 get one free: VAR-Monitor (order # VM-3500), list price $295, alarm capability provides continuous monitoring of VAR. Get $500 off Vortran's E-Surge Kit (order # ES-4070), sale price $2,000, regular list price $2,500. Vortran is also offering new package oxygen supply tubing Extend VAR Stockpile, 7-inch length (order # 2187S-20) list price $30 for a case of 20, and 20-inch length (order # 2188S-20) list price $50, case of 20. Call (800) 434-4034, or e-mail jmccarthy@vortran.com.

HAP-LESS

CareFusion announced the launch of the AirLife Diagnostic Catheter, a kit that helps clinicians obtain lower respiratory tract samples to accurately diagnose lung infections. The AirLife Diagnostic Catheter is designed to include everything a single clinician may need to perform the procedure and relies on advanced "mini" bronchial-alveolar lavage (mini-BAL) technology, a diagnostic procedure of washing a sample of cells and secretions from the bronchial airspaces to obtain a specimen from the lower respiratory airway at a patient's bedside. By allowing respiratory therapists to accurately obtain specimens, doctors can choose the right medication to help avoid excessive antibiotic use and quickly resolve the isolated infection. The AirLife Diagnostic Catheter was developed to help physicians and clinicians determine the right medication for their patients while helping reduce the time and cost of treating potentially life-threatening infections. The device makes the diagnosis process faster and more convenient and is designed to help reduce cross-contamination to allow for more accurate and consistent sampling. Contact carefusion.com.

ON GUARD

Covidien announced the global launch of Mallinckrodt TaperGuard and TaperGuard Evac endotracheal tubes. The TaperGuard line of endotracheal tubes incorporates a unique, taper-shaped cuff made from polyvinylchloride (PVC) that is designed to substantially reduce the risk of microaspiration. The TaperGuard Evac endotracheal tube additionally provides for secretion drainage through an integrated suction lumen. As a result, the TaperGuard Evac endotracheal tube is associated with a reduction in ventilator-associated pneumonia (VAP). The TaperGuard line of endotracheal tubes offers a superior cuff seal, compared with conventional endotracheal tubes, to help block secretions from entering the airways. Specifically, the innovative taper-shaped cuff design substantially reduces microaspiration by an average of 90%, versus the conventional barrel-shaped PVC cuff, found on the most widely used endotracheal tube—the Mallinckrodt Hi-Lo endotracheal tube. The advanced design of the TaperGuard endotracheal tube has the potential to significantly minimize many of the risks associated with post-intubation pulmonary complications. The TaperGuard Evac endotracheal tube combines the TaperGuard cuff with Mallinckrodt Evac technology, which offers secretion management capabilities by enabling continuous or intermittent drainage of secretions that collect above the cuff. Contact covidien.com.

SLEEP THERAPY

The ImThera THN sleep therapy clinical trials currently underway in Belgium are set to wrap up later this summer. Using a multi-contact electrode and a programmable pulse generator, ImThera's THN system delivers muscle tone to key tongue muscles. The system operates in continuous mode during sleep and functions in open loop, not requiring additional sensors or logic to detect the onset of apnea or related events. The aura6000 system effectively increases upper airway opening during sleep, disarming sleep apnea's primary mechanism and bringing profound relief both to its victims and to their loved ones. The product comprises an implanted multi-contact electrode specific to the hypoglossal nerve. The electrode connects to the IPG via a lead wire. It has an implantable pulse generator (IPG) enclosure which contains the electronics and the RF receive-transmit antenna. It is externally programmable, specifically for each patient, and re-chargeable. Externally, the system has a controller, charger and programmer device. The external controller interfaces to the IPG for patient functions and to the physician's computer for set-up and programming. Targeted Hypoglossal Neurostimulation (THN) Sleep Therapy utilizes a small electrical device to achieve increased upper airway flow. This device includes a small electrode that is implanted under the skin near the lower jaw and attached to the Hypoglossal Nerve (12th cranial nerve) connected to a pulse generator implanted near the surface of the upper chest. THN Sleep Therapy controls the movement of the tongue muscles such that the tongue is not allowed to fall back and block the airway during sleep. A doctor implants and programs the device to produce short bursts of electrical pulses that are delivered to the nerve. THN Sleep Therapy is able to target and stimulate only those muscles that deliver optimal opening of the airway. Contact imtheramedical.com. For a video go to YouTube.com, /watch?v=RSTKSt5hxgU&feature=related.

ON TRACK TRIALS

InterMune, Inc announced that the (FDA Pulmonary-Allergy Drugs Advisory Committee (PADAC) voted 9-3 to recommend approval of Esbriet (pirfenidone) for the treatment of patients with idiopathic pulmonary fibrosis (IPF) to reduce decline in lung function. Though the Advisory Committee's recommendations are not binding, they will be considered as the FDA completes its review of the New Drug Application (NDA) for Esbriet. Esbriet received Orphan Drug, Fast Track and Priority Review designations by the FDA. Priority Review designation may be granted by the FDA to an NDA for drugs that have the potential to offer major advances in treatment,

or provide a treatment where no adequate therapy exists. InterMune announced that it had submitted a Marketing Authorization Application (MAA) to the European Medicines Agency (EMA), seeking approval to market Esbriet for the treatment of IPF patients in the European Union. Esbriet (pirfenidone) has been granted Orphan Drug status in Europe. Preclinical and in-vitro evidence has shown that Esbriet has both anti-fibrotic and anti-inflammatory effects. Last winter, InterMune announced the results of the company's two global Phase 3 clinical trials evaluating Esbriet for the treatment of IPF, known as the CAPACITY trials. Prior to the CAPACITY results, data had previously been presented from another Phase 3 study and three Phase 2 clinical trials in more than 400 patients which suggested that Esbriet may positively affect lung function and disease progression in patients with IPF. In those clinical studies, Esbriet was safe and generally well tolerated, with the most frequent side effects reported being photosensitivity rash and gastrointestinal symptoms. Pirfenidone was previously approved for use in IPF patients in Japan. Contact intermune.com.

BABI.PLUS

B&B Medical Technologies has introduced the first FDA (510k) cleared bubble continuous Positive Airway Pressure (PAP) valve for use with infants weighing <10 kg. The unique design of the new Babi.Plus Bubble PAP Valve 0–10 cm H_2O allows airway pressure to be easily set without the cumbersome and time consuming tasks normally associated with bubble CPAP devices. Babi.Plus Bubble PAP Valve provides a safe, accurate and convenient method for delivering CPAP therapy to premature infants to increase end lung pressure above atmospheric in constant flow conditions. The patent-pending Babi.Plus Bubble PAP Valve is adjustable from 1 to 10 cm H_2O with an accuracy of ±1 cm of H_2O using gas flows from 1 to 12 liters per minute. A 360 degree swivel inlet accepts 15 mm OD and 22 mm ID circuit connectors for easy installation to the expiratory limb of the breathing circuit. A fluid level adjustment port allows water or acetic acid levels to be easily maintained without disconnecting the circuit or loss of PAP. The expiratory ports direct gas quietly away from clinicians. Contact bandb-medical.com.

POLE CLAMP

B&B Medical Technologies' new Venti.Plus Single Pole Clamp and Venti.Plus Dual Pole Clamp are strong, secure and designed to work in tandem with the Babi.Plus Bubble PAP Valve 0-10 cm H_2O and other devices mounted to standard hospital IV and equipment poles. The Venti.Plus Single Pole Clamp supports up to 3 kg devices, just right for the Babi.Plus Bubble PAP valve. The Venti.Plus Dual Pole Clamp supports up to 10 kg, which allows mounting two devices such as the Babi.Plus Bubble PAP Valve and a heated humidifier to the same pole. The Venti. Plus Pole Clamps are ISO compliant for universal compatibility and are easily cleaned between uses. The Pole Clamps are convenient, versatile and quickly secured with a thumb screw mechanism for positive attachment to most standard IV and equipment poles. The unique Pole Clamps provide a cost effective, multiple device mounting solution for respiratory care departments seeking to find budget efficiencies. The Venti. Plus pole clamps are a complementary product of the Babi.Plus Bubble PAP Valve product line, and are available separately. Contact bandb-medical.com.

SAVE ON SURVEILLANCE

Masimo announced that a new cost-effectiveness study shows that implementation of the Masimo Patient SafetyNet remote monitoring and clinician notification system with Masimo SET pulse oximetry saved one hospital $817,000 in its first year. The study projects that the hospital's future annual savings will be $1,295,000, providing a compelling financial rationale to expand monitoring in post-surgical patients on the general floor. In the study, Cost-Effectiveness of Patient Surveillance Systems, researchers at Dartmouth-Hitchcock Medical Center in Lebanon, NH, analyzed the cost savings associated with clinical outcome improvements shown in their clinical study published in the February 2010 issue of Anesthesiology, the first published report to demonstrate that continuous Measure-Through Motion and Low Perfusion pulse oximetry monitoring of post-surgical patients on the general floor with Masimo SET and automatic clinician notification with Masimo PatientSafetyNet leads to a "significant drop" in key clinical outcome measures, including fewer rescue events, fewer ICU transfers, and reduced annualized ICU days. After comparing cost data gathered before and after installation on Dartmouth's 36-bed post-surgical general care unit, researchers showed that implementation of Masimo Patient SafetyNet enabled clinicians to reduce hospital costs by $255 per patient the first year and a projected $404 per patient in subsequent years. Under the financial model established by researchers, if all 5,815 registered hospitals in the US were to implement Patient SafetyNet and realize the cost savings attained in the study, it would save between $4.7 and $7.5 billion in healthcare expenses each year. [Taenzer, et al, "Impact of Pulse Oximetry Surveillance on Rescue Events and Intensive Care Unit Transfers: A Before-and-After Concurrence Study." Anesthesiology, February 2010, Vol. 112, Issue 2.] Contact masimo.com.

DETECTION

Mercury Medical introduced the first full line of CO_2 detectors. The Neo-StatCO_2>Kg is the newest member of the Mercury family of CO_2 detector products. Neo StatCO_2 >Kg is the only CO_2 detector available for babies below 1 kg. Like its other family members, StatCO_2 for patients over 15 kg and the Mini StatCO_2 for patients 1-15 kg, it effectively provides 24 hour continuous performance with breath-to-breath color changes for ET Tube placement verification. Contact mercurymed.com.

UNINFLAMED

Pharmaxis Ltd announced the successful completion of a Phase IIa dose profiling study with its new anti-inflammatory agent ASM8 in patients with allergic asthma. The study met the pre-defined primary efficacy and safety endpoints and ASM8 was found to be safe at all doses tested and particularly effective at an inhaled dose of 8mg once per day. Compared to saline control, at this dose, bronchoconstriction following allergen challenge (as assessed by change in FEV1) was reduced by 32% (p=0.03) during the early phase of this response and by 49% (p=0.002) during the late phase of this response. In addition, inflammation as measured by sputum eosinophil count, 7 hours and 24 hours following allergen challenge was reduced by 49% (p=0.02) and by 57% (p=0.007) respectively. ASM8 was the leading clinical stage asset in the portfolio of drug candidates acquired by Pharmaxis in its recent takeover of the Canadian company, Topigen Pharmaceuticals Inc. The trial was designed to determine the efficacy and safety of ASM8 at a range of doses administered sequentially via inhalation to 12 patients with asthma followed by a controlled allergen challenge. ASM8 is a combination product of two RNA-silencing oligonucleotides targeted at a number of receptors for mediators of inflammation in asthma. Contact pharmaxic.com.au.

CLEARED

Dräger Medical Systems, Inc, US headquarters of Dräger Medical AG & Co KG, announced that it has received 510(k) clearance from the FDA to market the Evita Infinity V500 in the US. The ventilator is Dräger's latest and most advanced product in its ventilator product line. The Evita Infinity V500 ventilator offers the latest technology in mechanical ventilation for critically ill or injured adult, pediatric, and neonatal patients. Its versatility and range of operation is well suited for acute care facilities as well as university medical centers. The Evita Infinity V500 is a highly advanced ventilation unit for use in modern, acute care respiratory support. High-performance invasive and non-invasive ventilation, comprehensive monitoring and treatment functions, effective O_2-therapy—the V500 delivers advanced care to patients of all ages and acuity levels, including neonates. The V500 was developed in consultation with key physicians and respiratory therapists alike to offer clinicians a wide array of ventilation therapies required for critical care. Improvements in daily workflow, safety in the ICU, ease of use, and patient comfort are all realized with this new ventilator. With a company-wide focus to provide exceptional product support services, Dräger customers will continue to receive support from both its field support teams and Intensive Care Online Network (ICON). Contact draeger.com.

PLANT PRIZE

Royal Philips Electronics announced that the Philips Respironics' manufacturing plant in Murrysville, PA has been awarded a spot in IndustryWeek's Top 10 Best Plants of 2009. The 125,000-square-foot facility, which opened in 1990, is one of two manufacturing facilities Philips Respironics operates in the region. Rigorous judging criteria were used to evaluate management practices and performance in customer and supplier relations, employee involvement, productivity, cost reductions, manufacturing flexibility and responsiveness, inventory management, environmental and safety performance, and market results. As the manufacturer of six product lines, including medical devices to aid people suffering from sleep apnea, the Murrysville plant was recognized for excelling in continuous self evaluation and improvement. IndustryWeek praised the establishment of five basic focuses—quality, cost, delivery, safety, and morale—which has guided the plant to increase its labor efficiency by 30%. The plant has also developed an Exchange Team which encourages employees to actively engage in improving the organizational environment. The program has led the plant to install an onsite fitness center and establish a recycling program, which has led to a 50% decrease in plant waste materials that enter landfills. Contact philipsrespironics.com.

GOING MOBILE

Royal Philips Electronics and Cinterion Wireless Modules announced that the Philips Respironics System One sleep therapy solution won the Best Embedded End-to-End Service Award, part of the GSMA's Embedded Mobile Competition. The M2M solution integrates one of Cinterion's Evolution Platform modules and marries mobility and reliable two-way wireless communications with significant advancements in sleep apnea therapy. The device currently operates on the nPhase AT&T network in the US and will roll out in markets around the world over the coming year. System One provides sleep apnea treatment by delivering a specific flow of pressurized air through a mask to keep the airway open. The new solution integrates Cinterion's TC65i module to enable two-way, anywhere wireless communication between the patient's device and doctor. The Cinterion module sends sophisticated patient breathing data from the device to a secure EncoreAnywhere Web-based platform. Physicians log on to EncoreAnywhere to obtain timely, detailed breathing reports and respond with prescription air pressure changes sent instantly over-the-air to the device providing immediate patient relief. Cinterion's TC65i module provides on-board memory to store reports that detail every breath a patient takes for up to five days. In addition, the system provides storage capacity for six months of chronologically arranged compliance data necessary for reimbursement from healthcare providers. Contact respironicssleeptherapysystems.respironics.com.

GET SMART

Royal Philips Electronics announced its Know How Webinars program, an online learning series for sleep therapy and home respiratory professionals. Know How Webinars are presented live by clinical researchers, physicians, respiratory therapists, or subject matter experts from Philips Respironics and then placed on the Know How website for on-demand viewing. The webinars cover three categories: business, clinical, and products and programs. Business webinars include topics such as reimbursement guidelines, cost-saving strategies, and appropriate equipment selection. Clinical sessions are designed for physicians, respiratory therapists, and sleep technologists and topics include the latest findings on obstructive sleep apnea, the use of noninvasive and invasive ventilation, and trends in the use of home oxygen therapy. Product webinars comprise a review of the latest products and programs from Philips Respironics. All Know How Webinars are offered free of charge. The live Know How Webinars format includes a moderator, presenter, and a question-and-answer session that enables participants to interact with the presenter. On-demand, pre-recorded webinars are available at any time by registering at the Know How Webinars at knowhow.respironics.com.

ACQUISITION

Royal Philips Electronics announced that it has acquired the Somnolyzer 24 x 7 automated scoring solutions business of the Siesta Group in Vienna. This FDA-cleared solution helps improve the productivity of sleep centers and is based on the most advanced and clinically validated automated-scoring technology on the market. The Siesta Group is a research and clinical software company specializing in polysomnography scoring solutions for sleep centers. This automated scoring technology can also enable sleep centers in emerging markets to cope with the challenges of increasing demand for sleep diagnostic testing and the scarcity of sleep specialists. The acquired business will become part of the sleep diagnostics business within Philips Home Healthcare Solutions.

CHEK-UP

Roche Diagnostics announced that the FDA has granted CLIA-waived status to the CoaguChek XS Plus system, a point-of-care anticoagulation monitor that offers connectivity and data management tools to help healthcare professionals manage PT/INR (blood clotting time) testing. The waiver means that the monitoring technology may now be used in a broader range of clinical settings, such as labs that do not meet the requirements to do moderate- or high-complexity testing as defined by the Clinical Laboratory Improvement Amendments (CLIA) of 1988. The CoaguChek XS Plus system works with the RALS-Plus information management system, which provides

reporting and device management capabilities, to help hospital staff streamline the regulatory compliance process, capture reimbursable costs, and improve their organizational efficiency. In addition, recent enhancements to the system include the ability to hold up to 1000 patient results and the reduction of the sample size requirement to 8 microliters. The system uses two-level, built-in quality controls to help ensure the accuracy of PT/INR test results, but also offers optional liquid quality controls for facilities with policies requiring the use of external quality control measures. Clinicians have been using CoaguChek systems for PT/INR (Prothrombin Time/International Normalized Ratio) testing since 1994. The CoaguChek XS Plus system, which provides results in about a minute and has a 97% correlation to lab analyzer results, represents the fifth generation of point-of-care anticoagulation monitoring devices from Roche Diagnostics. Contact roche-diagnostics.us.

SOLUTIONS

Radiometer announced that it is expanding the TCM4 platform with several new transcutaneous modules and sensors. The TCM TOSCA and the TCM CombiM modules and sensors will increase patient safety, while promoting greater comfort. The TCM TOSCA provides accurate respiratory, ventilation and pulse rate monitoring through a single sensor. The CombiM offers up to 12 hours of continuous ventilation and oxygen status. Contact radiometeramerica.com.

UNOBSTRUCTED

A post-hoc analysis of COPD data for SYMBICORT was presented at AAAAI. These data from the serial spirometry subset of the SHINE and SUN studies demonstrated that SYMBICORT helped patients with even the most severe COPD by delivering significant improvement of airflow obstruction, as defined by ATS standards. They are the first to explore the reversibility of airflow obstruction in response to an ICS/LABA combination treatment across different COPD severities. Results showed that SYMBICORT demonstrated reversibility of airflow obstruction in a large percentage of patients with severe and very severe COPD (53% and 36%, respectively) based on ATS criteria. In the post-hoc analysis of the serial spirometry subgroup, a greater percentage of patients with moderate COPD experienced improvement in airflow obstruction with SYMBICORT (69%) compared with formoterol alone (47%) based on ATS criteria, suggesting that patients with the moderate stage of the disease in particular may benefit from combination therapy. Approximately 36% of patients with very severe COPD with an average baseline predose FEV1 of 0.64 L, were able to attain an additional 200 mL absolute increase in FEV1 from baseline, which means their lung function improved by approximately 30% after taking SYMBICORT. These data add to previous findings that have shown the overall efficacy of SYMBICORT in improving airflow obstruction in patients with moderate to very severe COPD, which has been traditionally considered irreversible in terms of airflow obstruction.

Here is the abstract: Bronchodilator Responsiveness to Formoterol (FM)-Containing Treatments by Chronic Obstructive Pulmonary Disease (COPD) Severity Classification. Donald P. Tashkin, MD; Bartolome R. Celli, MD; Stephen I. Rennard, MD; Jennifer McElhattan, MS; Ubaldo J. Martin, MD The authors are with UCLA, Harvard, the University of Nebraska, and AstraZeneca, LP. Rationale: Effect of COPD severity on airway reversibility to FM has not been evaluated extensively. We investigated reversibility to FM-containing treatment in moderate to very severe COPD patients. Methods: Data were pooled from common treatment arms in 2 randomized, double-blind, multicenter studies (I: 6-mo; NCT00206154 [Drugs. 2008;68:1975-2000]; II: 12-mo; NCT00206167 [Drugs. 2009;69:549-65]) in COPD patients ≥ 40 y. Treatments: twice-daily budesonide/FM pressurized metered-dose inhaler (BUD/FM pMDI) 320/9 µg (n = 101 [I]; n =121 [II]), BUD/FM pMDI 160/9 µg (n = 102 [I]; n = 121 [II]), FM dry powder inhaler 9 µg (n = 104 [I]; n = 124 [II]), placebo (n = 108 [I]; n = 125 [II]). Airflow obstruction reversibility was assessed 30 min after study medication on day of randomization as part of serial spirometry testing based on forced expiratory volume in 1 s (FEV1) improvement thresholds ≥ 12% and ≥ 200 mL (American Thoracic Society [ATS] criterion) and ≥ 15%. Data were assessed overall and by GOLD 2008 severity stage based on post bronchodilator FEV1 in each treatment group. Results: Reversibility of airflow obstruction was achieved by a majority of patients after FM-containing treatment (51% – 54% [ATS criterion]; 66% – 73% [≥ 15% criterion]). Percentage of responders to FM-containing treatment appeared to decrease with increasing COPD severity using the ATS criterion (stage II: 47% – 69%; III: 53% – 62%; IV: 31% – 41%), but not when applying the ≥ 15% criterion (II: 45% – 71%; III: 66% – 74%; IV: 65% – 89%). Percentage of responders tended to be higher for BUD/FM versus FM. Conclusions: FM-containing treatments result in significant reversibility of airflow obstruction in a large percentage of COPD patients, including those with severe and very severe COPD. Contact mysymbicort.com.

DISPENSATION

Thayer Medical Corporation announced improved solutions for inline pMDI delivery and new distribution channels for all of its Ventilator Circuit Components and hand-held respiratory products. Thayer Medical's Single Spray pMDI Adapter and patented, dual-spray MiniSpacer MDI Dispenser/Adapter are compatible with commonly used pMDI canisters: these safe and simple devices actuate the canister's medication metering valve, including canisters with integrated dose counters, metal tips, and plastic tips. Ventilated patients can now receive the aerosolized medication prescribed by their physician. Using standard fittings, these pMDI Adapters fit securely in the inspiratory limb and remain in the circuit until it is disposed. Thayer's Single Spray adapter directs the aerosol plume toward the patient, while the MiniSpacer dispenser's bi-directional nozzle delivers medication both upstream and downstream for improved drug delivery. Thayer's products may be purchased from most national distributors or directly from Thayer. Thayer products, manufactured in the US, are also under contract with several group purchasing organizations. The company is the original designer and manufacturer of the Valved Tee Adapter. Contact thayermedical.com.

SEPARATE SUCTION

Teleflex Medical announced the introduction of the Teleflex ISIS HVT, the first convertible endotracheal tube. The Teleflex ISIS HVT features an integrated suction port and separate suction line allowing for subglottic secretion suctioning on demand. Now clinicians can be free from the burden of choosing which tube is best for the patient at the time of intubation. When needed, the suction tube attaches to the Teleflex ISIS HVT via a secure locking connection. Both connection ports can be sealed upon disconnection, reducing the risk of cross-contamination when not in use. This versatile design allows for use of one endotracheal tube to meet the needs of patients requiring both short- and long-term ventilation. This versatile product provides

flexibility in access for post-operative subglottic suctioning, a clinically proven strategy for reducing Ventilator Assozciated Pneumonia (VAP), the most common infection acquired by adults and children in intensive care units (ICUs) today. During mechanical ventilation, secretions from the upper respiratory tract accumulate above the endotracheal tube cuff. Studies have shown that these secretions can seep past the cuff into the lower tract, causing pneumonia. Drainage of the subglottic secretions has been proven as an effective strategy in preventing early-onset VAP. The clinical challenge encountered today is that the endotracheal tube chosen for initial intubation doesn't always allow for easy access to this valuable practice. The Teleflex ISIS HVT eliminates many of the common objections to using traditional subglottic secretion suctioning (SGS) tubes, which can be up to seven times more expensive than standard tubes. Patients who need access to SGS often are not intubated with the appropriate tube, and approximately 20% of patients will require long-term ventilation. It is difficult to predict which patients will require long-term intubation, and if a SGS tube is not used at initial intubation, the patient must be extubated and re-intubated, which disturbs the airway. ISIS solves this problem in a cost-effective manner. The attachment for subglottic suctioning is used—and paid for—only when needed. Contact teleflexmedical.com.

VALUABLE

The Center for Health Value Innovation (vbhealth.org announced that The TriZetto Group, Inc (trizetto.com) has joined its growing membership of healthcare industry innovators. This collaboration is expected to accelerate the development of new value-based strategies, which many industry analysts and leaders believe are vital to healthcare reform. The introduction of "levers" of value-based design incentives is now recognized as one of the most effective approaches to encourage individuals to adopt healthier lifestyles and effectively manage chronic conditions by adhering to recognized healthcare guidelines. In its recently released book, Leveraging Health (2009), authors from the Center articulate the role of value-based solutions to enhance workplace health and productivity and promote financial sustainability for organizations.

BLOOD GAS

Siemens RAPIDLab 1200 series of blood gas analyzers offers neonatal bilirubin (nBili) point of care testing with 60 second turnaround time, detects elevated levels of bilirubin. If undetected, this condition can lead to a variety of health issues in newborn infants, from jaundice to neurological disorders, and in severe cases, brain damage. Siemens neonatal bilirubin (nBili) test requires 100uL sample of whole blood, measuring 2-30 mgdl and does not require any sample preparation, while providing fast and accurate results and does not increase monthly operating costs. Siemens RAPIDLab systems nBili testing is conducted as part of a neonatal test panel that includes blood gas, pH, electrolytes, metabolites, total hemoglobin and CO-oximetry, with no additional reagents needed for nBili testing. For additional information, visit usa.siemens.com/bloodgas.

SLEEP TESTING

Braebon offers a full range of Home Sleep Testing (HST) products called the MediByte and MediByte Jr. Renewed interest in HST has been largely driven by CMS approval in March 2008, which addresses the growing need for inexpensive and simple diagnostic tools for sleep apnea. To address this need, Braebon introduced the MediByte which remains the world's smallest Type 3 apnea and snoring recorder. The 12-channel MediByte exceeds new guidelines for portable monitoring, whereas the 6-channel MediByte Jr offers sophisticated capabilities with enhanced patient ease-of-use. Both products are very simple to operate within any existing respiratory department or sleep laboratory, and toll-free technical support, training videos, comprehensive user guides, and webinars are available to simplify training. The MediByte and MediByte Jr are capable of recording two consecutive nights and are compatible with any CPAP, which means you can record flow and CPAP pressure when using therapy. Sensitivity, specificity, and overall correlation were all found to be very high in recent studies comparing the MediByte to sleep laboratory recordings. The Braebon MediByte has proven itself a valuable diagnostic and compliance tool on six continents. Contact (888) 462-4841 x218, braebon.com.

