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August 2016 VOLUME 17, ISSUE 2

Inspire

The Journal of the Association for Respiratory Technology & Physiology

INSIDE THIS ISSUE:

FIRST WORD

VOLUME 17, ISSUE 2. AUGUST 2016

After the 70's colour fest of the previous issue, it is a more austere issue this time— in keeping with the "we are all in it together" philosophy espoused by our ex-chancellor (£50K a lecture anyone?).

I don't feel I can let this issue pass without mentioning the Brexit vote (and statistically it is likely that 52% of this readership voted 'Leave' and 48% 'Remain' so I must consider what I say). The ramifications for Healthcare are unclear—and who can really predict what will happen? I was reminded of the whole EU 'thing' when editing the first article, concerning the European COPD coalition, and again during a C4 News item (based at GOSH) where it appears EU academic funding may be at risk but I don't think there is anyone who can say with certainty what will happen—if anyone knows of such a person then please ask them to write an article and to contact me! All this at the time when London is about to host the European Respiratory Congress, with various associated publicity events which I know many ARTP members will be participating in.

To continue our 40th anniversary year, we have another archive article from Inspire (Breath)—this time a summary of the first year, in the era of Punk Rock (what's that?). I find these back issues fascinating as they are from the years just before I started as a Student 'MPPM Technician' and it is informative looking at the salaries on offer when a job advertisement is listed (£194 a month if I recall, which then decreased temporarily before continuing to soar without fail to match the rises in rail fares… ?!). Remember, all the back issues are being diligently tracked down and scanned to the archive by Keith Butterfield so if you are interested (and an ARTP member, of course) then they can be viewed here. Speaking of ARTP member benefits, we have an article from an ARTP conference grant winner here.

From the past to the future. As usual 'On the Blower' summarises the latest offerings in technology from respiratory and sleep-related companies and there is a fascinating article from Alan Moore on a particularly futuristic device, indeed reminiscent of gadgets seen in 1960s Sci-Fi and now apparently aimed at the consumer market. How small will these devices become? Will we be wearing future lung function (& sleep) monitoring equipment (or swallow them as a pill!!)? Who will interpret all of the data?

Me? I still am amazed when my contactless payment works.

Finally, we are starting a series, *"The Role of Respiratory and Sleep Physiology in the preoperative risk assessment of patients undergoing elective surgery"*, opens with the case for Lung Function testing. Exercise testing will follow in the next issue. Let us know what you think. Until the next time and we hope to meet some of you at ERS London 2016!

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A WORD FROM THE CHAIR

Dr. Karl Sylvester

ARTP Honorary Chair

Another bumper edition of Inspire for your delectation with some outstanding articles for your perusal. I hope you have all been enjoying our wonderful summer. Not too wet, warm on occasions, just how our lungs like it.

So London has the pleasure of hosting the European Respiratory Society conference this year……just as the country decides to leave the EU, although not all the country, but we won't go into that. We're not a political organisation but hopefully the ramifications of the exit won't hit us too hard as scientists and as deliverers of patient services. I'm sure there are many capable public servants beavering in the background to ensure the impact will be minimal!

Along with London hosting the ERS congress, ARTP have had the pleasure of assisting with the organisation of this year's European Lung Foundation's Healthy Lungs for Life event. There are a number of events taking place in the capital region around the ERS congress, the main event taking place in Trafalgar Square on the 2nd/3rd September. A number of ARTP members have kindly volunteered their services to perform spirometry and exhaled nitric oxide on members of the public. Judging from previous events this will be a busy few days but a very worthwhile exercise in raising the profile of respiratory disease and the impact of air pollution on the health of our respiratory system. The ERS congress is always an amazing event to attend. I always come away highly motivated to produce more research having had some insightful, sometimes heated but friendly, discussions with colleagues from around Europe. ARTP are always very well represented with many members presenting their research to over 20,000 delegates, making the ERS the biggest and best respiratory and sleep congress in the world. I would highly recommend members attend. With the reduced rate joint ARTP/ERS membership, attending the congress just got even more economical.