POSITIVE EFFECTS

Masimo announced that a new clinical study shows Masimo PVI successfully predicts the hemodynamic effects of Positive End-Expiratory Pressure (PEEP) in mechanically ventilated patients after cardiac surgery. According to study researchers, the ability of PVI to predict the effects of PEEP may allow physicians to "optimize the respiratory uptake in oxygen and its delivery to the tissues." Masimo PVI has been shown on multiple clinical studies to continuously and noninvasively predict fluid responsiveness in mechanically-ventilated patients under general anesthesia. However, researchers in this study approached the relationship between PVI and fluid responsiveness in the reverse manner from which it is usually evaluated. Instead of looking at whether PVI predicts a positive response by the patient, they evaluated whether PVI predicated a negative response (decreased preload) with the addition of PEEP. Researchers studied 21 mechanically-ventilated and sedated patients in the postoperative period after coronary artery bypass graft (CABG) surgery. Patients were monitored via invasive pulmonary artery catheter for end-expiratory central venous pressure (CVP), end-expiratory pulmonary capillary wedge pressure (PCWP), cardiac index (cardiac output indexed to body surface area) (CI), pulse pressure variation (ΔPP), and stroke volume (SV), and PVI via a Masimo Rainbow SET Pulse CO-Oximeter sensor attached to the finger. Hemodynamic data was recorded at three successive tidal volumes (VT of 6, 8, and 10 mL/kg) during zero end-expiratory pressure (ZEEP) and after the addition of 10 cm H_2O PEEP for each VT and hemodynamically instable (HI) patients were defined as those with >15% decrease in CI after the addition of PEEP. Results showed that at a VT of 8 mL/kg, PVI was significantly higher in the HI group than in the non-HI group (13% ± 5% vs 9% ± 4%, $P<0.03$) and a PVI of 12% at ZEEP predicted a significant decrease in CI after the addition of PEEP in 6 patients with a sensitivity of 83% and a specificity of 80%. ΔPP was also significantly higher in the HI group than in the non-HI group; however CI, CVP, and PCWP were not different. At VT of 10 mL/kg, PVI was still significantly higher in the HI group than in the non-HI group (16% ± 7% vs 10% ± 4%, $P<0.01$) and a PVI of 13% at ZEEP predicted a significant decrease in CI after the addition of PEEP in 9 patients with a sensitivity of 78% and a specificity of 83%. Researchers concluded that Masimo PVI may be "useful in automatically and noninvasively detecting the hemodynamic effects of PEEP when VT is ≥ 8 mL/kg in ventilated and sedated patients with acceptable sensitivity and specificity." The current study reinforces the value of PVI compared to invasive measures and highlights PVI's value for reliably detecting the hemodynamic effects of PEEP and predicting hemodynamic

instability. PVI is available as part of Masimo Rainbow SET Pulse CO-Oximetry. See Desebbe, et al, The Ability of Pleth Variability Index to Predict the Hemodynamic Effects of Positive End-Expiratory Pressure in Mechanically-Ventilated Patients Under General Anesthesia, Anesthesia & Analgesia, March 2010, vol. 110, no. 3, 792-798.Contact masimo.com.

ACCURACY

Masimo announced that a new clinical study demonstrates that noninvasive and continuous hemoglobin (SpHb) from Masimo Rainbow SET Pulse CO-Oximetry provides comparable accuracy as point-of-care invasive measurements of total hemoglobin versus standard laboratory invasive measurements of total hemoglobin. The study confirms that SpHb is accurate, reliable, and a clinically-acceptable alternative for monitoring hemoglobin, and is the first SpHb study presented in pediatric patients. Jou and colleagues at the Cincinnati Children's Hospital Medical Center in Ohio compared SpHb and point-of-care (POC) hemoglobin measurements to a standard laboratory hematology analyzer in 15 pediatric patients undergoing surgery. Compared to standard laboratory hemoglobin measurements, SpHb and iStat had a similar bias (-0.3 and 0.2 g/dL respectively) and standard deviation (1.1 and 0.5 g/dL, respectively). Researchers concluded that "SpHb offers clinically-acceptable absolute accuracy and very good trend accuracy" and that all significant directional changes in hemoglobin "were indicated by changes in SpHb." Additionally, researchers commented that "SpHb provided earlier indications of directional hemoglobin changes than intermittent tHb values." SpHb is available as part of Masimo Rainbow SET Pulse CO-Oximetry. See Jou, et al, Absolute and Trend Accuracy of Continuous and Noninvasive Hemoglobin in Pediatric Surgery Patients." Presentation S-401, Monday, March 22, 2010, 11 a.m. to 12:30 p.m.; International Anesthesia Research Society (IARS), Honolulu, HI. Contact masimo.com.

BLOOD GAS ROUNDTABLE

OPTI Medical

Please describe your current blood gas products.

OPTI Medical Systems is a leading manufacturer of blood gas instrumentation using patented optical fluorescent technology. OPTI Medical markets the OPTI CCA-TS Blood Gas Analyzer, a single-use patient cassette based system as well as the OPTI R Blood Gas Analyzer which utilizes a multi-use patient cassette in a more traditional bench top platform. OPTI Medical is the only blood gas manufacturer that provides both a single use portable blood gas analyzer in the OPTI CCA-TS while also offering a multi-use cassette-based system for bench-top use in the OPTI R. These two analyzers allow hospitals to easily standardize blood gas technologies using one vendor for both centralized and POC use based on specific requirements.

How has your company pursued R&D efforts to improve blood gas technology?

OPTI Medical is the only manufacturer utilizing optical fluorescent technology instead of the traditional electrode based systems on all of our blood gas analyzer models. OPTI Medical continues to enhance this technology by adding new parameters to the test menu for increased clinical utilization.

What cost-savings/benefits does your technology offer?

Utilizing light as a reference with optical fluorescence provides customer benefits such as decreased downtime and lower maintenance and service costs due to the absence of traditional electrodes. The OPTI CCA-TS Blood Gas Analyzer also provides a low, fixed and predictable operating cost per test with no stand-by costs while the OPTI R Blood Gas Analyzer provides the benefits of a traditional bench top blood gas analyzer while requiring less maintenance and downtime.

How does your product help implement quality control?

The OPTI CCA-TS Blood Gas Analyzer utilizes a daily electronic QC for lower costs than comparable systems utilizing daily liquid QC. This is important for low volume locations such as small hospitals or POC testing locations where liquid QC could be costly and cumbersome. The OPTI CCA-TS also provides a QC Lock-Out menu for peace of mind that all QC policies and procedures will be adhered to before reporting patient results. The OPTI R Blood Gas Analyzer on the other hand provides the user with Auto-QC similar to other bench top blood gas analyzers where no external daily QC is required. The Auto-QC menu allows for the user to pre-program three levels of QC at required intervals based on hospital protocols.

How does your product provide for accuracy in measurement?

Optical fluorescent technology is a time tested method for reporting traditional blood gas, co-ox, electrolyte and metabolite measurements. Both the OPTI CCA-TS and OPTI R Blood Gas Analyzers perform calibration and QC procedures for internal and external checks based on requirements that adhere to CLIA regulations. The OPTI R also has software for Opti Quality Monitoring (OQM) for continuous monitoring of sensor integrity and is able to perform corrective actions as needed without user intervention.

What type of training and customer assistance/support programs do you have in place?

OPTI Medical has various levels of customer training and implementation programs that we can provide based on the level of experience and need in implementing new analyzers. Please contact your local OPTI Representative for further details. All customer technical support is offered 24/7/365 via toll free access.

RNA Medical

Please describe your current blood gas products.

RNA Medical is a developer and supplier of innovative quality control products for the hospital, point of care and physician's office markets. RNA has a wide variety of QC materials for the laboratory. For daily QC, RNA offers aqueous, dye-based, and bovine blood-based products for use with blood gas, critical blood analyte, CO-Oximetry, and diabetes care instrumentation. Products for calibration verification and linearity include blood gas and critical blood analyte, CO-Oximetry, and POC glucose.

How has your company pursued R&D efforts to improve blood gas technology?

In addition to QC products. RNA recently introduced heparinized glass capillary collection tubes with a puncture-resistant Mylar covering. Safe-Wrap Blood Collection Tubes reduce the risks associated with broken glass while at the same time offer the preferred collection material for capillary blood gas samples.

What cost savings/benefits does your technology offer?
RNA Medical blood gas quality control products provide laboratory and POC customers with a proven, independent solution at an attractive cost. Most of RNA Medical's QC materials and Calibration Verification Controls are assayed for multiple instruments. The time saved by ordering from one source for multiple analyzers is a great benefit to the end users.

How does your product help implement quality control?
The use of traditional quality control materials enables administrators to ensure compliance beyond the onboard electronic quality control which are not able to assess sample path and operator performance.

How does your product provide for accuracy in measurement?
RNA Medical is known for the lot to lot consistency of our quality control products which our customers have depended upon for years. Our most popular products are the Calibration Verification kits (CVC123 for Blood Gas and Electrolytes, CVC223 for Co-Oximetry) which enable linearity reporting. RNA also provides free online linearity graphing and peer group comparison through our PeerQC website for our CVC users.

What type of training and customer assistance/support programs do you have in place?
The RNA Medical PeerQC statistical service program for QC customers offers true on-line data submission and reporting options in real-time. Web-based graphing and reporting options are also available for calibration verification controls, eliminating manual data calculation and hand graphing.

Roche Diagnostics

Information provided by Larry Healy, Marketing Manager, Blood Gas Systems.

Please describe your current blood gas products.
The Roche Diagnostics cobas b 221 blood gas system helps clinicians maximize uptime while providing significant convenience and control with up to 40 days of onboard Auto QC, up to 42 days onboard stability of load-and-go reagents, and zero maintenance electrolytes. The configurable menu has options for blood gas (pO_2, pCO_2 and pH), electrolytes (Na^+, K^+, Cl^-, Ca^+, Hematocrit), metabolites (glucose, lactate, BUN), tHb/SO_2 and Co-oximetry (O_2Hb, HHb, COHb, MetHb, tHb, Bilirubin). With the only FDA 510(k) clearance for testing pleural fluid pH, as well as patient trend data and automated acid-base mapping trending, the cobas b 221 system provides actionable information and simplifies regulatory compliance. The cobas b 221 blood gas system coupled with cobas bge link Instrument Manager software enables monitoring and control of up to four decentralized systems from one location. cobas bge link enhances operational efficiency of all connected systems through screen sharing to provide immediate real-time performance status, maintenance updates and remote access for IT technical support 24/7.

How has your company pursued R& D efforts to improve blood gas technology?
Roche R&D efforts have led to many innovations in blood gas technology: the first blood gas analyzers with electrolytes; the first use of photometry to determine tHb and Hb derivatives; the first analyzer design with a full-color touch screen, liquid calibration to eliminate gas tanks, Auto QC; the first use of SMART reagents with radio frequency technology and zero maintenance electrodes; and the first polymer thick film technology sensors for metabolite detection. In addition, Roche R&D is incorporating many recent advances into a new-generation blood gas system that meets or exceeds the needs of the decentralized areas of the hospital to provide actionable information at the point of care.

What cost-savings/benefits does your technology offer?
The cobas b 221 blood gas system offers a number of cost-saving features. Having load-and-go reagents with 42 days of onboard stability extends reagent use and can reduce waste. Zero-maintenance electrodes eliminate the need to refill, soak, polish or replace caps, saving time and lowering costs. Onboard Auto QC holds up to 40 days of QC results and enables automatic lot-to-lot comparisons for improved convenience, capacity and compliance. And with liquid calibration, the cobas b 221 does not need gas tanks, reducing cost and eliminating the related safety concern. Barcode scanning and continuous self-monitoring of consumables helps ensure accurate documentation of lot numbers and ranges and helps prevent the use of expired controls, reagents and electrodes. QC and calibration default settings for all parameters prevent patient samples from being run until QC and calibration are in range. And continuous electronic monitoring provides operational status checks between calibration intervals, alerting the operator to a problem or re-running a calibration to maximize uptime.

How does your product help implement quality control?
The cobas b 221 blood gas system offers customers the tools necessary to implement quality control and meet compliance standards at the point of care. The system's Auto QC has onboard capacity for up to 40 days of QC material. Its onboard QC programming gives the user flexibility by providing user-defined programs to meet specific QC protocols. For example, the program manager can program the analyzer to run range studies for the new lot of QC while the current lot of QC is in use. With 20 gigabytes of onboard storage, the cobas b 221 system can maintain an average of five years' worth of QC, calibration and patient data for review and reporting. Roche's real-time peer review QC program, eQAP, helps ensure performance and regulatory compliance. In addition, cobas bge link Instrument Manager software provides real-time screen sharing and allows immediate access to QC, calibration and system status of all connected decentralized systems.

How does your product provide for accuracy in measurement?
The cobas b 221 system can be programmed to run 1-point calibrations every 30 minutes or 1 hour, 2-point calibrations every 4, 8 or 12 hours, and a 2-point system calibration every 8, 12 or 24 hours. Only after valid calibrations are completed can a sample be run. If a calibration error is detected, the system automatically reruns the calibration and the QC. In the critical care setting, spectrophotometer analysis of hemoglobin and its derivatives (co-oximetry), in combination with blood gas analysis, provides immediate actionable information about oxygen transport in human blood. The accuracy of the hemoglobin and bilirubin results depends on the performance of the co-oximetry technology. The co-oximetry module of the cobas b 221 blood gas system measures both hemoglobin derivatives and bilirubin spectrophotometrically in the

visible spectrum range (460nm to 660nm). Absorbance of the sample is measured at a total of 512 discrete wavelengths. The concentrations of hemoglobin, hemoglobin derivates and bilirubin are determined by applying an accepted mathematical algorthrim.[1] This enables the cobas b 221 system's co-oximetry technology to detect the presence of light-absorbing substances not covered by the reference spectra and to prevent the reporting of incorrect values due to interfering substances. This advanced co-oximetry design helps improve the accuracy of patient test results, which is demonstrated by a high correlation with results from accepted clinical chemistry test methods.

What type of training and customer assistance/support programs do you have in place?
Roche provides a number of educational materials to help operators run the cobas b 221 system properly and help maintain operator certification. The system comes with onboard video tutorials to instruct the user in proper operation. A Short Instruction for Use guide supports the tutorials, and a customer-based training CD-ROM, along with the Instruction for Use and Reference manuals provides detailed instructions to help operators avoid errors in using the equipment. Roche offers a two-day training program, at its Indianapolis headquarters for two operators, as well as on-site training for the facility. Roche also offers extensive online support through mylabonline.com, which gives users web-based access to all current documentation, such as MSDS sheets, package inserts, customer bulletins and manuals. Online CEU courses are available, as well, for all staff members to help maintain their lab and/or Respiratory Therapy accreditation. Roche's Indianapolis-based Tech Support team provides telephone support 24/7. With cobas bge link and Axeda software, all connected systems are accessible by Tech Support for immediate real-time troubleshooting, which may help reduce downtime and the need for a service visit. [Sources: cobas b 221 reference manual version 8.0 pp 20, 21; Schweiger G. Technical Aspects: Determination of Bilirubin on the Roche OMNI S, International Evaluation Workshop, October 23, 2003, Deutschlandsberg, Austria; Rolinski B et al. Evaluation of Total Bilirubin Determination in Neonatal Whole-Blood Samples by Multiwavelength Photometry on the Roche OMNI S Point-of-Care Analyzer. Point of Care, The Journal of Near Patient Testing and Technology; Volume 4, March 2005.]

Sarstedt Inc

Information provided by Peter Rumswinkel, Vice President/General Manager.

Please describe your current blood gas products.
Sarstedt 1ml and 2ml blood gas syringes contain a fine dispersion of calcium-balanced heparin, resulting in a large surface area for good solubility and quick mixing to ensure accurate results. A ventilation filter cap is available separately for the hygienic and contamination-free removal of air from the syringes after blood collection. The ventilation filter cap also serves as a closure for transport to the analyzer. Sarstedt blood gas capillaries are manufactured from break-resistant plastic with low gas permeability for safe collection and accurate test results. For optimal instrument compatibility, a variety of sizes and volumes are available. Secure caps replace messy putty, and mixing wires and magnet enable complete sample mixing.

How has your company pursued R&D efforts to improve blood gas technology?
Sarstedt recently developed its 1ml blood gas syringe to complement an existing 2ml version for reduced sampling volume, an important factor when samples are collected from individual patients many times per day. The corresponding ventilation filter cap was designed to minimize blood exposure when removing air from filled syringes and during transport. Also to increase user safety, break-resistant, yet flexible plastic was chosen for the production of blood gas capillaries. Additionally, the material has much lower gas permeability than the typical PVC used and is significantly more environmentally friendly.

How does your product provide for accuracy in measurement?
The preparation method in Sarstedt blood gas syringes provides a fine dispersion of anticoagulant, resulting in a large surface area for good solubility and quick mixing. The calcium-balanced heparin used ensures accurate electrolyte determination as well. Sarstedt blood gas capillaries are made from a special low gas permeable plastic in combination with calcium-balanced heparin coating for accurate test results. Coordinating mixing wires and magnet enable thorough and quick sample mixing.

What type of training and customer assistance/support programs do you have in place?
Sarstedt Product Support Specialists provide telephone support as well as assistance on-site as needed. In-services and product training can be arranged around the clock to train relevant staff on all shifts.

Instrumentation Laboratory

New Products: Instrumentation Laboratory has been at the forefront of breakthroughs in quality and information management throughout our fifty-year history which have provided significant enhancements to our critical care analyzers. Intelligent Quality Management (iQM), IL's patented quality control assurance system represents the "new standard for the future of QC." [James Westgard, PhD, developer of "Westgard Rules".] Developed specifically for the GEM Premier systems, iQM automatically and continuously detects, corrects and documents errors in real-time, to assure quality results and regulatory compliance 24/7, regardless of operator or testing location. Further, IL has developed GEMweb Plus software that allows managers to oversee all analyzers in the network for complete control. Users have unprecedented remote access to and control over any networked analyzer, from a networked analyzer or a PC, anywhere in or out of the hospital. Additionally, in January 2009, IL launched the GEM Premier 3500 critical care analyzer. Building on the unprecedented testing simplicity, flexibility and reliability of the GEM Premier 3000, the GEM Premier 3500 offers new capabilities, such as wireless communication to the LIS/HIS, in an enhanced system adaptable to the needs—and volume—of any hospital and lab. Instrumentation laboratory also offers its flagship critical care analyzer, the GEM Premier 4000, an expanded test menu, which includes BUN, Creatinine, Total Bilirubin, and HCO3, enhancing its applications and effectiveness in critical care testing. Improvements will also be added to further enhance GEMweb Plus, such as: onboard user training, onboard user certification and new interfacing capabilities.

Empowering the clinician to help manage pediatric patients.

CareFusion's portable NOX-T3 sleep monitor is designed with common sense features. The included software turns your day-to-day processes into an efficient workflow empowering you to spend more quality time with your pediatric patients.

carefusion.com

CareFusion

Product Applications: Ideal for both the laboratory and the point-of-care, including RT, ICU, NICU, CVOR, and ED are the GEM Premier 4000 and GEM Premier 3500 critical care analyzers. These analyzers measure pH, blood gases, electrolytes, metabolites and CO-Oximetry from a single sample of whole blood [integrated on the GEM Premier 4000 and with portable GEM OPL module on the GEM Premier 3500]. They are exceptionally easy-to-use, allowing users to perform timesensitive diagnostic tests efficiently and accurately.

Technical Support: An interactive Training Guide and Training Video accompany each installation of the GEM Premier 4000. IL's dedicated technical field representatives perform a comprehensive training program to ensure that end-users are not only comfortable running the system, but are fully competent in running different types of samples (from capillary tubes to syringes) by addressing both analytical testing and pre-analytical sample handling. These field-based technical representatives provide on-going and on-site training and support to maximize operator efficiency for the lifetime of the product. Additionally, IL's technical support group provides telephone assistance 24 hours a day, 7 days a week.

POC Implementation: Simplicity, flexibility, standardization, quality control and remote management are the key components to implementing a successful point-of-care testing program. The GEM Premier family of critical care analyzers represents a breakthrough in each of these arenas. The GEM Premier system is a single instrument platform that standardizes testing across the hospital—from the lab to the Intensive Care Unit, streamlining training, QC and ensuring comparable test results from varying locations. GEM Premier 4000 and GEM Premier 3500 cartridges offer flexibility through a comprehensive offering of analyte menu and test size options to meet the needs of each testing location. iQM standardizes quality so that you can assure quality results and regulatory compliance 24/7, regardless of operator or testing location. Additionally, GEMweb Plus software allows managers to oversee all analyzers in the network for complete control. Users have remote access to any networked analyzer, from a networked analyzer or a PC, anywhere in or out of the hospital.

User Assistance and Compliance: IL's GEM Premier 4000 and GEM Premier 3500 feature the only single-component, multi-use cartridge on the market today. Since all components for critical care testing are contained in the cartridge itself, there is virtually no need for maintenance or technical support. A single cartridge, which can be stored at room temperature at any testing site, is simply installed when needed. However, IL does have technical support staff in the field for customers to ensure optimal product performance and customer satisfaction. And, our technical support group is just a toll-free phone call away, 24 hours a day, 7 days a week. To assist customers with regulatory compliance, IL also offers customers a comprehensive document outlining how the GEM Premier 4000 and GEM Premier 3500, with iQM, meet every regulatory requirement of each regulatory agency. Additionally, IL conducts educational seminars throughout the year at customer hospitals and at national conferences. These seminars include experts in the field of diagnostics and quality control who discuss best practices in quality, regulatory compliance and other key components of a point-of-care testing program. These seminars provide Continuing Education Units (CEU) for attendees.

Cost Savings/Benefits: iQM, featured on the GEM Premier 4000 and GEM Premier 3500, automates the most manual and skill-intensive tasks in critical care testing. Traditional QC, both manual and auto, requires significant staff time (up to 16 hours/month/instrument) to meet regulatory and routine testing requirements. iQM automatically and continuously monitors all testing processes and components and provides continuous error detection, correction, and documentation in real-time, requiring no operator intervention, for maximum efficiency and better patient care. Moreover, the single-component, multi-use, non-refrigerated cartridge, is replaced every 30 days, significantly reducing inventory management-related costs. [GEM Premier 3500 PAK is replaced every 21 days.] GEMweb Plus, the unique information management software for the GEM Premier 4000, now available with the GEM Premier 3500 via GEMlink, allows remote management and control of all networked analyzers regardless of location, from any networked GEM Premier 4000 analyzer or PC, anywhere in or out of the hospital, optimizing analyzer up-time and saving staff time.

SLEEP ROUNDTABLE

Embla

What diagnostic and/or therapeutic sleep products do you offer?

Embla is the largest company in the world that is focused solely on sleep diagnostic solutions. We offer a complete range of products from our Embletta home sleep testing device, to in-lab and portable PSG systems with a choice of three PSG software platforms: Sandman, REMbrandt, and RemLogic. Embla also offers the Enterprise Sleep Business Management system, which supports all areas of the sleep business from referral through post study follow up. Through the development of products like Enterprise and our commitment to ongoing research, Embla provides innovative and time saving tools that help customers do their job effectively and efficiently.

What are the specific uses for your products in clinical facilities, sleep labs and/or in the home?

Embla products are used by sleep clinicians worldwide in the home, sleep lab, or hospital environment. The collected data can be managed and reviewed by sleep medicine clinicians either on site or remotely. Our product offering ranges from full multi-channel PSG systems to portable lightweight home testing equipment. The equipment is supported by a complete range of software applications that allows caregivers to collect, review, interpret and report information both locally and remotely.

Beyond the data collection, Embla Enterprise Sleep Business software allows users to manage and track patients throughout the continuum of care from the point of referral, through the scheduling, study, and patient follow up process. Enterprise reports are customizable and can provide otherwise time-consuming information on demand, including patient demographics, referral patterns, occupancy metrics, and report turnaround time. Enterprise is compatible with any PSG system, interfaces with hospital HL7 systems, and provides a paperless environment for your sleep facility.

How does your product enhance patient use and compliance?
Embla has a primary focus on helping caregivers provide the very best care to patients through the development of innovative products and services. These are designed to be used both during the diagnostic test and afterwards to follow compliance and patient well being. The Embla CPC Module, developed by researchers at the Beth Israel Deaconess Medical Center, is a breakthrough analysis tool that presents a picture of sleep quality, or "Pictogram," using only the data from one standard ECG channel. This tool can be used to predict treatment outcomes, and phenotype Sleep Disordered Breathing (SDB), The CPC Pictogram is also a powerful addition to sleep reports, giving the referring physician a graphic representation of the patient's sleep quality. The Embla CPC Module can also identify patients with Complex SA prior to therapy titration, allowing appropriate therapy to be implemented immediately. This saves time, money, and unnecessary therapy attempts, which in turn improves the patient experience. The Embla CPC Module can predict patient success or failure to Positive Airway Pressure (PAP) treatment with 90.9% accuracy rate [data on file]. Using this tool, sleep labs can enhance patient compliance by ensuring the correct treatment is implemented, and easily track CPAP efficacy over time. The CPC Module is available exclusively at Embla, and can be used in conjunction with RemLogic PSG software, or with the Embletta home sleep testing device. The CPC module works both in real-time or will analyze a previously recorded PSG in 24 seconds.

What training and education do you offer in the use of your product?
Embla has a variety of training programs that are specifically designed to complement our product line. We offer extensive onsite training on the features and functionality of our systems to new customers as well as existing customers who may have experienced staff turnover or wish to learn about the more advanced features available in our products. In addition to on site training we offer Web-based, instructor lead, real-time training sessions that are ideal for question and answer sessions between our customers staff and Embla Technical Support or Clinical Application Specialists. These courses are also ideal for getting new staff acquainted with Embla systems. Embla Web Training offers significant value for your training dollar with minimal disruption to staff schedule or work day. Enterprise customers also receive training designed for staff responsible for scheduling, creating productivity reports, managing cancellation lists as well as other daily tasks that allow the sleep lab to run efficiently. Whether it is a one bed facility or part of a multi-site hospital system with 30 beds, we can help improve productivity and the bottom line. As always, the Embla Technical Support team is available to customers 24 hours a day, 7 days a week.

Tell us about the latest clinical studies relevant to your product.
Embla is supporting multiple clinical research initiatives from recent work completed by the AASM on portable studies to ongoing clinical trials underway to evaluate the effectiveness of CPC. We also contribute to training schools and programs with software and equipment.

Discuss the latest developments in the sleep field, as these relate to your product.
The field of sleep medicine has in the past relied on subjective self-reporting methods, interviews, and psychological variables to assess sleep quality. Sleep questionnaires like the Pittsburgh Sleep Quality Index and Epworth Sleepiness Scale are used universally but because they are fundamentally subjective, do not offer truly comparative and consistent measures of disturbed sleep. It is also true that current standards used to score sleep do not always differentiate normal sleepers from poor sleepers. Using the Embla CPC Module, caregivers can add complementary information to PSG data by providing information to distinguish between good and poor sleep. The analysis also identifies what type of SDB a patient may have. Future developments with the CPC Module will allow us to provide very easy and effective ways to track patients sleep over time, providing a constant feedback to the caregiver on treatment efficacy. Frequent tracking could allow clinical decisions to be made earlier when a patient is not responding to current treatment. Other applications of the CPC Module could facilitate the intervention of therapy and identify those at risk for heart disease.

Resmed

Information provided by Drew Terry Sr., Director Product Management, Sleep SBU.