Of course the actual real event to attend just once a year has to be the ARTP conference. As you all now know, the next conference is going to be held in Belfast with some absolutely amazing events planned. Belfast is a lovely city with plenty to keep attendees entertained. We are also extremely lucky to have agreed attendance from Professor Sandra (Sandy) Anderson, who will deliver the PK Morgan Memorial Lecture on the development of the Mannitol Challenge test. We have tried for many years to get Prof Anderson to our conference and at last we have succeeded. As in every year the programme looks packed with presentations and research to whet every appetite, from our early career attendees to our more 'experienced' members.

Finally, I am delighted to announce that ARTP have decided to invite a patron to represent us on a wider scale with a higher public profile. I am also delighted to announce that Professor Greg Whyte has agreed to take on this role. Those of you fortunate enough will remember the excellent presentations Prof Whyte has delivered at past ARTP conferences. Prof Whyte is a past Olympian, having contested the Modern Pentathlon and is well known for training many celebrities to complete their unbelievably tough challenges as part of Sport Relief. Celebrities including Davina McCall, Eddie Izzard, John Bishop and David

Walliams to name a few. One of his main focuses is ensuring people adopt an active lifestyle for better all -round health. As respiratory and sleep physiologists I'm sure that's a campaign we can all get behind.

Enjoy the rest of your summer. Remember that the ARTP Board and Council are here to represent you as healthcare professionals. If there is anything you would like to comment or question please do not hesitate to contact me. I would like any member to feel that they can contact me or any member of the ARTP team without prejudice or judgement. If this is not the case then I would like to hear it. Look forward to hearing from you.

Karl

THE EUROPEAN COPD COALITION

Catherine Hartmann
Secretary General
European COPD Coalition (ECC)

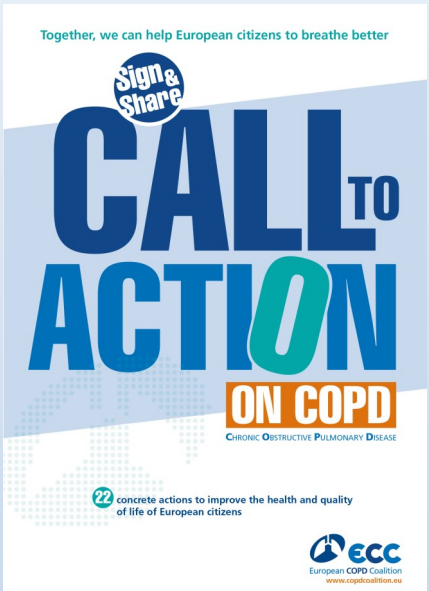
Brussels, Belgium
www.copdcoalition.eu

MEP Catherine Stihler WCD14

The European COPD Coalition is proud to have welcomed ARTP, in May 2016, as the newest member of the association, and the only representative of respiratory technicians/ physiologists.

ECC is a coalition open to everyone interested in fighting COPD: healthcare professionals (all professions), life science companies, patients and patients' representatives, charities, academics and informal care-givers.

ECC was founded in 2011 to raise awareness about COPD and advocate for political uptake of the issue. It is the only Europe-wide organisation aimed solely at these issues.



ECC's main mission is to advocate towards EU decision makers so that they better understand the scope of the disease