What diagnostic and/or therapeutic sleep products do you offer?
ResMed offers a full line of CPAP, APAP and VPAP bilevel flow generators, as well as adaptive servo-ventilation devices for the treatment of central sleep apnea. Key products include the S9 Elite, S9 AutoSet, VPAP Adapt SV and VPAP series of bilevels. Our devices are the quietest and most comfortable on the market in each of their respective categories. Complementing our range of devices is a full line of masks for every variety of patient and their preferences. ResMed nasal masks, nasal pillows and full-face masks offer innovative comfort technologies, like our dual-wall cushion technology and laminar flow venting that work with our ultra-quiet devices to deliver the quietest systems on the market. ResMed also offers diagnostic solutions for home sleep testing, including the ApneaLink and ApneaLink Plus. ApneaLink devices offer an affordable portable testing option that minimizes the cost of each test. Because ApneaLink devices are so simple to use, our customers get very high first-time success rates. Finally, ResMed recently released the VPAP Tx sleep lab solution, an all-in-one titration solution for the sleep lab. VPAP Tx is compatible with all PSG systems and enables use of ResMed's algorithms and comfort technologies in the sleep lab.

What are the specific uses for your products in clinical facilities, sleep labs and/or in the home?
• Our CPAP, AutoSet and VPAP products offer best-in-class therapy for the in-home treatment of sleep apnea and other forms of sleep-disordered breathing.

• VPAP Tx, ApneaLink and ApneaLink Plus are a perfect fit for sleep labs that diagnose and titrate patients for CPAP therapy. The ApneaLink devices may also be used in the hospital and other clinical settings to easily and cost-effectively diagnose patients with sleep apnea.

How does your product enhance patient use and compliance?
ResMed offers sophisticated technologies that are designed to maximize patient comfort and compliance:

• Enhanced Easy-Breathe motor: Ultra low radiated noise and conducted noise levels make ResMed products the quietest devices on the market. Low conducted noise results in patients' perception of "softer" delivery of therapy; patients report that their treatment pressure feels lower.

• Climate Control: Heated wire tubing and five sensors combine with intelligent software to provide warm, humidified air that is precisely controlled according to the patient's personal preference, and which adapts to changing environmental conditions to maintain temperature. No other company offers this level of intelligent humidification and control.

• Attractive design: The S9 platform is designed to look like it belongs in the bedroom and the bedside table. This helps overcome the stigma associated with therapy and helps patients feel more confident about incorporating it into their lifestyle.

• SlimLine tubing: The first major improvement in CPAP tubing options in 20 years, SlimLine tubing is smaller, lighter and less obtrusive than any other tubing. The lightweight design reduces tube drag on the mask and is less obtrusive when in use or on the bedside table.

What training and education do you offer in the use of your product?
• ResMed offers many education tools and options to help keep our customers and partners as informed and efficient as possible. Our Clinical Education team provides in-person training and educational services on our new products and technologies. To make learning our devices as efficient as possible, we also offer a suite of online interactive education programs, webinars and self-paced training tutorials.

Discuss the latest developments in the sleep field, and as these relate to your product.
Clinicians and HME providers are looking for solutions to make initiating and keeping patients on therapy easier. Our latest technological innovations are designed to overcome the barriers to therapy and help patients succeed.

• Our wireless monitoring system – ResTraxx – allows clinicians to monitor patients on a nearly real-time basis and easily identify at a glance those who require additional support to achieve compliance. ResTraxx also helps to identify patients who are struggling with therapy in the first few days, when efforts to help them acclimate to therapy are most critical and impactful to long-term compliance rates.

• Patient feedback: Our S9 platform also provides a basic sleep report to patients that enables them to see how they are doing on their therapy. When patients see how they are doing with respect to their own therapy goals, they are better able to make adjustments to their therapy or their sleep habits to resolve any issues.

CleveMed

What diagnostic and/or therapeutic sleep products do you offer? What are the specific uses for your products in clinical facilities, sleep labs and/or in the home?
CleveMed offers a complete line of sleep diagnostic products. Sapphire PSG and Crystal Monitor PSG Series are wireless systems for attended, unattended or remotely attended full PSG recordings in any setting. DreamPort expands the reach of the sleep lab by allowing remotely attended sleep studies to be done from anywhere, using a bedside system controlled by sleep technologists. With this internet-based upgrade to the Sapphire PSG system, the technologist can remotely monitor the patient's full PSG sleep data and video in real-time from almost any location, using a user-friendly portable bedside system. DreamPort is a great addition to a sleep monitoring program, and especially ideal for testing patients who may have difficulty coming to the sleep lab. The Type III SleepScout and SleepView along with a sleep web-portal make HST accessible. SleepScout is a portable type 3 sleep monitor that exceeds the AASM guidelines and CMS requirements. The SleepView is the smallest and lightest home sleep monitor that fulfills AASM guidelines available and is ergonomically designed for patients to perform a self test at home.

How does your product enhance patient use and compliance?
Our Home Sleep Testing product requires minimal hookup from the patient. Ease of use combined with self-diagnostic indicators facilitate quality recordings in the home. Our product can also be used in the home for consecutive nights if needed without returning the equipment home or even changing batteries.

What training and education do you offer in the use of your product?
Training is included in the purchase price of our PSG systems. Onsite training covers set-up, data collection, scoring, reporting and troubleshooting. We offer 24 hour customer support. Support is offered through e-mail, phone and interactive web meetings.

Tell us about the latest clinical studies relevant to your product.
CleveMed is currently conducting a number of clinical studies in sleep diagnosis and therapies at world-renowned hospitals and research organizations. One exciting research is finding a very high prevalence of OSA in cardiac surgery patients, further emphasizing the need for pre-surgical sleep evaluation.

Discuss the latest developments in the sleep field, and as these relate to your product.
Home sleep testing is much talked about right now. It could represent a paradigm shift in sleep medicine, but that remains to be seen. If HST were to succeed it must abide by AASM and insurance requirements and still be cost effective to deploy. CleveMed's HST SleepView product fits those requirements. Another development in the sleep field is tracking CPAP compliance. In addition to monitoring hourly use of CPAP, CleveMed believes that compliance must also include a more detailed cardiopulmonary evaluation to ensure clinical benefit especially for complex patients. Whether simple or sophisticated, tracking compliance is here to stay. CleveMed's SleepScout offers an effective and easy way to track CPAP compliance.

EXECUTIVE PROFILE

Covidien

Describe your products and their unique features.
Covidien, a leading global healthcare products company and

recognized innovator in mechanical ventilation and respiratory care devices, delivers reliable, indispensable respiratory care products for use in hospitals, healthcare facilities and homes. The company's integrated portfolio of respiratory and monitoring products spans broadly across pulse oximetry, airway and temperature management, critical care accessories, acute care and home ventilators and hospital software solutions. With more than 50 years of research and development experience in mechanical ventilation and respiratory care devices, Covidien offers many trusted critical care devices, including the Puritan Bennett 840 ventilator, the 700 Series ventilator and the 7200 Series ventilators. In the pulse oximetry category, Covidien created the first commercially viable pulse oximeter more than 20 years ago; we continue to lead the way in R&D today with the Nellcor OxiMax n-600x pulse oximeter with Alarm Management System, which helps clinicians more effectively, monitors a broad range of patients. Launched in late 2009, Covidien's Mallinckrodt TaperGuard line of endotracheal tubes introduced a revolutionary, tapered-cuff design that significantly reduces microaspiration—a term that refers to the dangerous seepage of foreign material past the tracheal cuff and into the respiratory tract.

Tell us about the latest advances in the area your product serves.

Microaspiration—the movement of secretions into the respiratory tract—is widely viewed as a cause of specific post-intubation pulmonary complications, including postoperative and ventilator-associated pneumonias. The overwhelming majority of such microaspiration cases stem from inadequately designed tracheal cuffs that fail to seal the tracheal passageway. The current standard endotracheal tube, which has a barrel-shaped high volume, low pressure cuff, was originally introduced in the mid-1970s as a redesign of the original red rubber tube. Though the gold standard for over 30 years, the barrel-shaped cuff provided an adequate air seal but did not adequately seal the patient's tracheal passageway. This allowed secretions to potentially migrate through folds in the cuff. Although these air seal gaps are very small—micro in size—they can allow gastric laden secretions or virulent secretions associated with pneumonia to enter into and be dispersed throughout the lungs. Post-intubation pulmonary complications, like pneumonia, are prevalent and costly for patients and society. Microaspiration of contaminated oro-pharyngeal and gastrointestinal secretions is a likely and modifiable risk factor for pneumonia.

The new Mallinckrodt TaperGuard line of endotracheal tubes reduce microaspiration by an average of 90% compared to conventional high volume low pressure cuffed endotracheal tubes. Data was presented at the New York State Society of Anesthesiologists Post-Graduate Assembly held in New York City. This study showed that not one patient intubated with TaperGuard endotracheal tubes showed signs of fluid leakage past the cuff (n=11). In contrast more than 40% of patients intubated with a conventional high volume low pressure cuff (n=9) exhibited clear evidence of microaspiration. When used in surgical procedures and critical care applications, TaperGuard endotracheal tubes will substantially reduce specific and severe risks related to the movement of secretions beyond the tube's sealing cuff, most notably from pneumonia. In addition to microaspiration reduction, the Mallinckrodt TaperGuard Evac endotracheal tube has been shown to reduce VAP by up to 75%. As a further example of the value of Covidien's integrated respiratory product portfolio, when the TaperGuard Evac endotracheal tube is used in conjunction with a Puritan Bennett 840 ventilator, clinicians can further reduce the risk of infection because of the ventilator's inspiratory and expiratory filters. These filters prevent the ventilators from becoming either inspiratory or expiratory transmission vectors for viral and bacterial agents. In addition, Covidien provides DAR filters and Heat and Moisture Exchangers (HMEs) as an effective and economic way to deliver appropriate humidification and protect the safety of mechanically ventilated patients. In a laboratory test of 48 filter and HME products, DAR HMEs ranked among the best for absolute humidity and resistance.[1]

Discuss your R&D process, including clinical user input.

Covidien is dedicated to creating innovative respiratory and monitoring solutions for clinicians and patients that ultimately lead to better clinical patient outcomes. Each year, medical professionals, organizations and customers partner with us to identify unmet clinical needs and to translate them into viable therapeutic solutions.

Discuss the educational services you offer for use of your product.

Covidien offers an exceptional level of service and technical support, including onsite and real-time training for clinicians. This hands-on service is complemented by a comprehensive array of clinical education resources, including a wide variety of free, accredited continuing education courses for registered nurses and respiratory therapists. Available through Covidien's Center for Clinical Excellence website, these self-paced courses can be accessed 24/7 and offer convenient post-testing, plus the ability to earn a Certificate of Completion that may be used to meet or accumulate contact hour requirements for re-licensure. In addition, dedicated training centers, fellowship grants and other continuing education programs are available. For example, during the American Society of Anesthesiologists' annual meeting, Covidien held a symposium on pulmonary complications related to post-intubation using Hi-Lo, Hi-Lo Evac, TaperGuard and TaperGuard Evac endotracheal tubes. The symposium brought together international experts in anesthesia and critical care medicine as well as attending practitioners to focus on the relationship between microaspiration and commonly used endotracheal tubes.

What new technology do you see as having the greatest impact on your area of expertise?

Technology gains with miniaturization are likely to have the greatest impact in the area of portable ventilation. The ability to produce ever smaller ventilators addresses a key healthcare concern facing clinicians and patients today: How do we make a significant improvement in a ventilation-dependent patient's quality of life and health outcome? The answer in part depends on the size of the ventilator. Covidien offers the Puritan Bennett 540 ventilator that weighs less than ten pounds and provide up to ten hours of portable operation. These improvements potentially provide ventilation-dependent patients—including adult and pediatric patients—the chance to live much less restrictive lives than would be possible with larger and more cumbersome equipment.

1 Lellouche F et al. Humidification performance of 48 passive airway humidifiers: Comparison with manufacturer data. Chest. 2009; 135(2).

Neonatal Bilirubin Method Evaluation: Whole Blood on RAPIDLab® 1200 versus Plasma on VITROS® 950 Chemistry System

T. Hotaling, J. Brunelle, K. Mullert

Abstract

Objective: To provide an assessment of whole blood neonatal bilirubin measurement derived optically compared with a reagent-based chemistry method utilizing plasma.

Relevance: As a diagnostic tool, bilirubin is measured in the neonate as an indicator of jaundice and for assessing the risk of kernicterus.

Method: We describe a performance evaluation of a new neonatal bilirubin assay on the Siemens RAPIDLab® 1200 Model 1245 and 1265 blood gas analyzers using unhemolyzed whole blood neonate specimens. The reference method was the Ortho-Clinical Diagnostics VITROS® 950 chemistry system (using plasma from the same specimens). The evaluation occurred in three studies, incorporating 28 test days across four RAPIDLab 1200 instruments and two chemistry analyzers.

Results: During the development of an unhemolyzed whole blood bilirubin assay, we determined that the hemoglobin type could profoundly affect the result. A significant bias was initially observed with clinical neonate specimens compared to internal contrived adult samples. Although the presence of scatter and fetal hemoglobin (fetalHb) had already been accounted for in the determination of total hemoglobin (tHb) and CO-oximetry fractions, it was not satisfactory for the determination of bilirubin specifically in neonates. Further compensation for native fetalHb was required. The graph at right (Figure 1) presents neonatal bilirubin values as determined by the RAPIDLab 1200 using additional fetal compensation versus the VITROS assay method. This example demonstrates excellent bilirubin correlation between the two methods on neonate patients with 2-20 mg/dL bilirubin at native tHb levels. Bilirubin-spiked cord blood (containing native fetalHb) and spiked adult blood (without fetalHb) were evaluated.

Conclusions: We conclude that the accuracy of the RAPIDLab 1200 whole blood bilirubin method is comparable to that of the VITROS plasma chemistry method. The absence of a statistically significant difference in bias between spiked cord and spiked adult samples indicates the effectiveness of the fetalHb compensation algorithm.

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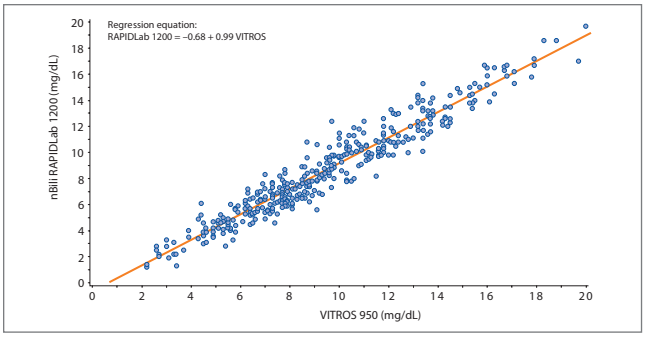


Figure 1. Neonatal bilirubin concentration on the RAPIDLab 1200 vs the VITROS 950 (all three studies, combined).

Background

Bilirubin, the main bile pigment in the liver, is a major end product of hemoglobin decomposition as aged or damaged red blood cells are routinely destroyed. Hemoglobin degradation results in the formation of unconjugated bilirubin. As the unconjugated bilirubin is lipid-soluble, it cannot be excreted until it is bound to albumin and carried to the liver, where it is made water-soluble by conjugation and passed in the urine. For the clinician, bilirubin is considered an index of liver function, as it reflects the liver's ability to take up, process, and secrete bilirubin. Impaired conjugation of bilirubin in the liver can result in elevated bilirubin levels in the blood. An increased level of bilirubin in the blood (hyperbilirubinemia) causes jaundice, resulting in discoloration of body tissues.

Jaundice in newborns is usually harmless, a consequence of immature hepatic function and the normal breakdown of fetal hemoglobin as it is replaced with adult hemoglobin. Severe neonatal jaundice, however, may indicate more serious conditions, including erythrocyte hemolysis (erythroblastosis fetalis) generally caused by blood incompatibilities between baby and mother. Newborn bilirubin levels should be closely monitored, as extremely high levels of bilirubin in infants may cause a form of brain damage (bilirubin encephalopathy or kernicterus).

The Siemens RAPIDLab 1200 blood gas systems are designed to measure pH, pO_2, pCO_2, Na+, K+, Ca++, Cl-, glucose and lactate on unhemolyzed whole blood. Direct multiple wavelength spectrophotometry technology measuring light transmission through the same specimen is also applied to determine concentrations of total hemoglobin and its derivatives (tHb, FO_2Hb, FCOHb, FMetHb, FHHb).

The option to additionally report total bilirubin on neonatal whole blood specimens (nBili) has recently been introduced on the RAPIDLab 1245 and RAPIDLab 1265 models of the RAPIDLab 1200 blood gas series.

The RAPIDLab 1245 and RAPIDLab 1265 analyzers assess neonatal bilirubin concurrently with tHb and CO-oximetry on whole blood using direct spectrophotometry. Raw bilirubin values are determined by iterative least-squares analysis and further adjustments made to produce the reported nBili results. The VITROS analyzer, on the other hand, first employs a caffeine and sodium benzoate reactive chemistry step on plasma (or serum) matrix. After a fixed incubation period, endpoint colorimetric dual-wavelength analysis is made to determine the concentrations of unconjugated and conjugated bilirubin fractions which, when added together, are used to derive the reported total neonatal bilirubin (NBIL) value.

Assessments of neonatal total bilirubin were conducted to determine the comparability of the two methods which utilize different sample matrixes.

Materials and Methods

All samples were obtained from clinical patients and evaluated in the core chemistry lab at the hospital site during three separate studies across 28 test days, incorporating four different RAPIDLab 1245 units and two VITROS instruments.

As bilirubin is light sensitive, care was taken to keep the test samples protected from light exposure prior to testing. The majority of samples tested were from neonatal patients. Gender was equally distributed, and the neonate ethnic profile was reflective of the demographic mixture of the region's population. The neonatal patients' ages ranged from less than 1 through 14 days, with the majority being ≤5 days old. In addition, remnant arterial and/or venous whole blood taken immediately from umbilical cords was tested. A small number of remnant whole blood samples from adult patients were also evaluated as described below.

Neonatal samples were collected as whole blood in amber-colored microtainers (plasma separator tubes with heparin; Becton Dickinson). For each neonate test sample, a small volume was removed via glass capillary and measured on a RAPIDLab 1245 blood gas analyzer. The volume remaining in the microtainers was spun in a centrifuge. The resulting plasma was poured off into plastic cups and measured using the NBIL assay on either of two VITROS chemistry analyzers resident in the core chemistry lab. For each neonate test specimen, the whole blood RAPIDLab 1245 nBili value was compared to the corresponding plasma VITROS NBIL result, in mg/dL.

In similar fashion, portions of remnant adult and cord whole blood samples were measured on a RAPIDLab 1245 and compared to the corresponding plasma matrix measured on the VITROS. Prior to testing, some of these remnant specimens were doped with varying amounts of concentrated bilirubin spiking solution (100 mg/dL unconjugated in 0.85% HSA, pH adjusted) to artificially elevate the bilirubin concentration detailed later in this report.

Results

Described below is a neonatal bilirubin performance evaluation of the new RAPIDLab 1200 blood gas system bilirubin measurement, using whole blood, compared to the VITROS as the plasma chemistry reference method.

Early development of the whole blood nBili measurement on the RAPIDLab 1200 series indicated a pronounced inverse relationship of tHb/hematocrit versus raw bilirubin results; as tHb increases, the raw bilirubin results decreases. To compensate for this relationship, a mathematical hematocrit correction was applied to the raw nBili results. An effective hematocrit correction is of importance as the tHb/hematocrit distribution may be different and/or more diverse among various sample source populations. Figure 2 illustrates the tHb distribution of the test samples at the clinical site differentiated by sample source (adult, cord, and neonate). The bilirubin determination for the neonatal population (in blue), overall displaying a wide spread and overall larger tHb values (mean=18.2 g/dL), would be inversely affected by a poor or no hematocrit correction. The adult population (in light green), overall has a lower average tHb (mean=13.8 g/dL). The tHb distribution for cord specimens (in orange) falls slightly less than midway (mean=15.5 g/dL) between the neonatal and adult peaks.

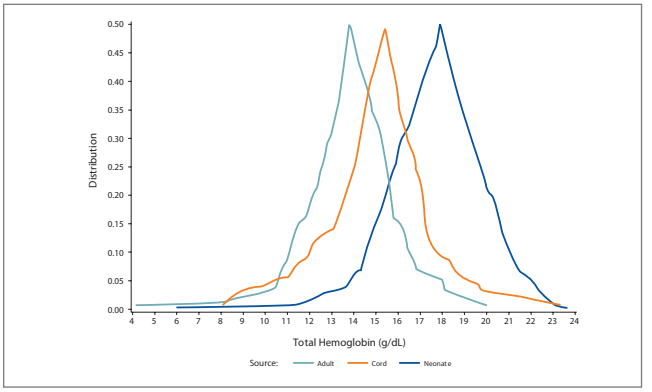


Figure 2. Mountain plot showing distribution of total (native) hemoglobin in adults (light green), neonates (blue), and cord blood (orange).

Despite the application of a RAPIDLab 1200 nBili hematocrit correction, significant bilirubin underrecovery and imprecision was observed on the RAPIDLab 1200 versus the VITROS reference on neonatal samples (Figure 3).

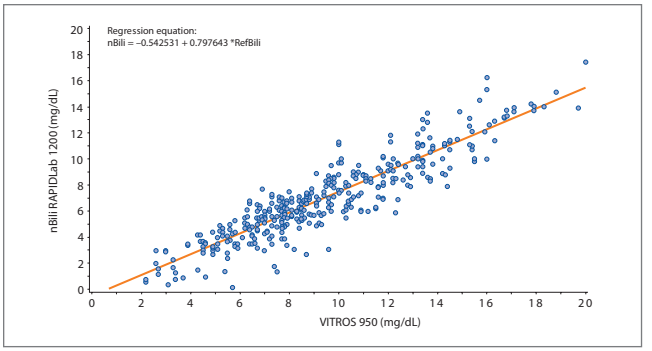


Figure 3. Interim method comparison of bilirubin measurement on the RAPIDLab 1200 versus the VITROS on neonatal specimens (with RAPIDLab 1200 nBili software using only hematocrit correction).

This underrecovery was not observed during internal developmental testing where adult whole blood samples adjusted for tHb and doped with various amounts of prepared unconjugated bilirubin spiking solution were used. An

adjustment for the presence of fetal hemoglobin was already being applied in determining the concentration of tHb and the CO-oximetry fractions on the RAPIDLab 1200. However, the original fetalHb compensation was determined to be inadequate for bilirubin determination.

Whole blood from adult and cord sources was spiked with varying concentrations of the same lot of prepared bilirubin. Cord whole blood, unlike adult, contains elevated levels of native fetalHb. Therefore, the significant difference in the specimens is not the bilirubin source (native versus artificial), but the presence of fetal hemoglobin. Figure 4 exhibits method comparison of RAPIDLab 1200 bilirubin results versus the VITROS for spiked adult and cord samples using the refined fetalHb correction vector.

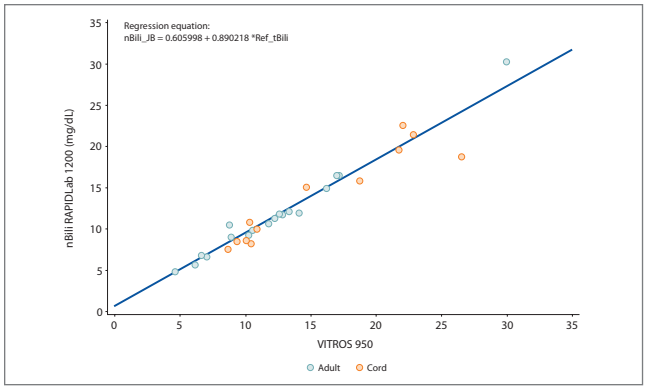


Figure 4. Bilirubin recovery of spiked adult and cord samples: RAPIDLab 1200 vs. VITROS.

On the basis of t-test analysis of the RAPIDLab 1200 mean bilirubin bias against the VITROS for spiked cord and spiked adult samples, the two populations are statistically equivalent (i.e., there is not enough evidence to conclude with 95% confidence that the two populations are different; Table 1). This supports the use of the additional fetalHb compensation and minimizes the difference seen between contrived and natural specimens.

Spiked Cord Samples			Spiked Adult Samples			t-Test		Reject
N	mean bias	SD	N	mean bias	SD	t Stat	Pr > t	Null?
12	–1.55	2.26	18	–0.44	0.83	1.62	0.13	No

Table 1. Statistical comparison of bias (RAPIDLab 1200–VITROS) for bilirubin-spiked samples.

Once this correction for native fetalHb was applied to the clinical neonatal data set utilized in Figure 3, the final method comparison of bilirubin on the RAPIDLab 1200 versus the VITROS chemistry system demonstrated good correlation. Both bias and precision showed observable improvement (Figure 5).

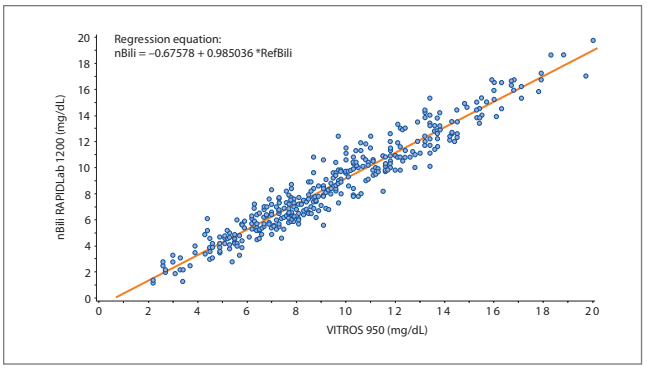


Figure 5. Final method comparison of RAPIDLab 1200 versus VITROS on neonatal specimens (with final RAPIDLab 1200 nBili software using hematocrit and fetalHb corrections).

Despite the differences between the technology and the sample matrix, RAPIDLab 1200 nBili versus VITROS NBIL shows excellent correlation. Linear regression comparison of the clinical neonate specimens using pre- versus post-fetalHb correction (RMSE=root mean square, r2=correlation coefficient) is outlined in Table 2.

Figure	RAPIDLab 1200 Software	N	Intercept	Slope	RMSE	r^2
3	Interim (no fetalHb correction)	379	–0.54	0.80	1.258	0.832
5	Final (with fetalHb correction)	378	–0.68	0.99	0.966	0.928

Table 2. Comparison of linear regression analysis of method comparison of RAPIDLab 1200 pre- or post-fetalHb correction vs VITROS.

Conclusions

A feature of the RAPIDLab 1200 series of blood gas analyzers is the ability to quantify and report patient results for blood gases, pH, electrolytes, metabolites and CO-oximetry. Neonatal total bilirubin is now available on the same analyzers from the same single whole blood sample, eliminating the need for an additional draw.