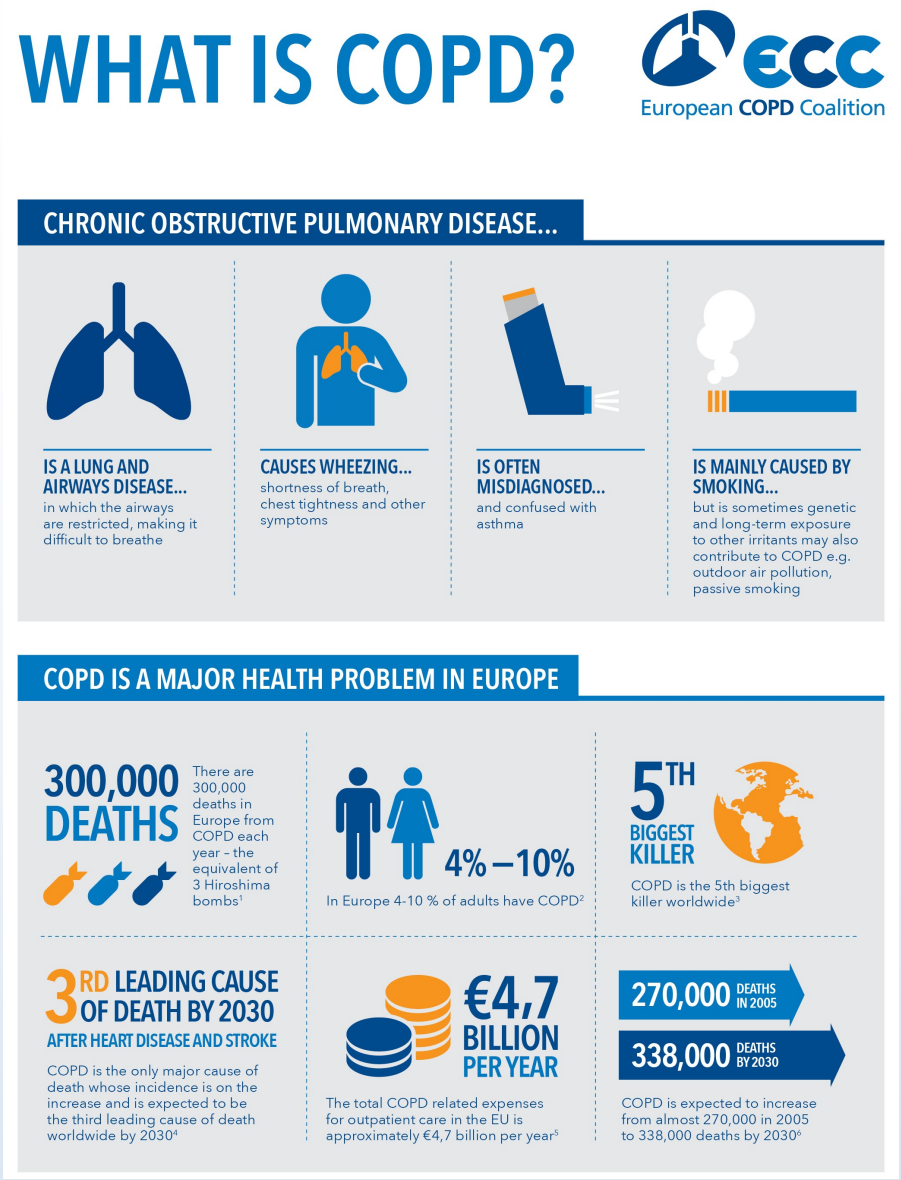
ECC envisages a future where:

* patients living with COPD in Europe are relieved from the burden of the disease through high quality care enabling their lives to be more productive in both workplace and home
* caregivers for those living with COPD are better enabled to support them
* policy makers are committed to the implementation of an EU policy on COPD
* a harmonised research framework across Europe improves our understanding of the disease.

ECC's main mission is to advocate towards EU decision makers to ensure they better understand the scope of COPD and to suggest recommendations for EU policies on disease prevention, earlier diagnosis, better care and research training in COPD for healthcare professionals. We work towards a European framework (or strategy) for COPD.

ECC also aim to share information and raise awareness of the impact on COPD of the two main risk factors: smoking and exposure to poor air quality.

We also actively contribute to debates and reflections on aligned subjects such as non-communicable diseases (generally), access to care, eHealth, protection of health and well-being and the role of healthcare professionals.



To develop these subjects and share our views, we use social media, open letters, articles in the press, public and private meetings, articles on **ECC**'s website (www.copdcoalition.eu) and full page ads in magazines widely read by EU leaders. We raise awareness on COPD through free spirometry events – in which prominent members of ARTP have been instrumental – e.g. World COPD Day campaign. We meet the leaders, representing their countries at EU level, to brief them about COPD and contribute by sending amendments, parliamentary questions, position papers and holding meetings.

We are presently working on the production of a *"COPD Atlas"*, with data on COPD prevalence, incidence, mortality in the 28 EU Member States. This will be published both on-line and in print, to be used as an advocacy tool towards politicians. We have published *"COPD Standards of Care"* and are working towards disseminating the findings of what was a literature review, which produced 12 recommendations to a pan -European survey. **ECC** is continuing to promote its *"Call to Action on COPD"*, which lists 22 concrete measures EU Member States should implement to tackle the disease. We invite you to visit our website for further details and to sign this *Call*.

ECC would love to know more about your recommendations on COPD, your views on how the disease is managed and what you think should be done to improve the situation of both patients living with COPD and their carers (both formal and informal).