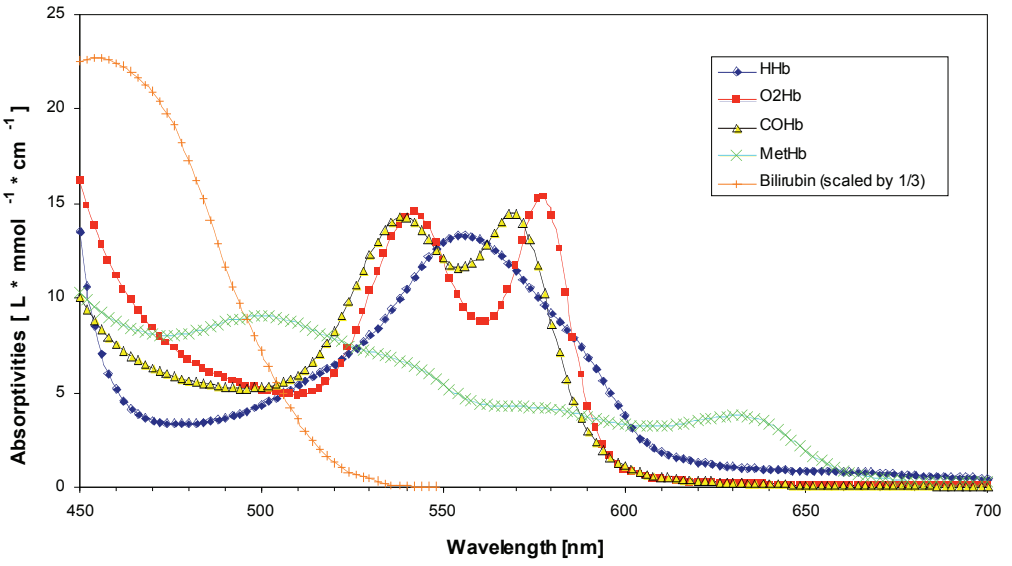
The testing concludes that the accuracy of the RAPIDLab 1200 whole blood bilirubin method is comparable to that of the VITROS 950 plasma chemistry method. The absence of a statistically significant difference in bias between spiked cord and spiked adult samples indicates the effectiveness of the fetalHb compensation algorithm.

The new RAPIDLab 1200 neonatal total bilirubin measurement provides an alternative method to conventional chemistry analyzers. Using direct spectrophotometry, it provides results in only 60 seconds on whole blood neonatal specimens. RAPIDLab 1200 neonatal bilirubin results are comparable to those obtained with the VITROS chemistry system, which uses a combination of reagent and optical technology on samples requiring separation into plasma and a 5-minute incubation period.

Bili Study

Spectroscopic analysis of hemoglobin and its derivatives (co-oximetry), in combination with blood gas analysis, provides actionable information about oxygen transport in human blood. The accuracy of the hemoglobin and bilirubin results depends on the performance of the co-oximetry technology. The co-oximetry module of the Roche cobas b 221 blood gas system measures both hemoglobin derivatives and bilirubin spectrophotometrically in the visible spectrum range (460nm to 660nm). Absorbance of the sample is measured at a total of 512 discrete wavelengths. The concentrations of hemoglobin, hemoglobin derivates and bilirubin are determined by applying an accepted mathematical algorthrim.[1] This enables the cobas b 221 system's co-oximetry technology to detect the presence of light-absorbing substances not covered by the reference spectra and to prevent incorrect values due to interfering substances from being reported.[3] This advanced co-oximetry design helps improve the accuracy of patient test results, which is demonstrated by a high correlation with results from accepted clinical chemistry test methods.[2] *References: 1. cobas b 221 reference manual version 8.0 pp 20, 21; 2. Bolinski, Boris et al. Evaluation of Total Bilirubin Determination in Neonatal Whole-Blood Samples by Multiwavelength Photometry on the Roche OMNI S Point-of-Care Analyzer. Point of Care, The Journal of Near Patient Testing and Technology; Volume 4, March 2005; 3. Schweiger, Gerd. Technical Aspects: Determination of Bilirubin on the Roche OMNI S, International Evaluation Workshop, October 23, 2003, Deutschlandsberg, Austria; 4. H. Hallemann et al. Technical Aspects of Bilirubin Determination in Whole Blood Care, The Journal of Near Patient Testing and Technology, Volume 4, March 2005.*

Absorbance of Hemoglobin Derivatives and Bilirubin[4]



The information was provided by Roche Diagnostics.

The Cost Effectiveness of Noninvasive Ventilation (NIV) in Hospital and Pre-Hospital Settings

Pamela Nelson-Artibey, MEd, RRT-NPS

Noninvasive ventilation (NIV), when used in the appropriate patient population, has the ability to improve patient mortality, address patient comfort, and reduce costs.[1] There is strong evidence supporting the application of NIV in patients with congestive heart failure, chronic obstructive pulmonary disease (COPD) exacerbation, immunocomprised patients, and COPD patients being weaned from mechanical ventilation. There is also moderately strong evidence to support NIV in patients with asthma, cystic fibrosis, postoperative respiratory failure, and DNI (do not intubate) patients.[2] NIV is for spontaneously breathing patients only. NIV is contraindicated for hemodynamically unstable patients and patients in cardiac/respiratory arrest, with insufficient respiratory drive, or with upper airway obstruction.[3] This paper highlights the cost effectiveness of NIV within both the pre-hospital and hospital settings. While NIV offers significant cost advantages over traditional ventilation via endotracheal intubation, it also offers equally significant benefits to patients in the form of decreased length of stay, reduced sedation that is associated with intubation and decreased morbidity and mortality rates.[4,5,6] Furthermore, many patients in respiratory distress may be spared the misery of endotracheal intubation, which takes away their ability to communicate, and the accompanying sedation, which deprives them of their cognitive abilities. Although the need for invasive ventilation will always exist, many patients can be successfully treated with NIV.

Pre-hospital use of NIV

Until recent years, NIV was reserved for in-hospital settings, but thanks to improvements in equipment and education, the benefits of NIV may begin as early as when first responders arrive in a patient's home. In recent years, pre-hospital CPAP (continuous positive airway pressure) devices, which deliver a basic form of noninvasive ventilatory support, have been adopted in many emergency medical services (EMS) systems worldwide. Until the advent of CPAP, EMS providers were limited to using either 100% high flow oxygen via mask or intubation for patients in acute respiratory distress. CPAP now offers a new alternative to patient care in the pre-hospital setting. In a 2008 article, Houston Fire Department paramedic, Charles Harper, explained that medical personnel caring for patients with COPD exacerbation and pulmonary edema started using CPAP devices for their patients instead of intubating them. According to the article, patients who ended up intubated and in the ICU typically had first-day ventilation costs of approximately $8,000. Officials for Memorial Hermann Hospital in Houston, Texas, acknowledged that initiating CPAP instead of intubating some of these patients could save an estimated $800,000 per year.[7]

A study by Hubble et al that was featured in the July 2008 issue of Prehospital Emergency Care, evaluated the cost-effectiveness of NIV in pre-hospital settings. Their analysis showed a significant cost reduction and improved patient outcomes when using CPAP.

During a one-year period, CPAP was used 120 times (4:1000 patients). The cost per CPAP application was $89 and resulted in .75 lives saved for every 1000 patients treated at a cost of $490 per life saved. The average length of stay (LOS) in the hospital for non-intubated patients was 5 days vs 10 days for intubated patients, of which at least 5 days were in the ICU. Using the total criteria, the hospital savings were estimated at $499,717 per year, less the cost of equipment, supplies and training.[8] In reviewing Dr Hubble's study, Dr Keith Wesley, Minnesota State EMS Director, suggested that these savings were fairly conservative and that a hospital with more frequent intubation rates could save an estimated $1,118,050 per year. This would result in a cost savings of $9,317 per CPAP use.[9]

NIV in the hospital

The economic benefits of using NIV in the hospital setting are well documented for both acute and chronic patients.[4,5] Many studies have shown not only the cost effectiveness of NIV but the beneficial aspects to patient care.[4,5,8,9]

In the United Kingdom a randomized control trial was conducted in 14 participating centers. The researchers found that noninvasive ventilation reduced the need for intubation by 44% and the in-hospital mortality decreased by 50% in patients with severe exacerbation of chronic pulmonary disease.[4] Another review in the United States concluded that NIV was associated with lower rates of pneumonia, intubation, and mortality.[10]

Nava et al explained that NIV is widely used today as a valid treatment to avoid intubation and its complications.[11] While conventional invasive ventilation is a life-saving procedure; the most important risk factor is in fact endotracheal intubation.[11] Nava pointed out that the risks of endotracheal intubation include nosocomial pneumonia, damaged tracheal mucosa, increased patient discomfort, the inability to speak, and the need for sedatives. Therefore, NIV should be considered in early

treatment of established acute respiratory failure (ARF) patients to avoid further deterioration and intubation.[11] Dr Arroliga, head of Critical Care Medicine at the Cleveland Clinic, believes that NIV avoids the complications of intubation, incurs shorter stays in the hospital, lowers mortality rates, and lowers healthcare costs. Another advantage he pointed out is that NIV is more comfortable for patients as they can retain the ability to speak, swallow, and protect their airway.[12]

Ventilator-associated pneumonia

Whenever a patient is intubated, they run the risk of contracting an infection known as ventilator-associated pneumonia (VAP). VAP is one of the most significant risks facing intubated patients on a ventilator.[13,14] According to the Centers for Medicare and Medicaid Services, the average cost of a VAP infection runs about $135,795 per hospital stay with an estimated 30,867 reported cases of VAP in the US each year.[15] In a statement by the Center for Disease Control and Prevention's National Nosocomial Infection Surveillance System (NNIS) in their 2002 report, patients receiving continuous mechanical ventilation were 6 to 21 times more at risk for developing healthcare-associated pneumonia than those patients who were not receiving mechanical ventilation.[16] In reviewing cohort studies by various physicians, their findings suggested that implementing NIV results in a decreased rate of nosocomial pneumonia and infections.[17] Dr Dean Hess compared 12 studies relating to NIV being administered to patients at risk for pneumonia. The study revealed that compared to patients receiving invasive mechanical ventilation (in four studies), the rate of pneumonia was lower with the use of NIV. In addition, Hess suggested that ventilator associated pneumonia is a misnomer, and perhaps "endotracheal-tube-associated-pneumonia" is a more accurate term. With NIV, because there is no intubation, there is virtually no risk of VAP.[10]

NIV for COPD

COPD is one of the leading causes of death, illness and disability in the United States.[14] In 2000, COPD caused 119,000 deaths, 726,000 hospitalizations, and 1.5 million emergency department visits.[17] The standard treatment generally includes inhaled bronchodilators, systemic corticosteroids, supplemental oxygen, and antibiotics.[14] In one particular study, the cost-effectiveness of NIV, added to the standard treatment, was reviewed and analyzed from the data obtained by several studies.[5] The primary outcomes that the authors were looking for was to see a reduction in hospital mortality and endotracheal intubations. Their cost analysis revealed that using NIV instead of endotracheal intubation in patients with acute exacerbation of COPD resulted in cost savings of $3,244 per patient admission.[5] With all the documented clinical trials showing the clinical effectiveness of NIV in this patient group and the cost savings for the hospital, Keenan et al felt that NIV showed a clear dominance in this arena. Viewing this from a hospital perspective, NIV demonstrates a clear economic value in the treatment of severe, acute exacerbation of COPD.[5]

NIV success factors

European countries are also seeing an increase in the use of NIV for the treatment of patients with COPD.[18] An article featured in the European Respiratory Journal cited that a lack of training was the main reason NIV was not implemented more often.[18] According to Leger et al any hospital that has the potential for treating patients with acute and chronic respiratory failure should have noninvasive ventilation available to them. It was also stated that the experience and training of the staff to adequately monitor the patient was clearly linked to the success of NIV.[18] This article revealed that with proper training and education, NIV is a very successful tool for the treatment of patients with COPD.

The successful implementation of NIV also depends on the acceptance and compliance of the patient; which is influenced by the clinicians attitude and level of confidence in initiating NIV may play an important role.[18] This is why education and training are essential for the health care professional.[18] In a study conducted over an 8-year period (1992-1999) in patients with ARF, 248 patients were analyzed.[19] The result showed that NIV success rates increased over the course of time with education and experience of the patient care staff. Carlucci concluded in her study that clinical practice may change over time so that with increased staff training more severely ill patients may be successfully treated with NIV at a lower cost and reduced risk of failure.[19]

Conclusions

With a mounting body of evidence now available for review, NIV is clearly very cost-effective and a more efficient form of treatment for patients who are within the treatment criteria.[1,4,5,8,12,20] Today, NIV represents one of the current medical technologies proven to help reduce length of stay, morbidity, mortality, risks of infection, and cost of care.[1,4,5,8,10,11,20] As NIV eliminates the financial and clinical consequences of unnecessary endotracheal intubations in the pre-hospital setting, it behooves hospital administrators and clinicians, in close association with their EMS partners, to expand the use of NIV. Using NIV as the first form of treatment, especially in patients with acute exacerbation of COPD and acute pulmonary edema, from the pre-hospital setting through the hospital will save on medical costs and improve outcomes to the benefit of patients and healthcare providers alike. While NIV may not be appropriate for all patient types, understanding NIV protocols and guidelines will help clinicians make better decisions for their patients.

Faced with ever increasing cost control pressures, it may be encouraging to know that the clinical and economic advantages of NIV, in appropriate patient populations, represent a significant untapped or under-utilized source of savings that can actually improve patient outcomes.

References

1 Seiver A. Noninvasive Ventilation: A Primer for Medical Center Administrators. Philips Whiter Paper; Nov 2008.
2 Liesching T, Kwok H, Hill N. Acute Applications of Noninvasive Positive Pressure Ventilation. Chest 2003; 124:699-713.
3 J Crit Care 2004 Vol. 19:82-91
4 Plant P, Owen J, Parrott S, Elliott M. Cost effectiveness of ward based non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease: economic analysis of randomized controlled trial. BMJ 2003; 326: 1-5.
5 Keenan S, Gregor J, Sibbald W. Cook D, Gafni A. Noninvasive positive pressure ventilation in the setting of severe, acute exacerbations of chronic obstructive pulmonary disease: More effective and less expensive. Crit Care Med 2000; Vol 28, No. 6 (2094-2102).
6 Hess D. Should Noninvasive Positive-Pressure Ventilation Be

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Fast Aerosol Delivery

Laszlo Sandor

Faster aerosol delivery benefits RT workload and lowers costs, according to study in a recent issue of Respiratory Care.*

Respiratory caregivers have long known the benefits of providing aerosol therapy delivered via small volume nebulizers. Researchers at the Cleveland Clinic in Ohio sought to ascertain the results of using a faster nebulizer, in order to evaluate the effects of quicker aerosol deliver on possible staff resource reallocation.

Hoisington et al compared work distribution in a post-thoracic surgery ward over a 30-day period. They implemented the use of two nebulizers, the VixOne, for nebulization during the baseline period of nine minutes, and the NebuTech HDN for treatment during the intervention period of not more than three minutes.

The number of procedures were found to be similar during the baseline and intervention periods, 33.8 per shift versus 33.3 per shift, respectively. The number of SNV treatments were similar as well, 11.9 vs 11.8. The procedure time required was 4.7 hours vs 3.6 hours. According to the authors, "The time savings from the faster nebulizer corresponded to 1.8 full-time equivalents and theoretical net annual savings of $66,491." The authors concluded that the NebuTech HDN "substantially reduces SVN-administration time, without adverse effects or events."

Background

Administering aerosol therapy is a time-consuming procedure. At the Cleveland Clinic, for instance 40% of the clinical workload outside the ICU is absorbed by inpatient respiratory therapy. Administering SVN treatment and the time it takes is related to the demands of the procedure, calculated by aerosol output and volume. As such, the investigators posited that a nebulizer with faster delivery could shorten the amount of time spent on inpatient therapy.

Study Parameters

In the study, eight RTs administered 3 mL of albueterol or levalbuterol three times a day for 30 days. The researchers divided workload into categories associated with bronchodilator treatment, physician-ordered treatment, and for procedures such as desaturation studies and consultation.

In a subsequent follow-up period, the investigators measured workload two days a week over 10 weeks throughout the hospital. Using this workload data, a hypothetical treatment time with the NebuTech was evaluated vs the nine minute time for standard nebulizer treatment, and compared using mean and median calculations.

Results

The time involved in therapy administration was higher in the baseline period, at 4.7 hours, than in the intervention period, 2.6 hours. The total therapy work time administering SVN treatments was considerably lower in the intervention period, at 16% vs 38%, and the median total daily administration time was 1.8 hours vs .6 hours. The authors noted that the time was saved without simultaneous administration of treatments (stacking) to patients during the administration period. The time for non-time-sensitive procedures such as ambulatory desaturation measurements, patient assessment and the like was greater in the intervention period (.75 h vs .50 h), underscoring the investigators' hypothesis that time saved by using a faster nebulizer could be applied to those activities.

According to the authors, anecdotal evidence based on discussion with patients revealed that the patients who were treated with the NebuTech nebulizer "preferred the shorter treatment time."

Follow-Up

In the follow-up period, the authors summed up the workload from several wards to determine a hypothetical assigment of staffing and care. Results showed that use of the NebuTech would have allowed a staff reduction of 1.8 full time RTs, and calculated the time-savings using a faster nebulizer to be almost $79,000. With cost adjustment for the price of the NebuTech, the theoretical net annual savings from its use was pegged at just under $66,500.

Conclusion

The authors concluded that the reduced treatment time gave RTs more time to perform other duties, and that the use of the faster nebulizer had no adverse affects on care. The authors noted that assigning monetary values to time savings, however, introduced possible statistical variables outside the ken of the study, and stated that pure cost savings shouldn't be the overriding analytical criteria for the use of the faster nebulizer, and that other factors such as the RT shortage should be considered when reviewing the results of the study.

The authors speculated, based on historical data, that complex nebulizer treatments, which were outside the scope of their study, would yield even greater benefits.

Laszlo Sandor is Associate Editor of Respiratory Therapy. *Information for this review article is from the article A Comparison of Respiratory Care Workload With 2 Different Nebulizers, by Edward R. Hoisington, RRT; Robert L. Chatburn, RRT-NPS FAARC; and James K. Stoller, MD, MSc, FAARC, in Respir Care 2009;54(4):495– 499. The referenced article can be accessed on Respiratory Care's website or on Salter Labs' website.

Adaptive Pressure Control Ventilation, Limitations and Best Practices

Bill Lamb, BS, RRT, CPRT, FAARC; Paul Garbarini, MS, RRT

Adaptive Pressure Control Ventilation (APC) is a mandatory breath type best characterized as a Volume Targeted Pressure Control breath (Pressure Control - Time Cycled - Pressure Limited). Pressure is constant during inspiration, flow is variable depending on volume target, patient effort and respiratory sytem compliance and resistance. Adaptive adjustments to inspiratory pressure are made between breaths to deliver a minimum target tidal volume. Available versions of APC in the US include Pressure Regulated Volume Control (PRVC), AutoFlow, Flow Sync, Adaptive Pressure Ventilation (APV), Volume Control Plus (VC+) and Pressure Control Volume Guarantee (PCVG). In the November 2009 issue of Respiratory Careand its related editorial, Mireles, Chatburn and Jaber point out the relative lack of evidence supporting the use of APC breath types and the fact that these adaptive pressure control breath types allow for weaning of the inspiratory pressure when the patient is breathing above the target tidal volume and conclude that "Adaptive Pressure Control algorithms differ between ventilators in their response to increasing patient effort. Notably, some ventilators allow the patient to assume all of the WOB, and some provide a minimal level of WOB regardless of patient effort."

Indeed, Adaptive Pressure Control breath types wean pressure when actual tidal volumes are greater than the set tidal volume. As adaptive breaths use pressure as the control variable during inspiration, if actual tidal volume is less than the target tidal volume, inspiratory pressure is increased breath to breath (usually by no more than 3 cmH_2O per breath) to achieve the target tidal volume. Conversely, if actual tidal volume, often assisted by the patient, is greater than the set minimal target tidal volume, inspiratory pressure is weaned breath to breath in an attempt to bring the actual tidal volume into the target tidal volume range. Some ventilators will not wean inspiratory pressure below a predetermined level. In the vast majority of patients, this adaptive control mechanism process works well. A minimal inspiratory pressure level is used to deliver the tidal volume, thus exposing the patient to the lowest inspiratory pressure possible. The patient's inspiratory flow demand is matched to patient effort, thereby improving patient ventilator synchrony. As the patient's condition and strength improves, inspiratory pressure is automatically weaned.

In conditions where the patient is breathing above the target tidal volume as a result of increased effort due to respiratory distress or neurological drive, the adaptive pressure control mechanism weans the inspiratory pressure per algorithm and may result in a suboptimal work of breathing for the patient.

Best Practice

Clinicians should be aware of these potential situations and be prepared to recognize, assess, and treat them. Clinicians must know their ventilatory support equipment and how it responds to such conditions. Clinicians should be diligent in assessment of their patients and have appropriate alarms set to alert them at the bedside (eg High Tidal Volume, High Minute Volume, Low Pressure and High Respiratory Rate) and must immediately assess their patient in these situations and take action.

Why is the patient currently breathing in this pattern?

In situations where it is deemed that the patient presently needs additional support: consider setting the target tidal volume at or near the patient's actual tidal volume to support them through the exacerbation. Consider increasing the set rate to "capture" the patient. Consider shortening the inspiratory time as this will increase the pressure level needed to achieve the same target volume in a shorter time (if it does not cause asynchrony). Consider adjusting the ramp or rise setting so the current pressure level is reached faster (ie higher peak inspiratory flow). Consider additional automatic tube compensation if available.

In situations that are neurogenic in etiology, or due to anxiety or where high WOB is due to increased metabolic demands and when sedation is not appropriate, consider pressure control ventilation to support the patient, which provides a constant level of support. It may not be possible to fix the problem with the ventilator and control of the patient's respiratory drive with sedative/paralytic agents may be necessary if unable to treat the underlying cause or the potential for Volu/Baro trauma is present.

The clinician must also consider the effects of leaks and how and where their ventilator measures target VT. Most Adaptive Pressure Breath Volume Targeted Pressure Control breath types are vulnerable to excessive leaks in the system that may bias the ventilator's logic. The clinician must understand how the ventilator monitors and controls APC breath types: does the ventilator measure expiratory volumes for its APV logic or does it use inspiratory volumes? Some ventilators monitor both inspiratory and expiratory volumes at the patient to provide potentially more stable volumes in the presence of leaks (eg Hamilton ventilators). These variables will determine how the ventilator responds in such situations.

This article was provided by Hamilton Medical, Inc.

The ventilator should have an adjustable low pressure alarm to alert the caregiver to a low inspiratory pressure situation such as when the PIP is weaned more than desirable.

Indeed, more evidence based data is warranted to support the use of all modes and breath types used in mechanical ventilation; however, these studies are very complicated and costly and require potentially thousands of patients to show a clear cause and effect on outcome (due to co-morbidities, medications, diagnosis, etc). In the meantime, the clinician must know their ventilator, know their patient and be prepared to intervene when the patient and the technology do not mix appropriately. [Source: Respiratory Care, November 2009 Vol 54, No 11, pp 1467-1472, pp 1451-1452.]

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Used in All Forms of Acute Respiratory Failure? Respiratory Care, May 2003; (50)2.(568-581)
7 Davis, R. New Device brings fast help to failing heart. USA Today Aug 2008. http://www.usatoday.com/news/health/2007-10-10-heart-failure_N.htm
8 Hubble M, Richards E, Wilfong D. Estimates of Cost-Effectiveness of Prehospital Continuous Positive Pressure in the Management of Acute Pulmonary Edema. Prehospital Emergency Care 2008; Vol 12, Issue 3 (277-285).
9 Wesley K. CPAP Saves Lives and Money. http:www.jems.com/news_and_articles/columns/Wesley/cpap_saves_livesand_money.htm
10 Hess D., Noninvasive Positive Pressure Ventilation and Ventilator-Associated Pneumonia. Respiratory Care, July 2005, Vol 50, No. 7 (924-931).
11 Nava S, P. Navalesi, G. Conti. Time of non-invasive ventilation. Critical Care Medicine (2006) 32:361-370
12 Arroliga A. Noninvasive Position Pressure Ventilation in Acute Respiratory Failure: Does it improve outcomes? Cleveland Clinical Journal of Medicine, August 2001, V 68, No. 8 (677-679)
13 Washington University in St. Louis (2008, February 16). Gene Chips Used to Distinguish Ventilator-associated Pneumonia from Underlying Critical Illness. ScieneDaily. http://www.sciencedaily.com/releases/2008/02/080213090516.htm
14 http://copd.emedtv.com/copd/copd-statistics.html
15 CMS Proposes Additions to List of Hospital-Acquired Conditions for Fiscal Year 2009. http://www.cms.hhs.gov/apps/media/press/fastsheet/asp?
16 http://haiwatch.com/VAP.aspx
17 Girou E, Brun-GBuission C, Taille S, et al. Secular Trends in Nosocomial Infections and Mortality Associated With Noninvasive Ventilation in Patients With Exacerbation of COPD and Pulmonary Edema. Caring for the Critically Ill Patient. JAMA Dec 2003; Vol 290, No 22 (2985-2991).
18 Leger P, Lair-Groneneveld G. Infrastructure, funding and follow-up in a programme of noninvasive ventilation. European Respiratory Journal 2002; ISSN 0903-1936 (1573-1578).
19 Carlucci A, Delmastro M. Rubini F, Fracchia C, Nava S. Changes in the practice of non-invasive ventilation in treating COPD patients over 8 years. Intensive Care Med (2003) 29: 419-425
20 Tuggy, J., Plant, P., Elliot, M. Domiciliary Non-invasive Ventilation for Recurrent Acidotic Exacerbations of COPD: An Economic Analysis. Thorax 2003; 58: 867-871.

Additional References

Foti G, Sangalli F, Berra L, Sironi S, Cazzaniga M, Rossi GP, Bellani G, Pesenti A. Is helmet CPAP first line pre-hospital treatment of presumed severe acute pulmonary edema? Intensive Care Med. 2008 Nov 22.

Plant P K, Owen J L, Elliott M W. One year period prevalence study of respiratory acidosis in acute exacerbations of COPD: implications for the provision of non-invasive ventilation and oxygen administration. Thorax 2000;55;550-554.

Preventing Critical Medication Errors With the Administration of Continuous Aerosolized Medication

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Background: Medication errors injure 1.5 million people and cost billions of dollars annually.[1] Tubing misconnections have been identified as an important and under-reported problem that contributes to the overall problem of medication errors.[2] Of nine cases involving tubing misconnections, eight resulted in death or permanent loss of function. Consequently, the Joint Commission recommends against the use of non-intravenous equipment, including nebulizers that can mate with leur connectors on patient IV lines. The Commission's recommendations prompted us to take a proactive approach for assuring the safe delivery of continuously aerosolized medications.

Method: We assembled a panel of experts including respiratory therapists, pharmacists, nurses, and risk managers to explore various options for the safe delivery of continuously aerosolized medications while preserving—and leveraging—all the advantages of innovative technology.

Results: The panel concluded that an exclusive respiratory therapy infusion pump with a dedicated administration set that could not interface with a patient IV line was the best option.

Discussion: After several months of negotiations with various manufacturers, an infusion pump with SMART technology was chosen for exclusive use with inhaled medications. A dedicated administration set for the vibrating mesh nebulize was developed for us and six pulmonary infusion pumps (PIPs) were programmed with a library of inhaled medications. A green lock box serves as an additional physical barrier to prevent inadvertent IV administration of aerosolized medication. Access and management was limited to respiratory personnel with an exclusive respiratory password, further reducing the risk of a potentially critical/fatal error.