ECC strives to keep an on-going conversation with its members, in addition to sharing regular EU-related health news and monitoring developments around COPD. Please do let us know your opinions, recommendations and suggestions!

For more information: ECC 2015 annual report:

http://www.copdcoalition.eu/wp-content/uploads/2016/05/Rapport-annuel-ECC-2015-1.pdf

EU Commissioner for Health, Vytanis Andriukaitis takes a spirometry test in the European Commission headquarter building, the Berlaymont; Brussels, November 2015

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ARTP CONFERENCE GRANT WINNER

THE USE OF LUNG FUNCTION DATA IN NICE PATHWAYS AND GUIDANCE TO ASCERTAIN ELIGIBILITY FOR TREATMENT ON THE NHS. A CALL FOR MORE RESPIRATORY PHYSIOLOGISTS TO BECOME INVOLVED IN THE REVIEW PROCESS.

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Idiopathic Pulmonary Fibrosis (IPF) is a devastating lung disease of unknown cause that has a median survival of 2.5 to 3.5 years from diagnosis.[1] It is a restrictive lung disease involving the parenchyma of the lung where excessive fibrotic tissue is formed in alveolar epithelial cells thought to be driven by an abnormal wound healing response[2]. The progressive nature of the disease ultimately leads to respiratory failure and death and has a prognosis worse than the majority of cancers[3].

In early stages of IPF patients may present with dyspnoea on exertion and preliminary spirometric tests may demonstrate the FVC to be well preserved, with standardised residuals (SR) remaining within normal limits of +/- 1.64. However from the onset of the disease, to presentation in the lung function laboratory for the first time, the patient may have declined from +1.64 to -1.64 SR or additionally, the presence of co-existing emphysema can spuriously preserve lung volumes both eluding to the perception that the lung volume is and has been normal[4]. Spirometry as a single test might be unable to determine causality in these patients therefore it is important to obtain a TL_{CO} measurement to determine whether there is impairment within the lung parenchyma that may be contributing to the patient's symptoms of dyspnoea. Current practice in IPF suggests a repeat of both Spirometry and Gas Transfer measurements within 6 to 12 months can then determine whether the phenotype is the more aggressive or the slower progressing disease[5].

Clinical management of IPF remains unsatisfactory due to the limited availability of effective drug therapies[6]. Currently the only licensed treatment for IPF on the NHS is Pirfenidone, an oral anti-fibrotic that has been shown to reduce disease progression, as measured by the decline in FVC[7]. Adverse drug reactions (ADR's) from Pirfenidone, such as nausea, weight loss and photosensitive rash, show almost a third of patients cannot tolerate the treatment long term[8]. Current guidance by the National Institute of Health and Care Excellence (NICE), provide limited availability of Pirfenidone and Nintedanib (recently commissioned for the treatment of IPF on the NHS in England*) to patients with a Forced Vital Capacity of 50-80% predicted[9, 10]. NICE considered the evidence based on data from CAPACITY[11], the phase three randomised placebo controlled trials of Pirfenidone, to make their decision. However there are some rather remarkable choices made, both in the set-up of these trials and in the interpretation of the trial data, that has had a clear knock-on effect to the prescription of the drug to the IPF patient today. Patients with an FVC of less than 50 % predicted and less than 35 % predicted for TL_{CO} were excluded, most likely because these patients had a higher risk of death and therefore at greater risk of not surviving to the end of the trial. Clinical specialists stated that it is relatively rare for patients with a

* Ed. different rules may apply in Scotland

confirmed IPF diagnosis to have FVC greater than 80 % predicted and that a value less than this is an acceptable threshold for initiating treatment in IPF. This is likely to have set the upper limit for FVC. Nowhere in this eligibility statement has a recommendation been made for acceptable reference values to ascertain a patient's % predicted.

Nintedanib, a tyrosine kinase inhibitor, previously used in the treatment of lung cancer, has also been shown to slow the rate of decline in lung function in patients with IPF[12]. The INPULSIS trials, a phase three randomised placebo controlled trial of Nintedanib vs placebo, included patients with a TL_{CO} between 30-79% predicted and an FVC greater than 50% predicted; there was no upper limit[12].