Conclusion: Development of a unique PIP with restricted user access represents a new standard for safe delivery of continuously aerosolized medications.

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Introduction

According to the Institute of Medicine (IOM) of the National Academies of Science, medication errors injure 1.5 million people and are associated with extra costs, conservatively estimated at 3.5 billion dollars annually.[1] Tubing misconnections have been identified by the Joint Commission as an important and under-reported problem that contributes to the overall problem of medication errors.[2] Unfortunately, well-defined protocols regarding when and how to report a suspected error by a colleague do not exist, compounding the problem.[10]

According to the Joint Commission Sentinel Event Database, to date there have been nine reported cases involving tubing misconnections. Of these, eight resulted in death and one involved permanent loss of function. As a result, Joint Commission recommendations include avoiding the purchase of non-intravenous equipment such as nebulizers that can mate with the leur connectors on patient IV lines. Their recommendations prompted us to take a proactive approach for the safe delivery of continuously aerosolized medications.

A common practice in respiratory therapy has been to use continuous feed nebulizers fitted with the same luer locks designed for use with IV bag and pump sets. This means that medication formulated for administration to a continuous nebulizer could accidentally and catastrophically be administered to a patient via IV, or vice versa. Of special concern is inhaled epoprostenol sodium (Flolan) which is often administered at doses that could potentially produce undesirable results if mistakenly given via IV route. We proposed an innovative administrative set and integrated system for continuous nebulization that cannot be directly attached to a patient's IV, eliminating/reducing the potential risk of administering these drugs by the wrong route.

In addition, we developed a new system which incorporated the use of vibrating mesh electronic micro-pump nebulizers equipped with drop-by-drop technology allowing for titration of medication, further increasing aerosol delivery. This is a contrast to previous practice, delivery via small volume nebulizer (SVN), which required a change in the medication concentration, a costly and wasteful practice.

This paper will review common practice regarding continuously inhaled mediations. Focus will be placed on complying with Joint Commission safety standards, their potential impact on respiratory practice and why we as respiratory therapists

Figure 1. Oxygen tubing connected to a needleless port on a patient IV produced a fatal error

should be concerned. We will examine the customary practice of delivering inhaled medication utilizing infusion pumps to fill nebulizers. Along the way we will point out where errors could occur and their potential effects. Finally we will present a new paradigm in safe and effective delivery of continuously inhaled medications such as beta agonists and Flolan.

Alerts and Error Reporting

The US Food and Drug Administration (FDA) monitors medication errors and makes recommendations for safe practice. In their report issued in 2008 they state that the National Coordinating Council for Medication Error Reporting and Prevention defines a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer." The agency, an independent body comprised of 27 organizations from AARP to the FDA, goes on to say that, "such events may be related to professional practice, health care products, procedures, and systems, including prescribing: order communication; product labeling, packaging and nomenclature, compounding, dispensing, distribution, administration, education, monitoring and use."[3]

In April of 2006 the Joint Commission issued a Sentinel Event Alert entitled, "Tubing Misconnections-A Persistent and Potentially Deadly Occurrence."[2] This alert reminds us that life-threatening errors are a reality in health care, but that increased awareness and analysis of these errors can lead to a dramatic improvement in safety. In one example, an error which involved the accidental connection of oxygen connective tubing from a nebulizer to an IV line caused instant death in a pediatric patient.[4] (Figure 1) There are also numerous anecdotal reports of deaths associated with misconnected tubing and inhaled Flolan. Fatal occurrences of hypoxemia, hypotension, and respiratory arrest have all been observed following an overdose of Flolan.[8] Many of these have not been reported outside of the institution where they occurred.

The Joint Commission's report specifically recommended not using devices such as nebulizers that can easily be attached to patient IV lines. It also recommended labeling and/or color coding all tubes and catheters so they can be easily distinguished.

In 2000, the Institute of Medicine published a report entitled "To Err is Human: Building a Safer Health System."[9] According to the report, preventable adverse events are a leading cause of death in the United States. Even conservative estimates indicate that more patients die annually of preventable adverse events related to healthcare than from motor vehicle accidents (43,458), breast cancer (42,297), or AIDS (16,516).[9]

Method

As clinicians, the authors were made aware of the potential dangers related to the administration of respiratory medications. Our goal was to standardize the procedures we use to treat patients by designing a system and products that are as foolproof as possible.

In order to examine our options, we assembled a panel of experts within our organization including respiratory, pharmacists, nurses, and risk managers. Our challenge was to deliver continuously aerosolized medications safely while preserving—and leveraging—innovative technology. It was important that we reduce and/or eliminate the risk of tubing misconnections with continuously aerosolized medications. Of special concern to us was the risk of a misconnection with inhaled Flolan because of its potential dangers if administered incorrectly.

The Process and Panel Recommendations

Several steps were necessary in order to accomplish the desired goals, including:

- Expert panel discussions
- Review of common practice
- Isolation of potential areas for critical errors
- Determination of the best course of action
- Solicitation of an infusion pump manufacturer for participation.

Common leur connector

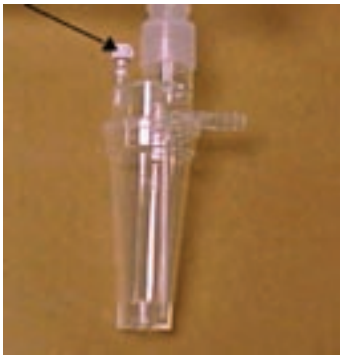


Figure 2. MiniHEART® with leur connector

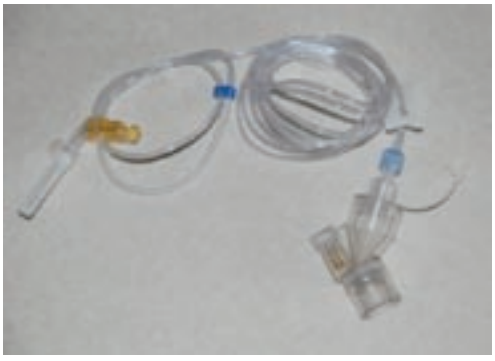


Figure 3. Company X prototype of the respiratory solution set attached to an Aerogen Aeroneb Solo.

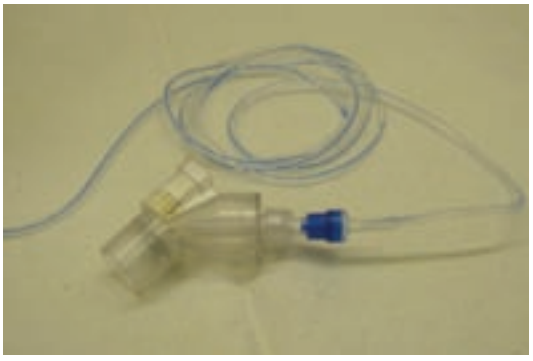


Figure 4. First prototype respiratory solution set by CME America. Notice the blue colored stripe that would distinguish it from other tubing in the hospital. In the next phase, the stripe was changed to green as a standard in our institution indicating inhaled medication.

Table 1. List of commonly used continuous nebulizer with IV fittings

Jet Nebulizer	Nebulizer Output
MiniHEART® continuous SVN	8 ml/hour output
Air Life® Brand Misty Finity® Small Volume Continuous Nebulizer with built in IV ports	2 ml/hour or 4
UniHEART™ Continuous SVN	9 ml/hour output
Air Life® Misty Finity® Medium Volume Continuous Nebulizer	8 ml/hour or 20 ml/ hour output
Ez flow from Mercury Medical®	2 ml/hour

Additional steps involved writing protocols, training staff and implementation.

Common Practice and Areas for Potential Errors

It is common practice in respiratory care to use continuous feed nebulizers fitted with the same luer locks designed for use with IV bag and pump sets. We used a MiniHEART nebulizer (Figure 2) with the same IV tubing used by the nurses. Tubing was attached to the common luer fitting on the nebulizer. The miniHEART provided the lowest available flow rate of 2 lpm, as compared to other continuous jet nebulizers. There are a variety of continuous jet nebulizers on the market that have similar IV fittings. Some examples are listed in Table 1.

The nebulizers are filled by a continuous-feed system by an IV pump or gravity feed via tubing connected to a built in IV port on the nebulizer. The fittings may be a luer fitting or an opening that allows for adaptation of IV tubing. The set infusion rate on the IV pump usually matches the output of the nebulizer because jet nebulizers have a fixed output based on a specified flow rate.

We used the same IV pump (Baxter Flo-Gard 6201) and IV solution set that our nursing staff use to deliver IV medications. The IV solution set was attached to the leur connector on the nebulizer and the infusion pump was set at the manufacturer's output of the nebulizer (8ml/hour). The nebulizer was placed in line on the inspiratory limb of the ventilator circuit.

Inhaled Flolan required a slightly different procedure, which included the involvement of multiple clinicians (respiratory therapy, nursing, pharmacy, and anesthesia) performing multiple duties. This chaotic approach created a greater potential for a critical errors. See Table 2.

The Jet Nebulizer

There are some inherent problems associated with jet nebulizers, some of which include a required fill volume, powered by a gas flow, and variability among individual nebulizers. The risk of cross contamination is high, and they are associated with poor lung deposition. Difficulty in determining drug delivery is an additional factor. The most significant concern to our panel from a safety perspective was the presence of a common connector on the nebulizer, which we felt created the potential for tubing misconnections. Alternate delivery methods such as large volume nebulizers may provide improved safety but may sacrifice efficiency and are not appropriate for mechanically ventilated patients.

Vibrating Mesh Nebulizer

The electronic micro-pump vibrating mesh (VM) nebulizer (Aerogen Aeroneb Solo) that we used creates aerosol differently than a jet nebulizer, and does not share many of the jet nebulizer's limitations. Medication is nebulized "drop by drop" as it reaches the aerosol generator; aerosol is generated when drops come in contact with the vibrating mesh. This "drop by drop" feature allows for volumetric dosing of medication, a new paradigm in continuous nebulized medication delivery with the additional benefit of a precise variable delivery system. There is no fill volume, residual volume, or added flow associated with VM nebulizers. According to the manufacturer, a high percentage of the aerosol produced is within the respirable range and aerosol production is consistent throughout the cycle. The Solo has a dedicated adaptor for continuous nebulization, which made it attractive for our purposes. The adaptor can only be mated to the Solo connector and cannot attach to luer connectors on patient IV lines.

Results

Best Course of Action

We determined that the best course of action would be to develop a system unique to the delivery of inhaled medications. Our plan was to combine a VM nebulizer with a dedicated adapter with a computerized programmable infusion pump (SMART pump) for maximum efficiency and safety. Programmable infusion pumps were one of the technologies identified in the 2006 IOM report that help reduce the frequency and severity of medication errors. A specified number of infusion pumps (6) were allocated as pulmonary infusion pumps (PIP), and were programmed exclusively with inhaled medications and password protected, allowing only authorized personnel access to the pump and the medication library. Pumps and tubing are color coded with a blue stripe as a visual indicator for inhaled medication. A colored lock box provides a physical barrier to the medication, preventing anyone from tampering with the medication. Focus was placed on a system that is distinct and non-interchangeable with commonly used IV administration sets.

The next step, finding an infusion company to manufacture a dedicated respiratory solution set, proved to be the most challenging piece of the puzzle. This portion of the process took a lot of determination and persistence, and close to two years to complete. Our wish list of features for a respiratory solution set included; colored coding specific to inhaled medication, the Solo adaptor bonded to the end, and distinct labeling. We approached several companies. One company did present us with a prototype shown in Figure 3. CME America, an infusion company based

Table 2. Potential areas for critical errors associated with old method

Problems Associated with Inhaled Flolan and Continuous Bronchodilator Therapy (CBT)
The nebulizer had a common connector The tubing had a common connector Solution set was the same tubing as patient IVs Using the same infusion pumps used to administer IV medications No safety mechanisms in place The infusion pumps were not clearly marked for inhalation No visual indicators on pumps, nebs or tubings indicating inhaled medication The luer connector that attaches to the nebulizer can easily be attached to a luer connector on a patient IV The medication bags look like any other IV medication bag
Problems Specific to Inhaled Flolan
Medication easily accessible to nurses who also administer IV medication Medication listed and charted in the IV section of the electronic record Too many people involved in the handling of the medication No control over who handles the medication Different process in the OR Medication not used in the OR would be sent up with the patient and if RT not notified could be hung by the RN and delivered intravenously

Figure 5. CME America's BodyGuard 575 infusion pump customized with green lock box.

in Colorado, presented us with a solution customized to our specifications. They also responded quickly and efficiently by presenting us with the first batch of respiratory solution set prototypes within weeks of our initial correspondence (Figure 4).

Their infusion pump (BodyGuard 575 by CME America) features: password protection, anti-free flow protection, a programmable medication library, a green lock box, a blue stripe and labeled respiratory solution set. The pump is electrically powered and can be run on either rechargeable or disposable batteries, which makes it easy to transport patients on continuous aerosol therapy. Future plans include: a micro-dot on the solution set that would be read by the pump to identify the type of solution set, a green face plate, replacing current labeling with Pulmonary Infusion Pump, and a green stripe on the tubing unique to inhaled medications. Another application that is in trials is a bar coding feature to identify the medication and the patient.

Protocols, Staff Training, and Implementation

In addition to providing dedicated equipment that was visually distinguishable and unable to connect to the pumps and tubing used in IV administration, we also determined that respiratory therapy would solely be responsible for managing the PIPs, the idea being that the fewer people involved the fewer areas for potential error. We also developed a streamlined process for the administration of inhaled Flolan that excluded the nurse and allowed anesthesia access to the PIP via password.

Discussion

Our initial goals included providing safe, effective continuous aerosolized medication while creating as many physical barriers to avert tubing misconnections and medication errors as possible. The lack of industry standards in this area presented a particularly interesting dilemma.

The development of unique pulmonary infusion pumps and a unique respiratory solution set for inhaled medication represents a new standard for safe delivery of continuously aerosolized medications. With proper safety precautions in place tubing misconnections are preventable errors. Our innovative respiratory solution set and integrated system for continuous nebulization that cannot be directly attached to a patient's IV, removes the possibility of administrating these drugs by the wrong route.

Providing safe and effective care should produce positive patient outcomes and in due course reduce hospital days and overall cost. We believe that these efforts are in direct response to a growing need in this area. We believe that our system provides the ultimate in safe effective continuous aerosol delivery, and it is our hope that our efforts will produce a program that can be sustained and replicated.

Continuous aerosolized medication plays a vital role in the treatment of critically ill patients and Joint Commission recommendations have a direct impact on our choice of equipment. A proactive approach to safe administration can insure the continued existence of its use or active involvement in the decision process. Respiratory therapists have the expertise and clinical knowledge to make educated decisions concerning best practice regarding aerosol delivery and should be making decisions of this magnitude.

In addition to safe delivery, accurate and efficient aerosol delivery will provide improved outcomes and reduce costs. Drop by drop nebulization can increase accuracy of drug delivery, and reduce waste associated with reformulation of concentrations, thereby potentially reducing associated costs.

Bibliography

1 News from the National Academies, July 20 2006 www8.nationalacadamies.org/oninews/newsitem.aspx?recordID=11623.
2 The Joint Commission. Tubing misconnections-a persistent and potentially deadly occurrence. Sentinel Event Alert. Issue 36 - April 3, 2006.
3 FDA Medication Errors, March 14, 2008 http:/www.fda.gov/oder/drug/MedErrors/default.htm.
4 ISMP Medication Safety Alert, June 17, 2004 www.ismp.org/MSAarticles/tubingprint:ftm.
5 Inside the Joint Commission, June 23, 2008, www.decisionhealth.com.
6 Beyea SC, Simmons D, Hills RW. Caution Tubing Misconnections can be Deadly. AORN Journal. March 2007
7 Crone KG, Muraski MB, Skeel JD, Love-Gregory L, Ladenson JH, Grunowski AM. Between a Rock and a Hard Place: Disclosing Medical Errors. Clinical Chemistry 52:1809-1814, July 2006.
8 Flolan (epoprostenal sodium) prescribing information.
9 Institute of Medicine. To err is human: building a safer health system, 2000 National Academy Press Washington, DC.
10 Leistoiko T, Schelde C. An Alternative method for Titratable Aerosolized prostacyclin Administration during mechanical Ventilation, 2008 open Forum Abstracts.

The Sleep Quality Recovery of a Snorer's Bed Partner

Preetam J. Schramm, PhD, RPSGT; Anthony Neville, PhD; David Baker, BSc.

In consultation, a bed partner often complains about loud snoring from the patient suspected of obstructive sleep apnea. The bed partner commonly adds that their sleep is disturbed, unsatisfying and complains of insomnia leading to daytime fatigue. This combination of disruptions can lead to the couple sleeping in separate rooms and usually results in the snorer being scheduled for an overnight polysomnogram test.

The availability of objective measures is limited when trying to understand either the impact that snoring has on the bed partner or the sleep quality improvement when ventilation therapy is used to treat the snoring and possible sleep apnea. Identifying the impact of disturbances and having objective measures of sleep for both partners and then incorporating such knowledge into the current clinical practice could significantly contribute to our understanding in the field of sleep medicine.

Consequently, we designed a case study to record the sleep quality of a married couple sleeping in the same bed without intervention on baseline night and on the subsequent night with continuous positive airway pressure (CPAP; S8 Autoset Vantage, ResMed, San Diego, CA) being worn by the snorer. Both subjects were studied because of snoring and suspicion of sleep apnea in the male partner (47 yrs; BMI 27) and its impact on the female partner (40 yrs, BMI 24). CPAP was used because it is an accepted indication for treating sleep apnea and eliminating snoring at optimal pressure. Simultaneous recordings were made using a small portable device (Embla Systems, Broomfield, CO) currently in beta testing that records the heartbeat, actigraphy, body position and snoring during sleep.

Recording the electrocardiogram (ECG) and using the Cardiopulmonary Coupling (CPC) algorithm to analyze the beat to beat variability represents a new way to view sleep. CPC uses 2 separate physiological streams of data input (autonomic and respiration) and mathematically captures the common activity that is strongly modulated by a third physiological stream (electrocortical activity).[1]

The result of this interplay creates a simple picture of sleep that provides information about sleep quality that is independent of conventional EEG-based measures. The graphical output that the CPC analysis creates is called a Sleep Spectrogram that displays the integrated ("coupled") biological oscillations of sleep, and provides the data series in both a summary graph and as quantitative variables. The Sleep Spectrogram approach is fundamentally different in that it eliminates the need for arbitrary scoring rules by directly measuring biological signals and provides a unique view into sleep physiology and pathology.

In the ECG-derived sleep spectrogram analysis, high frequency coupling (HFC) is the accepted biomarker of stable and undisturbed sleep, while low frequency coupling (LFC) is increased in states of fragmented sleep.[2] NREM duration, total sleep time and REM duration demonstrate positive correlations to HFC while LFC correlates positively with the arousal index and respiratory disturbance index.[3]

Using an accelerometer, snores are detected as high frequency motion (30-100Hz). After filtering and averaging, individual snore events are detected as peaks above and below thresholds to eliminate movement artifact. Snore events require duration of between 0.75s and 2.75s. Snoring is expressed as the percent of snores for the sleep period and the number of snores detected.

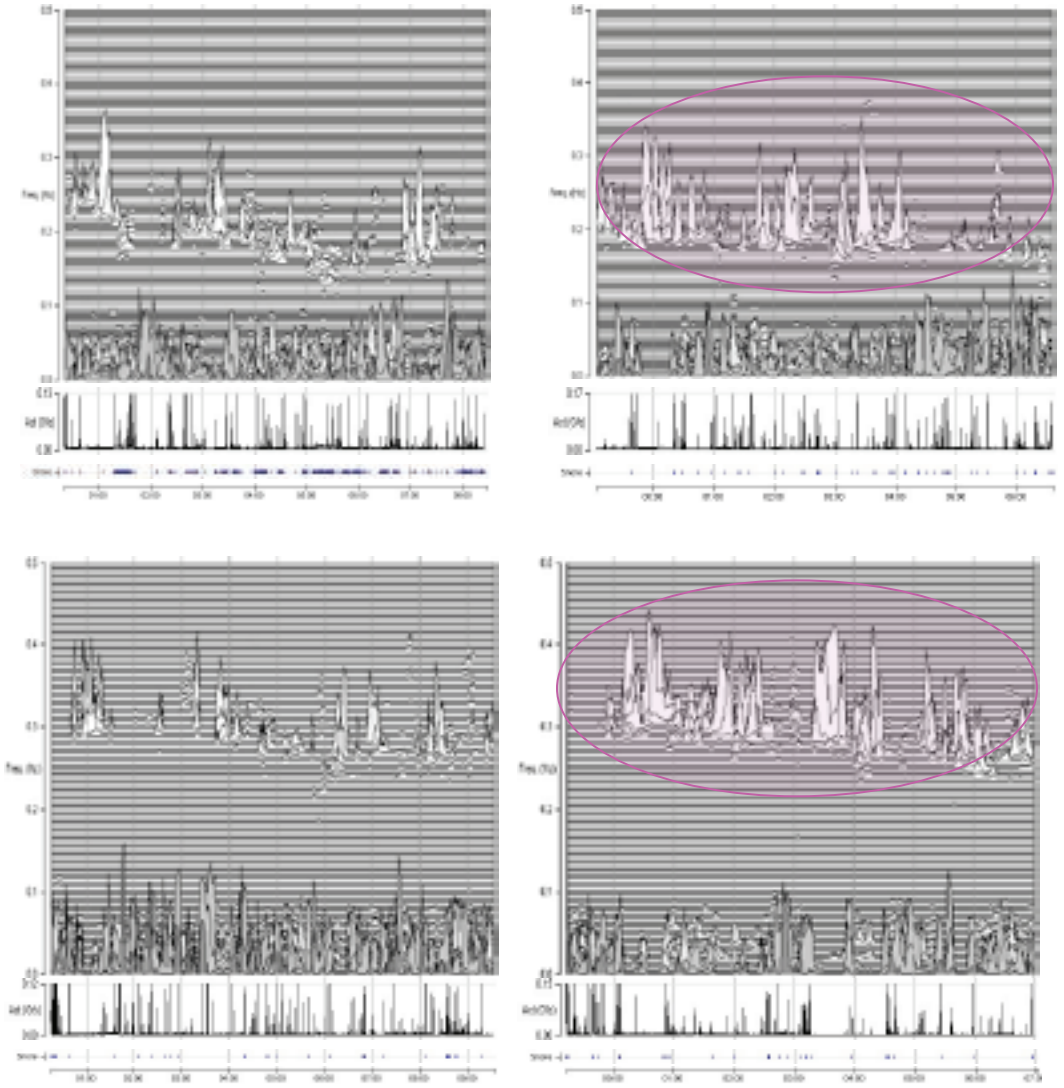
The results from night 1 without CPAP show decreased restful sleep in both individuals with HFC less than the expected normal >50% value. LFC is increased in both subjects with values >30%. On night 2 with CPAP intervention, stable sleep increased in both subjects. The wife had a 34% increase of HFC and corresponding LFC decrease of 23%. On CPAP, the snorer showed an increase of almost 11% HFC and 15% decrease of LFC. Snoring decreased by 543 events, with auto CPAP at 12.5 cm H_2O pressure. (Figure 1; Table 1)

Table 1. Comparison of CPC and snore variables between bed partners on night 1 without CPAP and night 2 with the snorer using CPAP

	Wife			Husband: Snorer		
	Night 1	Night 2	Difference	Night 1 w/o CPAP	Night 2 CPAP	Difference
HFC	28.52	63.18	34.66	45.85	56.81	10.96
LFC	44.87	20.91	-23.96	36.68	21.60	-15.08
VLFC	26.62	15.91	-10.71	16.59	21.60	5.01
eLFC bb	24.71	9.55	-15.16	11.35	4.69	-6.66
Snoring (% of sleep period)	0.06	0.08	0.02	2.56	0.07	-2.49
Snore events	16	23	7	557	14	-543

CPC analysis demonstrates the quantitative degradation of sleep quality caused by snoring and subsequent improvement with CPAP intervention in both bed partners.

This article was provided by Embla Systems.



Night 1 Without CPAP

Night 2 With CPAP

Figure 1: CPC Sleep Spectrograms from both bed partners.

Sleep stability and quality: The top left panel shows reduced high frequency coupling (stable sleep) from the snorer on night 1 and the top right panel shows its improvement (circled) on night 2 with CPAP. The bottom left panel shows significant decrease of HFC on night 1 in the wife and the bottom right panel shows recovery (circled) on night 2 while the snorer uses CPAP. On the Y axis coupling frequency is in Hertz and clock time in hours is on the X axis.

References

1 Thomas RJ, M. J., Peng CK, Goldberger AL. (2005). "An electrocardiogram-based technique to assess cardiopulmonary coupling during sleep." Sleep Med Rev 28: 1151-1161.

2 Thomas RJ, M. J., Peng CK, Goldberger AL, Crofford L, Chervin R. (2009). "Impaired sleep quality in fibromyalgia: Detection and quantification with ECG-based cardiopulmonary coupling spectrograms." Sleep Med. 2009 Dec 14. [Epub ahead of print]

3 Schramm P and Madison S. An Electrocardiogram-Based Technique to Identify Complex Sleep Apnea in Patients with Diabetes and Sleep Disordered Breathing. Abstract ID 791312, accepted 02/08/2010; Sleep 2010.

Tracheostomy Care: The Importance of Humidification

Judi Villa

Each year an average of 75,000 tracheostomies are performed on patients at community hospitals in the United States. Due to a lack of published statistics, this number does not include tracheostomies performed at private and military hospitals. A tracheostomy is the procedure in which a tube is surgically inserted through the trachea (windpipe) to enable a patient's ability to breathe. A tracheostomy is performed to provide access to the airway when a patient's airway is obstructed. Often, the tracheostomy is short-term and can be removed when the problem obstruction is corrected. However, in cases where a patient is suffering from some forms of cancer, ALS, BPD (bronchopulmonary dysplasia), or TBI (Traumatic Brain Injury), for example, tracheostomies are often long-term or permanent.

Tracheostomy is the most frequently performed surgery in the ICU, and, is expected to increase in coming years. About 79 million baby boomers will reach age 65 by the year 2029, and they are more likely to face pulmonary and respiratory diseases. Other factors that will contribute to increased tracheostomies are, the rise in TBI injuries sustained by our servicemen and women engaged in conflicts overseas, as well as multiple births that find newborns requiring immediate tracheostomies for long-term airway management of underdeveloped respiratory systems.

Nebulization, or humidification, is critical for tracheotomized patients since the natural process of humidification no longer functions. The tracheostomy tube bypasses the natural mechanism by which the nose and mouth filter, moisturize and warm the air you breathe. With the trach tube, the trachea loses the sinus' natural function to humidify the nasopharynx or tracheal mucosa.

Currently, patients are required to spend up to five hours a day (as much as 40% of wake time) nebulizing through an aerosol nose/mouth mask and separately through a tracheostomy mask. This laborious process discourages treatment compliance. Non-compliance is widely recognized as leading to multiple complications, including dry nose and mouth, thick mucus, mucus plugs, as well as PPCs (Potentially Preventable Complications) which can include, infections and or TAP (Tracheostomy Assisted Pneumonia). These complications eventually require inpatient hospitalization for 48 hours of nebulization/humidification.

A new, one-of-a-kind delivery system for humidification addresses the patient compliance issue by reducing the time it takes to nebulize both nose/mouth and the tracheostomy stoma. The Wright Face & Tracheostomy Nebulizing Mask is conveniently designed to simultaneously humidify the nose, mouth and tracheostomy stoma. Patients benefit from the Wright Mask's convenience, as do caregivers, respiratory staff, hospitals and insurance providers. The Wright Mask delivery system provides doctors with a solution to the compliance problem, provides hospitals with a solution for optimizing nursing time and reduces re-hospitalization cost for this "high patient cost" population.

Compliance issues are a concern whether the patient is considered short-term (up to 18 months) or long-term (18 months to end of life). Vivian Wright, caregiver to a trach patient and inventor of The Wright Face & Trachesotomy Nebulizing Mask, knows this all too well. Her husband, Dean, had a tracheostomy while he was battling head and neck cancer. Dean had to nebulize 10 times a day - five times for his trach stoma and five times for his nose and mouth. Each time took 30 minutes, with Dean tethered to a nebulizer.

Dean started cutting back. At first, he'd wear only one of the masks for 15 minutes. Then he cut back to once a day. Then he stopped nebulizing his nose and mouth altogether. He said it took too long. "Later," he would tell Vivian when she urged him to nebulize.

Thick mucus clogged Dean's mouth and his trach. "His breathing was very labored," Vivian said. "It wasn't enough."

While flying from an out-of-town trip, a piece of dry tissue lodged in Dean's trach and clogged the tube. At 10,000 feet on final approach into Miami, Dean began choking to death. "He started gagging for air," Vivian said. "It was horrible. All you could hear throughout the full 737 was Dean gagging for life. He was dying up there, and there was nothing I could do."

Dean survived, but he spent the next 48 hours in the hospital for inpatient nebulizing. When he came home, Vivian realized there was something she could do. In her own living room, she pieced together the nose/mouth mask and the tracheostomy mask to allow Dean to simultaneously nebulize his upper and lower

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Table 1. The following O2 Saturations shows the results of the clinical trial

	Saturation, % mean	Ease of Device Use (1-10, 10 being easiest)	Comfort Ratings (1-10, 10 being most comfortable)	Ease of Breathing (1-10, 10 being easiest)
Conventional Facemask	99.06 percent, ± 0.98	8.7, ± 1.3	7.2, ± 1.6	8.4, ± 1.4
Trach-collar	99.01 percent, ± 1.06	8.9, ± 1.1	8.2, ± 1.5	8.8, ± 1.3
Wright Mask system	99.11 percent, ± 0.98	8.6, ± 1.4	6.9, ± 1.7	8.3, ± 1.4

NOTE: Room Air Baseline Saturation 99.03 percent, ±1.5. Table 1 taken from the University of Miami White Paper to be published June 1st, 2010. For more information please contact Dr Keith A. Candiotti at University of Miami, Department of Anesthesiology, Division of Clinical Research.

airways. Ten sessions a day were cut to five. Five hours was cut to 2 $^1/_2$.

"Trach patients need to nebulize," Vivian said. "They don't realize how important it is to keep the moisture at the same levels they had prior to the tracheostomy."

Clinical Trial

After Dean's death, Vivian patented the Wright Face & Tracheostomy Nebulizing Mask, and it is now available for all trach patients. This past summer, the Wright Mask underwent a clinical trial at the University of Miami. The clinical trial showed that the Wright Mask was comparable to the conventional face and trach masks in terms of saturation, ease of use and comfort. But it was superior in terms of saving time.

Dr Keith Candiotti, who conducted the clinical trial, said the Wright Mask was superior in terms of saving time. "It cuts the time in half. You don't have to do it twice," Candiotti said. "It's a busy world out there. How many gadgets in your life can cut a necessary task in half?"

In fact, Dr Candiotti wrote in the abstract from the clinical trial that the Wright Mask "is likely to become a preferred airway moisturization method due to its time efficiency and comfort." The full abstract from the clinical trial, Evaluation of the Wright Humidification Mask in Chronic Tracheostomy Patients, is posted online at http://www.wrighttrachsolutions.com/Abstracts.html.

Candiotti said the Mask showed "no adverse effects," but by cutting humidification time in half, it increased the likelihood that patients would actually humidify. "The Mask was equivalent in terms of usability. It was certainly superior in saving time," Candiotti said. "It's definitely a clever idea, and it should be beneficial. If you can save time on a necessary task, why wouldn't you do it?"

"The Wright System Mask, combining simultaneous humidification of both upper and lower airways, is likely to become a preferred airway moisturization method due to its time efficiency and comfort," Dr Candiotti wrote in the abstract. The full abstract from the clinical trial, Evaluation of the Wright Humidification Mask in Chronic Tracheostomy Patients, is posted online at http://www.wrighttrachsolutions.com/Abstracts.html. The full white paper from the clinical trial is posted online June 1st, 2010.

The problem with the conventional humidification procedure is that it is laborious for tracheostomy patients to carry it out day after day. Tracheostomy patients are living with other issues, many life threatening and/or life ending. To add a laborious treatment process that requires up to five hours from their day is the last thing most patients have the emotional discipline and physical endurance to do.

Therefore, most trached patients decrease or end their nebulizing regimen. In doing so, at the very least, they suffer dry nose, dry mouth and dry sinuses. Their mucus becomes thick, stringy and difficult to expel. With dry tissue, it becomes painful to gag, choke and cough out the mucus. All this increases the probability of life-threatening mucus plugs. The mucus lodges in the trach tube and blocks the tracheostomy airway. In addition, dry nose and mouth tissue is susceptible to splitting and bleeding. Corrosive blood threatens the sinus cavity, the esophagus and throat. At the very worst, pneumonia is a possibility if mucus and secretions are not expelled, tissue around the stoma dries, hardens and adheres to the trach tube resulting in blockage of the tube.

Nebulizing can mitigate these complications by reintroducing the necessary moisture into the nasal passages, nose and throat and thinning secretions. Coughing and swallowing both become easier. Mucus membranes don't stick together.

"For patients undergoing chemo-radiation, particularly for cancers of the throat and mouth, the problem is even more severe" said Dr Eugene N. Myers, Distinguished Professor and Emeritus Chair of the Department of Otolaryngology of the University of Pittsburgh School of Medicine. "The body normally produces about a quart of saliva each day to aid in digestion and moisturize the food we eat so we can swallow it. Saliva also keeps mucus membranes moist, so they don't stick together. Radiation destroys the salivary glands and dries up saliva, and the glands usually don't regenerate. Chemotherapy in conjunction with radiation exacerbates these side effects of treatment."

Dr Myers, who has performed more than 10,000 surgeries on patients with tumors of the head and neck, said a typical dose of radiation is estimated to be about 65 Gy, and treatment destroys about 80 percent of salivary glands. Add chemotherapy and the dosage goes up to about 80 Gy and destroys 90 to 95 percent of salivary glands. New radiation machines (IMRT) have been designed to overcome this problem, but the results have not been dramatic.

"The swallowing passage, the throat, the pharynx is deprived of this saliva," Dr Myers said. "It makes it very difficult to swallow. If people have proper moisturization of the mucus membranes, then it is more comfortable and the swallowing may be improved."

Patients who have had radiation also experience thicker secretions, and humidification can allow them to cough it up more easily, preventing heavy mucus from getting into the trach

Conventional Nebulizing vs. The Wright Process (Table 3)

The conventional nebulizing process takes 15 steps and two masks. The Wright nebulizing process takes only eight steps and one mask. It's this simple:

Conventional nebulizing process	Wright Mask nebulizing process
Connect the face mask tube to the nebulizing machine	Place the face mask over your nose and mouth and place the tracheostomy mask over your tracheostomy stoma
Fill the medicant container	Fill the medicant container
Place the face mask over your nose and mouth	Adjust the dents in mask tubes to fit your face
Adjust head straps for comfort	Adjust neck straps for comfort
Turn the machine on	Connect double-face mask tube to the nebulizing machine
After 30 minutes of nebulizing, remove the face mask	Turn the machine on
Turn the machine off	After 30 minutes of simultaneously nebulizing the nose and mouth and the tracheostomy, remove masks
Disconnect the face mask hose from the nebulizing machine	Turn the machine off
Connect the tracheostomy mask hose to the nebulizing machine	
Fill the medicant container	
Place the tracheostomy mask over the tracheostomy stoma	
Adjust the trach mask straps for comfort	
Turn the machine on	
After 30 minutes of nebulizing, remove the tracheostomy mask	
Turn the machine off	

tube, drying there and clogging the tube. Therefore, Dr Myers said, patients who humidify "seem to benefit very much from having this increased humidification. It allows them to be much more comfortable. They can swallow better."

The Economic Impact of Re-Hospitalization

Proper humidification directly impacts a patient's health, but it also has an economic value. Current statistics on hospital readmissions for non-compliant tracheostomy patients are difficult to come by. However, use of the Wright Mask delivery system should reduce the need for inpatient humidification treatments and save money.

	Other non-operating room therapeutic procedures on nose, mouth and throat
Total number of discharges	12,950
LOS (length of stay), days (mean)	3.5
Charges, $ (mean)	18,510
Costs, $ (mean)	6,081

Table 2. 12,950 patients were admitted to community hospitals for "other non-operating room therapeutic procedures to nose, mouth and throat in 2007," (From HCUP 2007 National Statistics)

Note: The above table does not include private or military hospital data. http://hcupnet.ahrq.gov/

A New Model Of Care

Most trach patients do the best they can to cope with dryness, difficulty swallowing and thick mucus. Some use saliva pills to help them secrete saliva, but the pills don't work for everyone because the saliva glands have been destroyed, and some patients experience heavy sweating from these pills. Others squirt glycerin-based sprays into their mouths, or place ice cubes in their mouths to soothe the mucus membranes and help them swallow. Most constantly carry a bottle of water with them to use as a lubricant when they eat.

Until now, the only other way to actually humidify the nose and mouth was to mimic what is done in a hospital setting, and Dr Myers said that is "very awkward to use in the home setting." The Wright Mask delivery system is "a big improvement, especially for home use," Dr Myers said.

Consider: The conventional nebulization process takes 15 steps, two masks and one hour. The Wright nebulizing process takes eight steps, one mask and 30 minutes. (See Table 3, A comparison of nebulization processes)

Dr Myers said patients can benefit from using the Wright Mask. "If patients feel more comfortable and they're getting along better, then they'll be more compliant with the treatment."

Making the nebulizing process easier not only can improve patient compliance, but it can also optimize nursing time and prevent re-hospitalizations, like Dean's, for inpatient humidification. A 3.5-day inpatient humidification treatment is estimated to cost about $6,081 per patient.

Conclusion

After Dean Wright started using the Wright Mask, he became a compliant patient. From that day on, he humidified, as instructed by his doctor, five times a day for 30 minutes each time. His nasal, mouth and trachea tissues were moist and healthy. Mucus and secretions were thin and easy to expel. Even Dean's lungs felt better. He never again had to go the hospital for costly inpatient humidification.

"To be tethered to an air compressor and a nebulizer for up to five hours a day wears away at the quality of your life," Vivian said. "Coming up with this Mask gave us 2 1/2 hours a day to be a normal couple. We could go for walks. We could sit and watch a football game without being tethered to a nebulizing machine."

Dean's dying wish was to see the Wright Mask become available to other trach patients. "Anything that can improve one's quality of life, even if it shaves off two hours during the day, makes a big difference," Vivian said. "It's all about quality of life."

"When one considers the reasons for a tracheotomy, which is

to provide the patient with a new airway so they can continue breathing, or as an exit route from where the patient is able to expel mucus that would otherwise fill the lungs, one realizes this procedure's importance." Vivian said.

"It is critical to carry out more studies in order to understand even the seemingly small effects tracheotomy procedures have on patients' hourly and daily quality of life. By its very nature, breathing through a tracheostomy can be likened to breathing in a sauna. Regular humidification treatments turn the 'sauna' feeling into a comfortable 'steam bath' for the nose, sinus cavity, mouth and trach" explained Vivian. "Moisture opens the nasal passages, moistens the mouth, nose and trach. Moisture thins secretions creating flowing easily expellable mucus."

Vivian explained, "As with a head cold, mucus impacts and dries the sinus cavity, creates a dry sore throat, brings on headaches, disrupts sleep, leaves patients lethargic and out of sorts and reduces patients' appetites. As with a chest cold, mucus-secretions fill lungs, create coughing, aspiration, gagging, headaches, sore chest and stomach muscles. One's throat becomes dry, and sleep, mood and appetites are affected. Humidification addresses these issues for trached patients as it does for all of us with colds. Just imagine living with head-chest cold like symptoms, day in and day out for as long as you're living with a trach.

"Historically, the tracheotomized patient population doesn't complain to their medical team about 'the small stuff'. However, trach patients are just now understanding that they need to share all 'effects' of living with a trach with their medical team. They are beginning to see that they are in fact a part of a team and that their medical team's success is enhanced by what they share with their medical teams," Vivian added.

References

1 U.S. Agency for Healthcare Research and Quality http://www.hcup-us.ahrq.gov Other Non-Operating Room Therapeutic Procedures To Nose, Mouth and Throat" From HCUP 2007 National Statistics.

2 Evaluation of the Wright Humidification Mask in Chronic Tracheostomy Patients. Enisa M. Carvalho MD, Nicolas A. Crescimone MD, Claudia R. Fernandez MD, Jadelis Giquel MD, Yiliam Rodriguez MD, Elizabeth Franzmann MD, Keith A. Candiotti MD (Abstract Online July 2009; White Paper Online June 2010, http://www.wrighttrachsolutions.com/Abstracts.html.

3 Conventional Nebulizing vs. The Wright Process Online http://www.wrightrachsolutions.com/Nebulizing.html.

True Or False

Paul Garbarini, MS, RRT

All Ventilator Patients Require Sedation For At Least Some Period of Time: True or False?

Over 50% of mechanically ventilated patients receive IV sedation. As of 2007, the rate of sedation for ventilated patients was 67%. Propofol accounted for 80% of sedative use and benzodiazepines (Lorazepam, Midazolam) were used for 20% of patients. Additionally, analgesia agents (morphine, fentanyl) were administered with sedative agents approximately 40% of the time.

Last month, the journal Lancet published a study which calls into question the routine practice of sedating patients on mechanical ventilation. The study, A protocol of no sedation for critically ill patients receiving mechanical ventilation: a randomised trial, contrary to the aforementioned common practice, actually provided no sedation to ventilated patients. One hundred forty patients were enrolled to receive either no sedation or Propofol for 48 hrs followed by Midazolam. The sedation group was given daily interruptions of sedation until awake. Both groups were allowed bolus analgesia with 2-5mg of morphine prn. The patients receiving no sedation had 4.2 less days on mechanical ventilation (13.8 vs 9.6 days). That's a 30% decrease in ventilator LOS. The authors note that further studies are warranted; however, this study certainly challenges our preconceived notions on what best practice may be in regards to sedating ventilated patients. Nevertheless, I would contend that this (and previously published material in Hamilton's newsletter) would support the contention that mandatory need for sedating the mechanically ventilated patient is a myth. [Source: A protocol of no sedation for critically ill patients receiving mechanical ventilation: a randomised trial.The Lancet, Volume 375, Issue 9713, Pages 475 - 480, 6 February 2010.]

Some ICU Rooms Have Bad Karma: True or False?

A lot of us who have worked in ICUs for years have a perception that certain ICU beds are associated with bad outcomes for patients. I recall room 350 in a general intensive care unit being such a room. This was a corner room in which you could not see the patient from other than immediately outside the room.

A recent article in CHEST, Relationship between ICU design and mortality, may shed some light on this. In this study of 664 medical ICU patients, patient's outcomes were referenced as to whether they were in a low visibility vs high visibility room. Low visibility rooms were those that were not in the line of sight of the central nursing station. No difference in hospital mortality was seen between high and low visibility rooms. However, in sicker patients (defined as those with Apache II scores greater than 30), hospital mortality was significantly higher (82% for low visibility vs 64% for high visibility).

ICU guidelines recommend direct line of sight for all patients or continuous video monitoring if there's no line of sight to the patient. The authors note that this ICU did not have video visualization of patients out of view of the nursing station. A review of Best-Practice ICU unit designs showed that 12/19 of these ICUs had a race track layout, in which all patients are visible to nurses and distances between patients and nurses are shorter. Additionally, the increasing adoption of electronic medical records/charting with computers adjacent to patient rooms is thought to increase visibility. Though this study did not try and identify specific cause and effect, as the author's note, it would seem reasonable to speculate that identification of critical events such as unplanned extubation would be identified sooner with ideal ICU design.

So indeed, it may not be a myth that there are certain ICU rooms associated with poorer outcomes. [Sources: Relationship between ICU design and mortality, Chest, chestpubs.org; A Decade of Adult Intensive Care Unit Design. A Study of the Physical Design Features of the Best-Practice Examples. Crit Care Nurs Q Vol. 29, No. 4, pp. 282-311, nursingcenter.com.]

Paul Garbarini is Clinical Support Manager, Hamilton Medical, Inc. This article is from Hamilton's newsletter. The author thanks Marian Benjamin, Editorial Director, RT: For Decision Makers in Respiratory Care, for suggesting this followup.

Anxiety is Associated With Diminished Exercise Performance and Quality of Life in Severe Emphysema

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Abstract

Background: Anxiety in patients with chronic obstructive pulmonary disease (COPD) is associated with self-reported disability. The purpose of this study is to determine whether there is an association between anxiety and functional measures, quality of life and dyspnea.

Methods: Data from 1,828 patients with moderate to severe emphysema enrolled in the National Emphysema Treatment Trial (NETT), collected prior to rehabilitation and randomization, were used in linear regression models to test the association between anxiety symptoms, measured by the Spielberger State Trait Anxiety Inventory (STAI) and: (a) six-minute walk distance test (6 MWD), (b) cycle ergometry peak workload, (c) St. Georges Respiratory Questionnaire (SRGQ), and (d) UCSD Shortness of Breath Questionnaire (SOBQ), after controlling for potential confounders including age, gender, FEV_1 (% predicted), DL_{CO} (% predicted), and the Beck Depression Inventory (BDI).

Results: Anxiety was significantly associated with worse functional capacity [6 MWD (B=-0.944, p<.001), ergometry peak workload (B=-.087, p=.04)], quality of life (B=.172, p<.001) and shortness of breath (B=.180, p<.001). Regression coefficients show that a 10 point increase in anxiety score is associated with a mean decrease in 6 MWD of 9 meters, a 1 Watt decrease in peak exercise workload, and an increase of almost 2 points on both the SGRQ and SOBQ.

Conclusion: In clinically stable patients with moderate to severe emphysema, anxiety is associated with worse exercise performance, quality of life and shortness of breath, after accounting for the influence of demographic and physiologic factors known to affect these outcomes.

Background

Chronic obstructive pulmonary disease (COPD) is a leading cause of disability and death. Disability, functional limitations and decreased quality of life in patients with COPD are correlated with objective physiologic measures of disease severity. However, a large proportion of the variance in functional status and quality of life associated with COPD is not explained by measures of pulmonary physiology. Psychological factors may play in important role in determining the impact of COPD on patient functioning. For example, anxiety in patients with COPD has been associated with decreased quality of life, more severe dyspnea, greater disability, and impaired functional status even after controlling for lung function and the presence of other chronic diseases. Anxiety is also a significant predictor of the frequency of hospitalizations for acute exacerbations of COPD.

Anxiety is a major clinical problem in patients with COPD. The prevalence of clinical anxiety disorders in patients with COPD is substantially higher than in the general public. Anxiety symptoms are very common in patients with COPD. In previously published studies 10-80% of patients endorsed anxiety symptoms, exceeding that for patients with other chronic medical conditions such as heart disease, renal disease, AIDS and cancer. Estimates for specific anxiety disorders range from a 10-32%, a 3- to 10-fold increase in COPD compared to the general population. The most common anxiety disorders diagnosed with COPD are generalized anxiety disorder and panic disorder, which may occur in as many as one-third of COPD patients. Defining the contribution of anxiety to functional impairment in COPD is a first step in determining the potential for interventions to combat anxiety to improve functional status.

Most previous studies of the impact of anxiety on patients with COPD have relied on patient self-report measures of functioning. In these studies self-report biases may confound the true association between psychological and physical health. Investigations that have included objective measures of functioning (e.g., 6-minute walk distance test (6 MWD)) have been limited by small sample size, or have included only patients selected for high levels of anxiety and depression.

In the current study, we hypothesized that anxiety would be associated with worse functional performance (6 MWD; maximal exercise capacity), health-related quality of life (SGRQ), and dyspnea (SOBQ), after controlling for the effects of potential confounders including age, pulmonary function and depression. We used data from a carefully characterized large group of patients with severe emphysema who were evaluated for the National Emphysema Treatment Trial (NETT). We also examined whether sex differences existed in the relationship between anxiety symptoms and outcomes variables (6 MWD, maximal exercise capacity, SGRQ, SOBQ).

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Methods

Ethics committee approval for the NETT was obtained from the Institutional Review Boards of all participating sites. Procedures for recruitment, screening, determination of eligibility, and assessments for the NETT are described in detail elsewhere. Briefly, 3777 patients were screened for the NETT from 1998 to 2002. Patients were included if they had moderate to severe emphysema, had been nonsmokers for at least 6 months, and did not have clinically significant comorbid conditions or circumstances that placed them at high risk for perioperative morbidity or mortality or made it unlikely that they would complete the trial. In order to maximize generalizability and sample heterogeneity, patients were included in the analyses if they had all of the required data from the initial screening assessment, prior to the start of the pre-randomization rehabilitation program. 1828 patients met these criteria. A total of 1218 patients went on to randomization to receive either lung volume reduction surgery or continued regular medical treatment. Patients failed to reach randomization for a number of reasons, for example failure to complete rehabilitation program and all postrehabilitation and randomization assessments, failure to obtain final approval for surgery just prior to randomization, and other new onset complications that met study exclusion criteria. Although no differences between randomized and non-randomized patients were expected in our analyses, in order to allow comparison with a number of other reports that are based on data only from randomized NETT subjects, our data analyses were also repeated for randomized patients with complete data from the initial screening assessment on all variables analyzed (n=1154).

Demographics and self-report measures were collected using standardized instruments including: the Spielberger State Trait Anxiety Inventory (STAI). The STAI is a 40-item self-report measure of enduring (trait) and transient (state) anxiety symptoms. Respondents rate how statements reflect how they generally feel on a 4-point scale. STAI state and trait scores range from 20-80. State anxiety is defined as unpleasant emotional arousal, characterized by feelings of tension and apprehension, and heightened autonomic nervous system activity, while trait anxiety measures a stable tendency to respond with state anxiety. The state anxiety scale of the questionnaire was chosen for our analyses in order to more closely match the time frame referenced by most of our other questionnaire measures (ie, current, versus past or typical, functioning). In addition the state anxiety measurement has been shown to be more valid than that of trait anxiety. The Beck Depression Inventory (BDI) is a 21 item self-report measure of symptoms of depression. Respondents choose statements that reflect how they have felt over the past 2 weeks. The BDI contains 13 items assessing cognitive-mood depressive symptoms (eg, sadness, guilt) and 8 items that assess physical-performance symptoms of depression (eg, fatigue, weight loss, physical health worries). The St Georges Respiratory Questionnaire (SGRQ) is a 60-item-disease specific instrument developed for use with patients with airflow limitation and designed to measure health-related quality of life. We used the full-scale SGRQ score in our analysis. The UCSD Shortness of Breath Questionnaire (UCSD-SOBQ) is a 33-item measure of shortness of breath while performing activities. Questionnaires were administered to subjects after performance of diagnostic testing and determination of study eligibility.

Table 1. Characteristics of enrolled NETT patients used in this report* (n = 1828).

Age at evaluation (years; Mean±SD)	66.7±6.3
Gender	1134 (62%) Male 694 (38%) Female
Race/ethnic group	1727 (94%) Non-Hispanic white 73 (4%) Non-Hispanic black 28 (2%) Other
FEV_1	
% of predicted (Mean±SD)	27.1±7.5
L (Mean±SD)	0.78±0.25
D_LCO	
% of predicted (Mean±SD)	28.2±10.1
ml/min/mmHg STPD (Mean±SD)	8.0±3.2
Beck Depression Inventory (Mean±SD)	9.5±6.0
Spielberger Anxiety Inventory – State (Mean±SD)	34.9±10.9
6-Minute Walk Test (meters; Mean±SD)	344.2 ± 105.8
Maximum Exercise Capacity (watts; Mean±SD)	35.6 ± 21.9
St. George's Respiratory Questionnaire – total score (Mean±SD)	56.4 ± 13.1
UCSD Shortness of Breath Questionnaire (Mean±SD)	64.9 ± 19.4

*Includes some patients who were not ultimately randomized to treatment. See Methods for additional details.

Pulmonary function tests, including spirometry and single-breath diffusing capacity (DL_{CO}), were performed in accordance with American Thoracic Society standards. Spirometry values used in this report (FEV_1) were obtained following bronchodilator (albuterol) administration. Percent of predicted values were calculated using normal reference values derived from Crapo and colleagues. The standardized 6 MWD protocol has been described in detail elsewhere and provided maximum distance walked. Maximum exercise capacity (watts) was measured on an electromagnetically-braked cycle ergometer that increased at a rate of 5 or 10 W per minute after 3 minutes of unloaded pedaling while subjects breathed 30 percent oxygen.

Descriptive statistics were performed. Analysis of variance was used to compare patients who were versus were not randomized in the NETT. For categorical variables a Pearson Chi-square test was performed. Next, four separate multiple linear regression models were computed to test the association between state anxiety and: (a) 6 MWD; (b) maximum exercise capacity; (c) St. Georges Respiratory Questionnaire total score; and (d) UCSD Shortness of Breath Questionnaire total score. In the first regression model, 6 MWD was entered as the dependent variable. Patient age, gender, FEV_1%, DL_{CO}%, Beck Depression Inventory score and Spielberger State Anxiety score were entered as the independent variables. The second through fourth models were identical to the first, except substituting maximum workload on cardiopulmonary exercise test, SGRQ total score, and UCSD SOBQ total score, respectively, as the dependent variable. In order to test for possible collinearity between independent variables, eigenvalues of the scaled and uncentered cross-products matrix, condition indices, variance-decomposition proportions, variance inflation factors (VIF) and tolerances were computed for individual variables. All statistical analyses were performed using SPSS statistical software (SPSS, Inc. Chicago, IL, USA). A probability value of p=.05 was used to determine statistical significance.

Table 2. Results of multiple linear regression analyses for 6MWD, maximum exercise, quality of life, and shortness of breath.

						Model fit	
	B	SE	Beta	*p*	95% Confidence Interval for B	R^2	*p*
6MWD							
Age (years)	-2.37	.37	-.14	<.001	[-3.09 , -1.65]		
Male Gender	45.04	4.78	.21	<.001	[35.67, 54.40]		
FEV_1%	3.39	.33	.25	<.001	[2.75, 4.03]		
DL_{CO}%	2.61	.23	.25	<.001	[2.15, 3.06]		
Depression-M	.26	.79	.01	.746	[-1.30, 1.81]		
Depression-P	-2.64	.85	-.08	.002	[-4.31, -.97]		
Anxiety	-.99	.24	-.10	<.001	[-1.45, -.52]	.22	<.001
Max. exercise							
Age (years)	-.62	.07	-.18	<.001	[-.75, -.49]		
Male Gender	20.44	.85	.45	<.001	[18.77, 22.11]		
FEV_1%	1.14	.06	.40	<.001	[1.03, 1.26]		
DL_{CO}%	.50	.04	.23	<.001	[.42, .58]		
Depression-M	.21	.14	.03	.142	[-.07, .49]		
Depression-P	-.73	.15	-.11	<.001	[-1.02, -.43]		
Anxiety	-.10	.04	-.05	.017	[-.19, -.02]	.43	<.001
Quality of life							
Age (years)	-.26	.04	-.13	<.001	[-.35, -.18]		
Male Gender	1.18	.56	.04	.037	[.07, 2.29]		
FEV_1%	-.10	.04	-.06	.012	[-.17, -.02]		
DL_{CO}%	-.07	.03	-.05	.018	[.-12, -.01]		
Depression-M	.31	.09	.09	.001	[.12, .49]		
Depression-P	1.34	.10	.33	<.001	[1.15, 1.54]		
Anxiety	.187	.03	.16	<.001	[.13, .24]	.28	<.001
Shortness of Breath							
Age (years)	-.132	.07	-.04	.045	[-.26, -.01]		
Male Gender	-2.940	.85	-.07	.001	[-4.61, -1.27]		
FEV_1%	-.345	.06	-.14	<.001	[-.46, -.23]		
DL_{CO}%	-.285	.04	-.15	<.001	[-.37, -.20]		
Depression-M	.139	.14	.03	.331	[-.14, .42]		
Depression-P	1.836	.15	.30	<.001	[1.54, 2.13]		
Anxiety	.206	.04	.12	<.001	[.12, .29]	.24	<.001

The STAI and BDI are not clinical diagnostic tools. However there are published cutoff scores for both instruments to indicate clinically significant symptom levels. In general population samples, cutoff scores of 19 and 40 are used for the STAI and BDI, respectively, to indicate clinically significant symptoms and likely diagnosis. For the BDI, scores of 10 or above indicate mild-moderate depressive symptoms. In geriatric outpatient populations higher cutoff scores have been recommended: 22 for the STAI and 44 for the BDI, based on assessment studies in persons aged 55 and older. Questions have also been raised about the interpretation of specific depression symptoms in patients with chronic medical illness, including COPD. Because of a concern that the full BDI score might overestimate depression severity in patients with more severe emphysema due to overlap between COPD severity and somatically-focused depression symptoms on the BDI (eg, fatigue, weight loss, physical health worries), we repeated each multiple regression analysis entering the totals of "cognitive-mood" and "physical-performance" BDI items separately as independent variables.

Results

In general, this study population was elderly and primarily white; approximately two-thirds were male. Subjects' age range was 28-89 years, with 96% of patients aged 55 or older. Subjects had severe airflow limitation and impaired diffusing capacity. Compared to published population norms for the SGRQ (mean=12.17) and 6 MWD (mean=555 meters) in similar age groups (ages 60-69), subjects in this study showed lower exercise performance and poorer health-related quality of life (Table 1). Subjects showed moderately high levels of baseline anxiety and depression. Thirty percent of subjects had state anxiety scores above 40 and twenty percent scored above 44. Forty-one percent of subjects had a BDI score of 10 or higher, indicating mild-moderate depressive symptoms. Eight percent of subjects scored 19 or higher on the BDI and 4% scored 22 or higher, indicating moderate-severe symptoms. Women had significantly higher anxiety (36.4 vs. 34.0, p<.001) and depression (10.3 vs 9.0, p<.001) scores than men. Non-randomized subjects differed significantly from randomized subjects in 6 MWD (337.3 m. vs 348.0 m., p=.04) and shortness of breath scores (63.5 vs. 65.5, p=.04), with non-randomized subjects showing greater impairment on both variables.

Results of multiple linear regression analyses showed that anxiety was significantly associated with decreased 6 MWD, even after adjusting for patient age, gender, FEV_1 (% predicted), DL_{CO} (% predicted), and depression (Table 2). Likewise, anxiety was significantly and inversely associated with maximal workload during cardiopulmonary exercise testing after adjusting for age, gender, FEV_1%, DL_{CO}%, and depression. Finally, after controlling for patient age, gender, FEV_1%, DL_{CO}%, and depression score, anxiety was also significantly associated with SGRQ and UCSD Shortness of Breath Questionnaire total scores. Regression coefficients from models with the BDI mood and physical symptom scores show that a 10-point increase in anxiety score is associated with a mean decrease in 6 MWD of 9 meters, a decrease in maximum exercise workload of almost 1 Watt, and an increase of approximately 2 points on the SGRQ and the UCSD SOBQ. Collinearity diagnostic test did not indicate significant collinearity between independent variables in the regression models (data not shown). Effects for anxiety were similar when limiting analyses to only randomized patients, but were not statistically significant for maximum workload (data not shown).

Total BDI depression score was also significantly associated with 6 MWD (B=-1.12, SE=0.43, p=.009), peak workload (B=-0.24, SE=.08, p=.002), SGRQ (B=.80, SE=0.05, p<.001) and UCSD Shortness of Breath Questionnaire (B=0.950, SE=0.08, p<.001) total scores. But, when BDI scores were separated into 'mood' and 'physical' symptoms scores, physical, but not mood, symptoms were associated with the dependent variables in all cases (Table 2).

In separate multivariate regression models predicting 6 MWD, maximum exercise workload, SGRQ, and UCSD Shortness of Breath Questionnaire total scores, a significant interaction was found between gender and anxiety score in predicting SGRQ total score after adjusting for age, FEV1%, DLCO%, and depression score. Anxiety was much more strongly associated with SGRQ for men (B±SE=0.23±.04; p<.001; 95% confidence interval [0.16, 0.30]), than for women (B±SE=0.09±.04; p=.03; 95% confidence interval [0.01, 0.18].

Discussion

This analysis of a large, prospectively studied cohort of patients with severe emphysema screened for enrollment in a clinical trial of lung volume reduction surgery makes several important observations about state anxiety. We show that state anxiety was significantly and independently associated with 1) shorter 6 MWD distance; 2) diminished maximum workload on cardiopulmonary exercise testing; 3) poorer health-related quality of life, and 4) more shortness of breath. It should be emphasized that our measure of anxiety evaluates a general

state of feeling anxious and does not indicate how anxious patients actually felt during exercise testing. Emotional distress experienced during exercise may be even more strongly associated with performance outcomes. Nonetheless, our findings suggest that anxiety may be a valid target for therapeutic interventions in patients with severe emphysema.

A key feature of our report is the objective measurement of physical functioning using well-validated physiologic measures, which allows us to extend the findings of other investigators who suggested greater impairment in physical functioning and quality of life with increasing levels of anxiety in COPD patients. Our results contrast with those of Borak et al, who reported no significant effect of anxiety on exercise performance, however the differences may relate mostly to methodological and data analytical issues. That study examined the effects of a number of psychological variables, including anxiety and depression, on 6 MWD in a group of 49 patients with moderate to severe COPD, and concluded that they had no effect at all on exercise performance. In their analyses, authors entered up to 15 independent variables into a multiple regression equation, with 6 MWD as the dependent variable. With only 49 patients, this model may have been underpowered to detect anything but very large effects. In addition, the power to detect an effect of anxiety was decreased further by the conversion of anxiety to a categorical variable of low, moderate or high based on subjects' scores on a continuous measure of anxiety. In contrast, our study analyzed anxiety as a continuous variable and, to our knowledge, utilized the largest sample size to date to examine the question.

Our results also contrast with those of Weaver and colleagues, who tested a causal model of factors affecting self-reported physical, mental, and social functioning including age, length of illness, FEV_1, dyspnea, depression, anxiety, self-esteem, and exercise capacity, as measured by the 12-minute walk test in patients with COPD. They found that anxiety was linked to exercise capacity, but only through its association with depression and dyspnea. It is possible that the differences in findings between these studies are due to the use of different measures of anxiety, depression, and dyspnea. In addition, our subjects were a more homogenous group with more severe COPD and an emphysematous phenotype.

Our analyses showed that depression, as measured by the BDI total score, was significantly associated with poorer exercise performance and worse health-related quality of life scores. But, our results indicate that the observed association between depression and other patient variables was due to the somatic symptoms of depression included on the BDI. These include, for example, "I get tired more easily than I used to", "It takes an extra effort to get started at doing something" and "My appetite is not as good as it used to be." It is easy to see that these depression symptoms are also likely to be indicators of COPD severity. Thus, it is difficult to conclude that the observed associations between BDI total score and patient functioning were related to depression per se, rather than items on the BDI that served as another proxy for COPD severity. Future studies should use measures of depression that minimize overlap with COPD symptoms.

Our analysis of the effect of gender on the association between anxiety and functioning found an interaction between gender and anxiety on quality of life reports. For men, higher anxiety was associated worse health-related quality of life, as measured by the SGRQ total score. For female patients this association was much weaker, although still statistically significant. This finding is somewhat surprising given that greater emotional distress and lower health satisfaction and quality of life have been found for women with COPD in many, but not all studies. In our data also, women reported greater symptoms of anxiety and depression than did men. Nonetheless our finding suggests that anxiety may impact men's ratings of health-related quality of life more than for woman. This interaction effect was not found for exercise performance or shortness of breath, indicating that the gender difference in the association between anxiety and quality of life is not due to a greater adverse impact of dyspnea or impaired physical functioning on quality of life for men. However it may be that anxiety has a greater impact on important activities and roles in men with COPD. Future research could be designed to more specifically study this potentially important phenomenon.

Several mechanisms, not mutually exclusive, may explain the link between anxiety and functional impairment in patients with COPD. First, anxiety may increase disability in COPD by increasing vigilance for, and amplification of, distressing respiratory sensations. The tendency to misinterpret ambiguous or potentially threatening stimuli, a characteristic of many anxiety disorders, would lead anxious COPD patients to avoid any activity that might produce these sensations. Second, patients with higher anxiety may be more emotionally sensitive to unpleasant somatic sensations, which would to lead to greater distress when these bodily cues are encountered. In a recent population-based longitudinal study, anxiety and depression were associated with the new onset of dyspnea, but not vice versa. Third, longitudinal experience with COPD symptoms may generate fearful or catastrophic beliefs about respiratory sensations, which, in turn, provoke anxiety that limits engagement in physical activity. Patients with COPD and panic disorder report more fearful thoughts about, and avoidance of, unpleasant somatic sensations than COPD patients without anxiety. Patients who endorse beliefs such as "dyspnea is always a sign of danger" or "activities that produce dyspnea make my COPD worse and should be avoided" are more functionally impaired and report poorer quality of life independent of COPD severity. Near-death episodes, need for ventilatory support, and other illness experiences could also influence the development of these fearful beliefs and frightening thoughts.

Why anxiety is so much more common in COPD than in the general population or in other disease states remains unclear. Repetitive experiences with hypoxia and hypercapnia might sensitize neural circuits that control fear responses, such as neurons in the amygdala and locus ceruleus, to overreact to either subsequent episodes of hypoxia and hypercapnia or to fearful perceptions of conditioned stimuli such as the sensation of breathlessness. These reactions would again lead to avoidance of physical activity and limit exercise performance. In addition, a vicious circle may ensue, in which dyspnea leads to anxiety, which produces a rapid, shallow breathing pattern, leading to air trapping and hyperinflation, creating further dyspnea and exercise limitations. Thus, anxiety in the context of COPD may represent a 'normal' response to the anxiogenic experience of repeated dyspnea, hypoxia, or hypercapnia; or it may reflect the presence of a pre-morbid anxiety problem that may become exacerbated in the presence of COPD symptoms. Deciphering the relative contributions of these two pathways to anxiety will require longitudinal studies beginning in more mild stages of COPD.

Our findings suggest that screening for anxiety may be important in patients with moderate to severe COPD. Treating anxiety when present in patients with COPD may not only reduce emotional distress, but also improve physical functioning and overall quality of life. Brief screening instruments have been validated for the detection of anxiety in medical settings. And, while there are no published large randomized controlled studies of treatments for anxiety disorders in patients with COPD, number of studies report decreased anxiety symptoms in COPD with antidepressant therapy, cognitive-behavioral therapy, or exercise therapy, including pulmonary rehabilitation.

Our findings from our analysis of data from the NETT have some limitations. As with all research reports from treatment trials such as the NETT, the most serious limitation is related to subject characteristics influenced by study selection criteria and subject self- selection. Subjects in this study had moderate to severe emphysema. In addition, subjects who participated in the NETT were not current cigarette smokers and had agreed to participate in a rigorous pulmonary rehabilitation program. As a result, it is important to note that our findings may not be generalizable to all patients with COPD. Likewise, since only patients with COPD were included (ie, there was not a non-COPD control group), our results are not generalizable to other patient groups. Second, questionnaires were administered prior to pulmonary rehabilitation and treatment randomization. Thus, while the measures were thus not influenced by the impact of rehabilitation or treatment, it is possible that subjects may have experienced heightened anxiety or mood symptoms in anticipation of rehabilitation participation or treatment assignment.

While the associations between state anxiety and exercise performance found in our study were statistically significant, the absolute effect sizes for anxiety were modest. We found that a 10-point increase in state anxiety score is associated with a mean decrease in 6 MWD of 9 meters, a decrease in maximum exercise workload of approximately 1 Watt, and an increase of approximately 2 points on the SGRQ and the UCSD SOBQ. Published guidelines for the 6 MWD suggest 50 meters change to indicate clinically significant changes in walk distance. For the SGRQ a change in 4 points is used to indicate clinically important differences in health-related quality of life. However these guidelines were based on within-subject changes observed in clinical trials, rather than between-subject differences in cross-sectional studies. Nonetheless, using these figures as a rough guide, a patient with a high state anxiety score (2 SD above the mean or STAI=57) in our sample would be expected to walk about 40 meters less on the 6 MWD and score 9 points worse on the SGRQ than a patient with low state anxiety (2 SD below the mean, or STAI score=13). Thus, while the effect of anxiety on patients with COPD appears to be clinically meaningful, the significance of our findings needs to be further evaluated.

Conclusion

In summary, we found that state anxiety is associated with worse functioning on measures of exercise performance, health-related quality of life and shortness of breath in patients with moderate to severe emphysema, after accounting for the influence of demographic and physiologic factors known to affect these outcomes. Our results support the need for additional research into the role of anxiety as an important source of functional impairment and decreased quality of life in patients with COPD. Future studies will need to examine the mechanisms by which anxiety impacts exercise performance.

The Role of Noninvasive Ventilation in Acute Cardiogenic Pulmonary Edema

Ashar Salman, Eric B. Milbrandt, Michael R. Pinsky

The expanded abstract cited by the commentary below is: Gray A, Goodacre S, Newby DE, Masson M, Sampson F, Nicholl J: Noninvasive ventilation in acute cardiogenic pulmonary edema. N Engl J Med 2008, 359:142-151.[1]

Noninvasive ventilation (NIV) (continuous positive airway pressure [CPAP] or noninvasive intermittent positive-pressure ventilation [NIPPV]) appears to be of benefit in the immediate treatment of patients with acute cardiogenic pulmonary edema and may reduce mortality.

The objective was to determine whether noninvasive ventilation reduces mortality and whether there are important differences in outcome associated with the method of treatment (CPAP or NIPPV). The design was an open, prospective, randomized controlled trial. The setting was 26 emergency departments in hospital in the UK between July 2003 and April 2007. The subjects were 1,069 patients age >16 years with a clinical diagnosis of acute cardiogenic pulmonary edema, as determined by chest radiograph, respiratory rate >20 breaths/min, and arterial pH<7.35. Exclusion criteria included a requirement for a lifesaving or emergency intervention, inability to give consent, or previous recruitment in the trial. All patients received standard concomitant therapy. Patients were randomly assigned to standard oxygen therapy (up to 15 liters per minute via face mask), CPAP (5 to 15 cm of water), or NIPPV (inspiratory pressure, 8 to 20 cm of water; expiratory pressure, 4 to 10 cm of water). The primary end point for the comparison between noninvasive ventilation and standard oxygen therapy was death within 7 days after the initiation of treatment, and the primary end point for the comparison between NIPPV and CPAP was death or intubation within 7 days. A total of 1069 patients (mean [±SD] age, 77.7±9.7 years; female sex, 56.9%) were assigned to standard oxygen therapy (367 patients), CPAP (346 patients), or NIPPV (356 patients). There was no significant difference in 7-day mortality between patients receiving standard oxygen therapy (9.8%) and those undergoing noninvasive ventilation (9.5%, P=0.87). There was no significant difference in the combined end point of death or intubation within 7 days between the two groups of patients undergoing noninvasive ventilation (11.7% for CPAP and 11.1% for NIPPV, P=0.81). As compared with standard oxygen therapy, noninvasive ventilation was associated with greater mean improvements at 1 hour after the beginning of treatment in patient-reported dyspnea (treatment difference, 0.7 on a visual-analogue scale ranging from 1 to 10; 95% confidence interval [CI], 0.2 to 1.3; P=0.008), heart rate (treatment difference, 4 beats per minute; 95% CI, 1 to 6; P=0.004), acidosis (treatment difference, pH 0.03; 95% CI, 0.02 to 0.04; P<0.001), and hypercapnia (treatment difference, 0.7 kPa [5.2 mm Hg]; 95% CI, 0.4 to 0.9; P<0.001). There were no treatment-related adverse events. The authors concluded: In patients with acute cardiogenic pulmonary edema, noninvasive ventilation induces a more rapid improvement in respiratory distress and metabolic disturbance than does standard oxygen therapy but has no effect on short-term mortality.

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Commentary

Acute cardiogenic pulmonary edema (ACPE) is common, costly, and lethal, with associated mortality rates of 10-20%.[2,3] When severe, it is traditionally managed with endotracheal intubation and mechanical ventilation. Interest in using noninvasive ventilation (NIV) in the treatment of ACPE has grown since the early work of Rasanen and colleagues from 1985.[4] Whether delivered in the form of continuous positive airway pressure (CPAP) or noninvasive intermittent positive pressure ventilation (NIPPV), NIV improves physiologic parameters in patients with ACPE, including decreasing respiratory acidosis, respiratory rate, work of breathing, heart rate, and sensation of dyspnea.[5,6] It may also reduce rates of endotracheal intubation.[5,7,8] A variety of clinical trials have been conducted in this area, though most were small, single-centered studies lacking power to determine if NIV reduces mortality.[4,9-18] Recent systematic reviews and meta-analyses suggest that indeed it may.[5-8] However, the small size of included studies and variation in study populations, interventions, and endpoints leave some doubt to the generalizability of these findings.

To address these uncertainties, Gray and colleagues performed a large, multicenter, randomized controlled trial in 1069 patients with ACPE to determine whether NIV improves survival and if NIPPV is superior to CPAP.[1] Their trial, referred to as the 3CPO (Three interventions in Cardiogenic Pulmonary Oedema) study, was completed in 26 emergency departments in the UK. Patients were randomized to three groups: standard oxygen therapy, CPAP (5 - 15 cm of H_2O), or NIPPV (8/4 to 20/10 cm of H_2O). There were no differences in baseline characteristics, comorbid conditions, or the receipt of standard medical treatments, such as diuretics, nitrates and opiates. Though NIV did provide more rapid improvement in respiratory distress and metabolic

disturbances, there were no differences in clinical outcomes, including mortality, rates of endotracheal intubation, length of stay, or myocardial infarction. There were no differences between CPAP and NIPPV in any of the primary or secondary outcomes. The authors conclude that in patients with ACPE, noninvasive ventilation produces more rapid resolution of metabolic abnormalities and respiratory distress but has no effect on short-term mortality.

This study has a number of strengths, most important of which is that it was the largest randomized trial to date in this area, enrolling more patients than the combined number of patients from all studies included in prior meta-analyses.[5-8] Some limitations deserve mention. This was a study of patients presenting to the emergency department and therefore may not apply to the use of NIV in the pre-hospital setting or to those patients who develop ACPE later in their hospital stay. Patients were excluded if they required lifesaving or emergency intervention, a group that might have benefited most from NIV. The most concerning limitation, however, is the considerable cross-over between groups and the lack of objective criteria for intubation. Fifty-six patients who failed standard oxygen treatment were rescued with NIV. Assuming that all 56 would have required intubation, the control 7-day intubation rate would have increased from 2.8% to 18.0%, which would have made the intubation rate in the standard oxygen treatment group significantly greater than the NIV group (2.9%).

Recommendation

The results of this study should not limit the use of NIV in the setting of ACPE. NIV leads to more rapid improvement of symptoms of respiratory distress and metabolic disturbances as compared to standard oxygen therapy. We further argue that based on this study, one should not draw a conclusion that NIV is ineffective in preventing intubation. Though NIV has not been convincingly shown to reduce mortality, it remains a valuable adjunct in the treatment of ACPE.

References

1 Gray A, Goodacre S, Newby DE, Masson M, Sampson F, Nicholl J: Noninvasive ventilation in acute cardiogenic pulmonary edema. N Engl J Med 2008, 359:142-151.

2 Jessup M, Brozena S: Heart failure. N Engl J Med 2003, 348:2007-2018.

3 Nieminen MS, Brutsaert D, Dickstein K, Drexler H, Follath F, Harjola VP, Hochadel M, Komajda M, Lassus J, Lopez-Sendon JL, Ponikowski P, Tavazzi L: EuroHeart Failure Survey II (EHFS II): a survey on hospitalized acute heart failure patients: description of population. Eur Heart J 2006, 27:2725-2736.

4 Rasanen J, Heikkila J, Downs J, Nikki P, Vaisanen I, Viitanen A: Continuous positive airway pressure by face mask in acute cardiogenic pulmonary edema. Am J Cardiol 1985, 55:296-300.

5 Masip J, Roque M, Sanchez B, Fernandez R, Subirana M, Exposito JA: Noninvasive ventilation in acute cardiogenic pulmonary edema: systematic review and meta-analysis. JAMA 2005, 294:3124-3130.

6 Vital FM, Saconato H, Ladeira MT, Sen A, Hawkes CA, Soares B, Burns KE, Atallah AN: Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary edema. Cochrane Database Syst Rev 2008, CD005351.

7 Peter JV, Moran JL, Phillips-Hughes J, Graham P, Bersten AD: Effect of noninvasive positive pressure ventilation (NIPPV) on mortality in patients with acute cardiogenic pulmonary oedema: a meta-analysis. Lancet 2006, 367:1155-1163.

8 Winck JC, Azevedo LF, Costa-Pereira A, Antonelli M, Wyatt JC: Efficacy and safety of non-invasive ventilation in the treatment of acute cardiogenic pulmonary edema—a systematic review and meta-analysis. Crit Care 2006, 10:R69.

9 Bersten AD, Holt AW, Vedig AE, Skowronski GA, Baggoley CJ: Treatment of severe cardiogenic pulmonary edema with continuous positive airway pressure delivered by face mask. N Engl J Med 1991, 325:1825-1830.

10 Crane SD, Elliott MW, Gilligan P, Richards K, Gray AJ: Randomised controlled comparison of continuous positive airways pressure, bilevel non-invasive ventilation, and standard treatment in emergency department patients with acute cardiogenic pulmonary oedema. Emerg Med J 2004, 21:155-161.

11 Kelly CA, Newby DE, McDonagh TA, Mackay TW, Barr J, Boon NA, Dargie HJ, Douglas NJ: Randomised controlled trial of continuous positive airway pressure and standard oxygen therapy in acute pulmonary oedema; effects on plasma brain natriuretic peptide concentrations. Eur Heart J 2002, 23:1379-1386.

12 L'Her E, Duquesne F, Girou E, de Rosiere XD, Le Conte P, Renault S, Allamy JP, Boles JM: Noninvasive continuous positive airway pressure in elderly cardiogenic pulmonary edema patients. Intensive Care Med 2004, 30:882-888.

13 Lin M, Yang YF, Chiang HT, Chang MS, Chiang BN, Cheitlin MD: Reappraisal of continuous positive airway pressure therapy in acute cardiogenic pulmonary edema. Short-term results and long-term follow-up. Chest 1995, 107:1379-1386.

14 Masip J, Betbese AJ, Paez J, Vecilla F, Canizares R, Padro J, Paz MA, de Otero J, Ballus J: Non-invasive pressure support ventilation versus conventional oxygen therapy in acute cardiogenic pulmonary oedema: a randomized trial. Lancet 2000, 356:2126-2132.

15 Nava S, Carbone G, DiBattista N, Bellone A, Baiardi P, Cosentini R, Marenco M, Giostra F, Borasi G, Groff P: Noninvasive ventilation in cardiogenic pulmonary edema: a multicenter randomized trial. Am J Respir Crit Care Med 2003, 168:1432-1437.

16 Park M, Lorenzi-Filho G, Feltrim MI, Viecili PR, Sangean MC, Volpe M, Leite PF, Mansur AJ: Oxygen therapy, continuous positive airway pressure, or noninvasive bilevel positive pressure ventilation in the treatment of acute cardiogenic pulmonary edema. Arq Bras Cardiol 2001, 76:221-230.

17 Park M, Sangean MC, Volpe MS, Feltrim MI, Nozawa E, Leite PF, Passos Amato MB, Lorenzi-Filho G: Randomized, prospective trial of oxygen, continuous positive airway pressure, and bilevel positive airway pressure by face mask in acute cardiogenic pulmonary edema. Crit Care Med 2004, 32:2407-2415.

18 Takeda S, Nejima J, Takano T, Nakanishi K, Takayama M, Sakamoto A, Ogawa R: Eff ect of nasal continuous positive airway pressure on pulmonary edema complicating acute myocardial infarction. Jpn Circ J 1998, 62:553-558.

Associations of Physical and Mental Health Problems With Chronic Cough in a Representative Population Cohort

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Abstract

Background: Although chronic cough is a common problem in clinical practice, data on the prevalence and characteristics of cough in the general population are scarce. Our aim was to determine the prevalence of chronic cough that is not associated with diagnosed respiratory conditions and examine the impact on health status and psychological health, in a representative adult population cohort

Methods: North West Adelaide Health Study (n stage 1=4060, stage 2=3160) is a representative population adult cohort. Clinical assessment included spirometry, anthropometry and skin tests. Questionnaires assessed demographics, lifestyle risk factors, quality of life, mental health and respiratory symptoms, doctor diagnosed conditions and medication use.

Results: Of the 3,355 people without identified lung disease at baseline, 18.2% reported chronic cough. In multiple logistic regression models, at follow-up, dry chronic cough without sputum production was significantly more common in males (OR 1.5, 95% CI 1.1, 1.9), current smokers (OR 4.9, 95% CI 3.4, 7.2), obesity (OR 1.9, 95% CI 1.3, 2.9), use of ACE inhibitors (OR 1.8, 95% CI 1.1, 2.9), severe mental health disturbance (OR 2.1, 95% CI 1.4, 3.1) and older age (40-59 years OR 1.7 95% CI 1.2, 2.4; ≥60 years OR 2.1 95% CI 1.3, 3.5). Among non-smokers only, all cough was significantly more common in men, those with severe mental health disturbance and obesity.

Conclusions: Chronic cough is a major cause of morbidity. Attention to cough is indicated in patients with obesity, psychological symptoms or smokers. Inquiring about cough in those with mental health problems may identify reversible morbidity.

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Background

Cough is the commonest symptom seen in primary care, and chronic cough is one of the most frequent reasons for new referrals to specialist pulmonologists. However, data on the prevalence of cough lasting more than eight weeks in the general population are scarce. Most reports of the prevalence of chronic cough in adults originate from specialist cough clinics and therefore reflect the experience of chronic cough in secondary or tertiary care. The prevalence of chronic cough (lasting more than eight weeks) has been variously reported at 10% to 30%. Where population data exist they are limited by methodological problems including use of selected age groups, self selection of questionnaire respondents, failure to differentiate between acute cough due to infection and chronic cough; or a lack of information on other respiratory conditions making it difficult to differentiate the impact of chronic cough from that of airways diseases such as asthma.

Chronic cough is associated with adverse effects on health-related quality of life. Successful treatment of cough often leads to major improvement in quality of life. Chronic cough is also associated with psychosocial problems that may be more pronounced than physical effects. However, the few studies that have evaluated the impact of cough on health status or psychological health have sampled from specialist clinic populations rather than the general population. Others studies are limited by the lack of use of a validated instrument of psychological health.

Our aim was to determine the prevalence of chronic cough in a representative adult population cohort, particularly cough that is not associated with diagnosed respiratory conditions, and examine the impact on health status and psychological health.

Methods

The North West Adelaide Health Study (NWAHS) is a representative biomedical longitudinal population cohort study of people aged eighteen years or older, randomly selected from the electronic white pages telephone directory and living in the north western suburbs of Adelaide, South Australia (regional population 0.6 million). NWAHS initially recruited between 2000 and 2002 with follow-up in 2004-05. The methods of the North West Adelaide Health Study and the validity of these methods of selection to achieve an unbiased sample have been described previously. In particular, there were no major differences between study participants and the comparison population in terms of health indicators or lifestyle behaviors.

Table 1. Prevalence (%) of all cough within baseline categories of demographic characteristics and mental health status in subjects without identifiable respiratory disease (n = 3355).

		Cough + / - sputum
All subjects (n = 3960)		20.5
No respiratory disease (n=3355)		18.2
Sex	Male	18.5
	Female	16.0
Smoking status	Current	29.6
	Former	15.6
	Never	11.8
Age (years)	< 40	20.0
	40 -54	12.2
	55 and over	18.7
GHQ 28		
Mental health condition	Yes	26.9
	No	14.2
Somatic symptoms	Yes	27.6
	No	14.0
Anxiety and insomnia	Yes	23.6
	No	15.4
Social dysfunction	Yes	28.3
	No	15.2
Severe depression	Yes	34.4
	No	15.7

Table 2. Prevalence of dry and productive cough at follow-up in subjects with and without identifiable respiratory disease according to respiratory conditions, demographic characteristics, and health status.

		Dry cough	Cough + sputum
All subjects (n=3206)		12.1	4.6
Respiratory disease			
Asthma* (433)		25	6
Emphysema † (43)		37	23
Chronic bronchitis † (227)		22	12
Airways obstruction ** (150)		30	11
≥12% FEV_1 reversibility (129)		14	9
No respiratory disease (n=2408)		8.8	3.8
Sex	Male	10.3	4.9
	Female	7.3	2.6
Smoking status	Current	20.9	7.3
	Former	6.6	2.4
	Never	5.5	3.3
Age (years)	< 40	6.3	4.9
	40 -54	10.5	3.6
	55 and over	10.4	1.9
Atopy	Yes	9.2	4.3
	No	8.0	2.9
ACE inhibitor use	Yes	14.4	2.7
	No	8.3	3.8
GHQ disturbance	High	15.9	7.8
	Low / none	7.7	3.2
Self-rated health general health	Fair / Poor	19.3	6.0
	Good / excellent	8.8	2.2
SF – 36 Mean (SE)	PCS	44.5 (0.5)	44.7 (0.8)
	MCS	49.6 (0.6)	47.8 (1.0)

* asthma: self reported current doctor diagnosed
† Self reported doctor diagnosed emphysema and chronic bronchitis
** Airways obstruction = post-bronchodilator FEV1/FVC <0.07

At stage 1, 4,060 adults underwent biomedical examination, representing 69% of those who completed the telephone interview. Overall, at Stage 2 follow-up (mean follow-up time = 3.5 years, range 1.7-5.8 years) survey data was obtained on 88% (n=3574) and clinic data on 79% (n=3206) of the Stage 1 NWAHS population using the same methodology and questions. One hundred subjects were deceased, 226 persons were unable to be contacted, and 160 refused further participation in the study. Telephone interviews investigated self-reported health status (including asthma and COPD), smoking status and demographic variables. A self-completed questionnaire comprised items on demographic information, risk factors (smoking, alcohol use), quality of life, mental health and respiratory symptoms. Smoking was categorized into self-reported current, former or never smoker. Clinic assessment by trained technicians included spirometry according to American Thoracic Society criteria, skin prick testing to a panel of eight common allergens, and measurement of height, weight. Obesity was classified as follows: Body mass index (BMI) in kilograms/metre2: Underweight: ≤ 18.49; Normal: 18.5-24.9; Overweight: 25.0-29.9; Obesity: ≥30.0. Medication use was identified when participants were also asked to bring all current medicines (including complementary medicines) into the clinic at their appointment.

Respiratory measures: Asthma was defined as current self-reported physician-diagnosed asthma or demonstration of a significant bronchodilator response (SBR) of at least 12% of baseline FEV1 in the absence of a doctor diagnosis of asthma. Participants with persistent airways obstruction (postbronchodilator FEV1/FVC ratio less than 0.70) were identified. Respiratory symptoms were assessed with the validated Chronic Lung Disease (CLD) Index. This is a 6-item instrument that includes items relating to frequency and intensity of dyspnea and wheeze and frequency of coughing and volume of sputum production. Chronic cough was defined as cough reported on most/every day in the past three months. Sputum was defined as at least 2 or 3 tablespoons per day.

Quality of life and Psychological measures: Health-related quality of life was assessed using the Medical Outcomes Study Short Form 36 Health Survey (SF-36) Physical Health Component Summary (PCS) and Mental Health Component Summary (MCS) scores. The PCS score is constructed such that the mean for the general population is set at 50 with a standard deviation of 10, and higher scores indicate better quality of life. At Stage 1 psychological health was measured by the General Health Questionnaire (GHQ-28), a well-validated and extensively used instrument designed to measure current psychiatric and affective disorders with a focus on disruptions to normal functioning rather than life-long traits. The GHQ-28 contains four subscales: anxiety and insomnia, somatic symptoms (other than cough), social dysfunction, and severe depression, providing more information than that of a single severity score. It screens, therefore, for acute rather than chronic conditions. Scores can be interpreted as indicating the severity of psychological disturbance on a continuum. In Australian community populations the GHQ-28 has shown sensitivity of 90% and specificity of 94% for clinically confirmed diagnoses based on the Composite International Diagnostic Interview. At follow-up the GHQ-12 was used, which excludes items most usually selected by physically ill individuals. The GHQ-12 has shown very similar figures to the GHQ-28 in validation studies.

Table 3. Multivariate logistic regression models for cough at follow-up in those without identifiable respiratory disease (n=2408) and among never/ex-smokers (n = 1938).

	All cough		Dry cough	Cough+sputum
	All subjects	Non-smokers		
	OR (95%C.I.)	OR (95%C.I.)	OR (95%C.I.)	OR (95%C.I.)
Male	1.6 (1.3-2.1)	1.5 (1.05-2.0)	1.4 (1.02-1.9)	2.3 (1.4-3.6)
Age				
18-39	1.0	1.0	1.0	1.0
40-59	1.5 (1.1-2.0)	1.4 (0.9-2.0)	1.9 (1.3-2.7)	0.7 (0.4-1.2)
60+	1.7 (1.1-2.5)	1.8 (1.2-2.8)	2.6 (1.6-4.1	0.6 (0.3-1.3)
GHQ disturbance				
mild-moderate	1.03 (0.7-1.6)	0.9 (0.5-1.6)	1.1 (0.7-1.8)	0.8 (0.4-1.8)
severe	2.2 (1.6-3.0)	1.8 (1.2-2.9)	2.1 (1.4-3.1)	2.6 (1.5-4.3)
Smoking status				
former smoker	0.9 (0.7-1.3)	-	1.01 (0.7-1.5)	0.8 (0.4-1.4)
current	4.1 (3.0-5.5)	-	5.4 (3.8-7.8)	2.5 (1.5-4.0)
ACE inhibitor use	1.6 (1.02-2.5)	1.4 (0.9-2.3)	1.8 (1.1-2.9)	1.1 (0.4-2.9)
Atopic	1.3 (0.97-1.7)	1.3 (0.9-1.8)	1.2 (0.9-1.7)	1.4 (0.9-2.2)
Anti-reflux agents	1.3 (0.8-2.0)	1.2 (0.7-2.0)	1.3 (0.8-2.0)	1.5 (0.7-3.4)
BMI				
overweight	1.00 (0.7-1.4)	1.2 (0.8-1.8)	1.4 (0.96-2.1)	0.5 (0.3-0.8)
obese	1.5 (1.1-2.0)	1.7 (1.1-2.6)	2.0 (1.2-2.9)	0.9 (0.5-1.5)

Statistical analysis: Data were weighted to the 1999 Estimated Residential Population for South Australia and Census data by region, age group, gender and probability of selection in the household, to provide population representative estimates. Data were analyzed using the Statistical Package for the Social Sciences (SPSS Version 15.0, SPSS Inc, Chicago, IL). Multivariable logistic regression analyses were conducted to assess the association of GHQ disturbance with chronic cough (all, dry, cough with sputum) after adjustment for sex, age, smoking, BMI and ACE inhibitor use. The models were also adjusted for reflux medication use as a proxy for GERD. An additional model assessing the association of all cough and GHQ disturbance was conducted in the population of never/former smokers.

Results

Of the 3,206 people who attended for biomedical assessment at follow-up, doctor-diagnosed current asthma was reported by 439 people (13.5 %). Emphysema had been diagnosed in 43 (1.3%) and chronic bronchitis in 239 (7.3%). Airways obstruction (post-bronchodilator FEV1/FVC <70%) was found in 150 (4.8%), and significant acute FEV1 reversibility (>12% & 0.2 L) in 128 (4.1%).

The prevalence of chronic cough at baseline within various demographic and clinical groups is shown in Table 1. Among people without identified airways or restrictive respiratory disease, chronic cough with or without sputum was more common in males, current smokers, those aged less than 40 and over 55 years, and in those with GHQ-28 identified psychological morbidity. Chronic cough was more common across the GHQ-28 domains of anxiety and insomnia, somatic symptoms, social dysfunction and severe depression. Table 2 shows the prevalence of chronic cough by type, in relation to participant characteristics at follow-up. Among people without identified respiratory disease, chronic cough was more common in males, current smokers, participants with high levels of psychological disturbance, and fair to poor general health, and in those using ACE inhibitors. Dry cough, which was more prevalent in older participants, was more common than cough productive of sputum across all population categories, including smokers. The prevalence of cough was not significantly different between former smokers and those who had never smoked.

Table 4. Prevalence of GHQ-12 disturbance and SF-36 PCS and MCS scores [mean (SE)] among those with and without cough at baseline and follow-up.

Cough		% GHQ disturbance (n)		SF-36 Mean (SE)	
		severe	≥ mild	PCS	MCS
Baseline	Follow-up				
No	No	10.0 (182)	21.0 (381)	51.4 (0.2)	52.8 (0.2)
	Yes	21.2* (33)	31.4* (49)	47.0* (0.7)	47.2* (0.7)
Yes	No	16.9 (40)	30.9 (73)	47.4 (0.6)	49.0 (0.6)
	Yes	24.8* (35)	36.2* (51)	44.6*†‡ (0.8)	46.3*‡ (0.8)

* p<.01 vs never cough

† p<.01 vs cough only at follow-up

‡ p<.01 vs cough only at baseline

In multiple regression analysis (Table 3), chronic cough without sputum production was seen more commonly in males, current smoking and with ageing. There were significant positive associations with severe depression, obesity and use of ACE inhibitors. Modest, but marginally non-significant associations were seen with atopy, and use of anti-reflux treatment. Cough productive of sputum was also more common in males and current smokers, and less common in those who were overweight. Again, a significant association was seen with severe depression. Cough with sputum was not significantly associated with use of ACE inhibitors or anti-reflux treatment. When the analysis was confined to only non-smokers, all cough was more common in men; those with severe depression, the obese, and those aged over 60 years. Again, nonsignificant associations were seen with atopy, and ACE-inhibitor use (Table 3). When models were analyzed without the GHQ variable, no changes were seen in the size of the associations with other variables and cough.

Participants reporting cough at any time were significantly more likely to have psychological disturbance on the GHQ-12 and report significantly lower quality of life compared to those without cough at any time (Table 4). Compared to people with cough at both time points, those with cough only at follow-up only had significantly higher mean PCS scores and a lower prevalence of severe psychological disturbance on the GHQ-12, although this was not statistically significant. Compared to people with cough at both time points, those with cough only at baseline had higher mean levels of both PCS and MCS scores, and a lower prevalence of any type of psychological disturbance on the GHQ-12, although this was not statistically significant (p=0.1).

Discussion

In a representative population sample we have shown that chronic, dry cough is common among people without known respiratory disease, with a prevalence of nearly 9% among adults. Cough productive of sputum occurs in around a further 4% of those without known lung disease. People with chronic cough report significant impairments in quality of life and psychological health, compared to those without cough. Across the population, chronic cough was significantly associated with obesity and severe depression, and was more common in men and in people aged over 60 years. Although cough was more common in people

who currently smoke, when only non-smokers were analyzed, the significant associations seen with depression, obesity, men and age persisted. The prevalence of cough was not significantly different between former smokers and those who had never smoked.

The frequency of chronic cough independent of other lung disease, with its strong associations with impaired mental health, particularly depression, and significantly reduced quality of life, indicates cough is a major contributor to morbidity in the community. The reduction in quality of life in general physical health is similar to that previously reported in Australian populations for asthma, diabetes, arthritis and depression alone. Although use of a coughspecific quality of life instrument may have elicited issues more closely related to cough, the SF- 36 correlates well with instruments such as the Leicester Cough Questionnaire. That major impairments were seen in a general health instrument indicates that chronic cough is not a minor problem and deserves thorough evaluation and treatment, particularly as most patients are able to respond to treatment for chronic cough.

Our data demonstrates that careful attention should be given to assessment and management of psychological morbidity in the large number of patients with chronic cough in the community, as well as those seen in referral centers. This may be especially the case in people in whom coughing persists in the absence of an identifiable cause and despite extended trials of empirical therapy. Chronic cough was common in smokers and smoking is associated with depression and mental health problems. However, we found the association between chronic cough and disturbance on the GHQ remained strong when only non-smokers were included in the analysis. Under-diagnosis of depression in patients with somatization, particularly major depression, has recently been identified as a significant problem in primary care. Conversely, inquiry regarding cough in patients with mental health problems may also be crucial in identifying reversible morbidity in this group. In one study, successful treatment of cough was correlated with improvements in depression scores in 70% of patients.

We found obesity to be significantly associated with dry cough and cough in never/ex-smokers. Janson et al have reported cough was significantly associated with obesity. However, the study population of 20-48 year olds included people with asthma and other respiratory diseases. As obesity has been shown to be significantly associated with asthma, it was unclear from that study whether obesity was linked to chronic cough independently of airways diseases. One possibility is that obesity increases the risk for gastro-esophageal reflux that is contributing to chronic cough in people with obesity. Regardless, our study indicates that chronic cough, with the concomitant problems of impairments in quality of life and mental health, needs to be added to the burden and morbidity of obesity in the community.

Comparison with previous studies examining the prevalence and associations of chronic cough are difficult due to differences in sampling and other methodological questions. We used a validated symptom score of chronic lung disease to identify cough frequency over the previous 3 months. The use of this tool differs from prior studies and makes direct comparison of prevalence between studies difficult. Studies using selected age groups have either excluded adults aged > 50 or > 60 years in whom chronic cough is common, thereby missing a large proportion of people with chronic cough. Coultas et al reported a prevalence of cough of 9.3% in people without airflow obstruction from US population data but limited the analysis to adults aged at least 45 years and did not analyse any associations with obesity or psychological disturbance. Zemp et al reported the prevalence of chronic bronchitis symptoms over ≥2 years in adults aged less than 60 years. Similar to our data they found no difference in prevalence in cough with sputum between never and former smokers (7%), with cough more common in current smokers (16.7%). Another community-based study sampled members of the public who requested an information sheet following a national UK radio broadcast, with risk of selfselection of questionnaire respondents. Studies differentiating between infection related acute cough and chronic cough were limited by a lack of information on other respiratory conditions or lung function limiting the ability to differentiate the impact of cough from that of airways diseases such as asthma. Other population studies did not differentiate acute from chronic cough. The strength of our study is that it comes from a representative population sample that was able to identify people with cough over a 3-month period, and those with airways obstruction or restriction on spirometry, previously diagnosed respiratory disease, and current medication use, adding to the generalizability of the findings.

Similar to other reports we found chronic cough is associated with adverse effects on healthrelated quality of life and psychological problems. However, previous studies reporting increased levels of emotional upset have been limited to small numbers of patients referred to specialist cough clinics. As only a small part of the population identified in epidemiological surveys seek medical help or advice for cough the population burden of disease from psychological problems associated with cough cannot be extrapolated from these studies. These studies in selected populations have revealed increased levels of depression and anxiety using validated questionnaires at frequencies comparable or in excess of that seen in other serious chronic diseases, such as diabetes, asthma or HIV-AIDS. Other reports linking cough to psychological morbidity have either not used a validated instrument of psychological health or were unable to specify the frequency, quality, duration, or intensity of reported coughing making it difficult to identify the contribution of chronic cough to this finding. When the GHQ variable was removed from the model the strength of associations with other variables did not change, suggesting the association between psychological disturbance and cough is not acting directly through other factors.

The direction of causality regarding cough and psychological problems is difficult to determine. We found that in terms of disturbance on the GHQ-28 that the group with cough a follow-up only was not significantly different from those with cough at both time points, suggesting there may be little effect of chronicity over our follow-up period of 4 to 5 years. However, we do not know if people had cough for all the follow-up period or recurrent cough only in the 3 months prior to each clinic assessment. Although those people with cough at baseline but who were no longer coughing had significantly higher physical health quality of life and were less likely to report disturbance on the GHQ. This can be interpreted as indicating chronic cough has both immediate and longer-term consequences for psychological health that may stem from the significant impact on general health experienced with cough. Alternatively, this

may suggest chronic cough is more likely to be seen in those with underlying anxiety or depression, and this may influence an individual's awareness of symptoms. However, anxiety about underlying serious illness has been identified as a concern for most patients with chronic cough. McGarvey and colleagues found no difference in anxiety trait measures between adults with persistent or idiopathic cough compared with those whose cough was successfully treated. There is not a close association between adverse effects of chronic cough and any specific causes, suggesting the adverse effects are related to the chronic cough itself. Successful treatment of cough can improve depression. Furthermore, the GHQ is an instrument designed to identify "the appearance of new phenomena of a distressing nature, rather than lifelong traits. It seems likely that there is a complex interplay between cough and psychological traits and problems that may vary with time.

Contrary to anecdotal observations, and consequent to the representativeness of our sample we found cough to be more common in men and in people aged over 60 years, two groups where there is evidence to suggest there is a tendency to under report symptoms to clinicians. Older population surveys have reported that cough is commoner in men, but women are more likely to be seen in specialist cough clinics. French et al reported that women with chronic cough are more inclined to present for medical attention than men because of greater HRQL impairments and cough-related psychosocial issues such as embarrassment caused bycough induced stress incontinence. Whether men are less likely to report cough as a symptom to primary care practitioners unless specifically asked remains an open question. However, as indicated earlier, given the prevalence of cough and related physical and mental health problems, there is a case to be made that simple enquiry about coughing may be worthwhile as screening tool for men in general practice, particularly in smokers, the obese, those with a history of allergy or from socially disadvantaged backgrounds. Previous population-based studies have excluded older age groups. The consistent association of chronic cough with advancing age in people without other recognized lung disease seen in our study again suggests that efforts at identifying and managing chronic cough and its related problems in older adults may make a major contribution to reducing morbidity in this burgeoning sector of the population.

Our study is limited by a lack of specific information regarding some of the common causes of chronic cough, such as upper airways syndrome or gastro-esophageal reflux disease. However, cough was marginally related to atopy, which itself is closely related to allergic rhinitis, a major cause of post-nasal drip syndrome. Also, it is now appreciated that the postnasal drip syndrome, like GERD, may be clinically silent, suggesting that self-report of symptoms may not accurately elicit these problems sufficiently to be confident of any associations in population studies. We were unable to identify people with undiagnosed respiratory disease that did not produce airways obstruction or restriction on spirometry, nor those with undiagnosed cough-variant asthma with normal spirometry. However, many people with cough-variant asthma develop wheezing within 3 years, and may have been diagnosed between baseline and follow-up. In addition, the similarity in multivariable models when identified asthma and COPD were included or omitted from the analyses suggests the findings are robust. Our survey was limited to households with telephones, but as 97% of the households in the region have telephones and the demographic characteristics were representative of the population of profile of Adelaide overall, the extent of any bias is likely to be small. There was also a potential bias from survey non-response, although response rates in our sample were higher than comparable biomedical population studies. The strength of this study is the large representative population sample measurements of other known respiratory problems, and lowdrop-out rate in follow-up, especially in people over 45 years who are more likely to be at risk for chronic cough.

In summary, chronic cough is a common problem that is significantly associated with reductions in physical and mental health. Investigation and management of chronic cough is therefore an important medical need. Patients with a history of smoking, obesity, allergy, or use of ACE inhibitors should be questioned regarding cough and active clinical care pursued. Careful attention to symptoms of psychological disturbance, including somatic symptoms, and their management may help identify depression and reduce the burden of this problem. Conversely, specifically inquiring about cough in patients with mental health problems may identify reversible physical and psychological morbidity in this group.

Efficacy and Safety of Indacaterol 150 µg Once-Daily in COPD

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Indacaterol is a novel, once-daily (od) inhaled, long-acting β_2-agonist in development for chronic obstructive pulmonary disease (COPD). This 12-week, double-blind study compared the efficacy, safety, and tolerability of indacaterol to that of placebo in patients with moderate-to-severe COPD. Efficacy variables included 24-h trough FEV_1 (mean of 23 h 10 min and 23 h 45 min post-dose) at Week 12 (primary endpoint) and after Day 1, and the percentage of COPD days with poor control (ie, worsening symptoms). Safety was assessed by adverse events (AEs), mean serum potassium and blood glucose, QTc (Fridericia), and vital signs. Patients were randomized (n=416, mean age 63 years) to receive either indacaterol 150 µg o.d. (n=211) or placebo (n=205) via a single-dose dry-powder inhaler; 87.5% completed the study. Trough FEV_1 (LSM±SEM) at Week 12 was 1.48±0.018 L for indacaterol and 1.35±0.019 L for placebo, a clinically relevant difference of 130±24 mL ($p<0.001$). Trough FEV_1 after one dose was significantly higher with indacaterol than placebo ($p<0.001$). Indacaterol demonstrated significantly higher peak FEV_1 than placebo, both on Day 1 and at Week 12, with indacaterol-placebo differences (LSM±SEM) of 190±28 ($p<0.001$) and 160±28 mL ($p<0.001$), respectively. Standardized AUC measurements for FEV_1 (between 5 min and 4 h, 5 min and 1 h, and 1 and 4 h post-dose) at Week 12 were all significantly greater with indacaterol than placebo ($p<0.001$), with LSM (± SEM) differences of 170±24, 180±24, and 170±24 mL, respectively. Indacaterol significantly reduced the percentage of days of poor control versus placebo by 22.5% ($p<0.001$) and was also associated with significantly reduced use of rescue medication ($p<0.001$). The overall rates of AEs were comparable between the groups (indacaterol 49.3%, placebo 46.8%), with the most common AEs being COPD worsening (indacaterol 8.5%, placebo 12.2%) and cough (indacaterol 6.2%, placebo 7.3%). One patient died in the placebo group. Serum potassium and blood glucose levels did not differ significantly between the two groups, and no patient had QTc >500 ms. [The authors conclude] that Indacaterol 150 µg od provided clinically significant and sustained bronchodilation, reduced rescue medication use, and had a safety and tolerability profile similar to placebo.

This was a 12-week, multi-center, double-blind, placebo-controlled, parallel-group, Phase III study in patients with moderate-to-severe COPD. The study comprised a pre-screening period, a 2-week screening/run-in period, and a 12-week double-blind treatment period. This pre-screening period was followed by a 14-day run-in period (Visits 1 and 2; Day 14 to Day 1), during which the eligibility of patients for the study was assessed and baseline patient diary data were collected. The study was conducted at 103 centers in 3 countries. A total of 788 patients were screened, with 416 randomized to either indacaterol 150 µg (n=211) or placebo (n=205). Overall, 364 patients (87.5%) completed the study, (Figure 1). Both treatment groups were comparable and well matched with respect to baseline demographic and disease characteristics (Table 1); 52.4% of patients were male and 92.5% were Caucasian. The mean duration of COPD was 6.9 years, with diagnosis status ranging from newly diagnosed to 38.7 years of disease history.

Almost all randomized patients (99%) had at least one active medical condition. For the primary endpoint, indacaterol provided a bronchodilator efficacy superior to that of placebo. At all post-baseline time points, indacaterol provided statistically superior FEV_1 to that of placebo ($p<0.001$). Over the 12 weeks of the study, the changes from baseline in both morning and evening PEF were significantly greater for indacaterol 150 µg versus placebo, with LSM±SEM improvements versus placebo of 24.6±3.18 and 23.6±3.11 L/min in morning and evening PEF, respectively (both, $p<0.001$). In addition, patients taking indacaterol 150 µg od required significantly less rescue medication compared with patients on placebo. The overall rate of AEs was comparable between the two treatment groups. Laboratory evaluations showed no clinically relevant differences between the indacaterol 150 µg and placebo groups.

The study results demonstrate a sustained 24-h duration of action of indacaterol on od dosing. The researchers note: is important that this is not accompanied by a loss in efficacy on chronic dosing. It is of note that the use of indacaterol was associated with an overall reduction in rescue medication use, with improvements observed both in daytime and night-time over a 24-h dosing interval. Indacaterol 150 µg od showed effective bronchodilation in patients with moderate-to-severe COPD, with a significantly reduced rescue medication use compared with placebo. Our results suggest that indacaterol may present a useful alternative to the currently available twice-daily LABAs, given the sustained 24-h bronchodilation on od dosing.

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