Whilst NICE current guidance for prescribing Pirfenidone and Nintedanib will mean that a large proportion of patients with IPF will get access to treatment on the NHS, there are a reasonable proportion of patients with a clinical need who will not. For example, the patient with co-existing emphysema whose lung volumes are spuriously preserved whilst the mixed disease state continues to have a dual impact on the parenchyma of the lung. Or consider the patient whose age, height, ethnicity or gender, and combinations of these factors, may lead to an unintentional bias using certain reference values that can deny access to the only treatment that has been proven to slow down the rate of progression.

196 patients with an MDT diagnosis of IPF were enrolled in a cohort study at a tertiary referral centre. Figure 1 demonstrates median survival for the cohort was around 3 years following diagnosis of IPF, which is in keeping with previous findings[1].

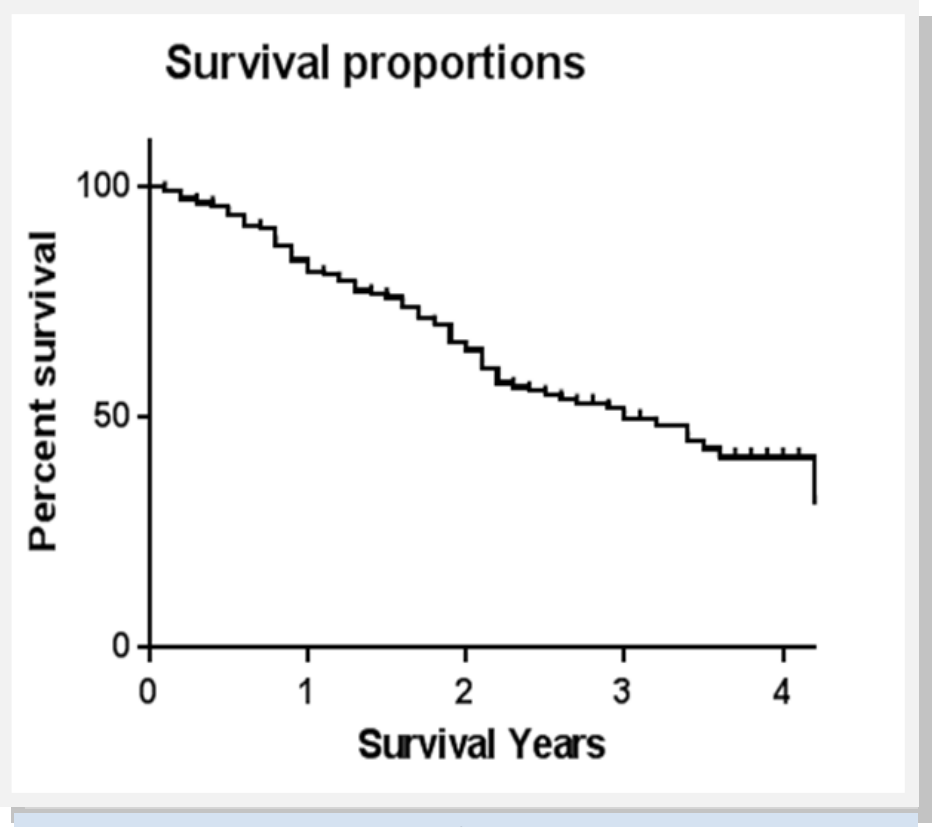

Figure 1. Kaplan Meier Survival Curve of IPF Cohort in years post-diagnosis

% Predicted baseline spirometry was calculated using reference values from the Global Lung Initiative (GLI)[13], SR's were also calculated alongside to make a direct comparison of the numbers of patients who would be eligible for treatment on the NHS with drugs such as Pirfenidone or Nintedanib. Table 1 demonstrates 68 patients will become ineligible if an FVC between -1.65 and -3.5 SR's is used to determine eligibility, compared to the 45 patients who would be ineligible if using the current FVC between 50-80% predicted criteria. However the bias in reference values associated with age, height, ethnicity and gender has now been removed.

	GLI FVC % between 50-80% criteria	GLI FVC between -3.5 to -1.65SR criteria
Patients FVC > Upper Limit (80%)	45	68
Patients FVC within acceptable range (50-80%)	128	115
Patients FVC < Lower Limit (50%)	23	13

Table 1. Numbers eligible for treatment with Pirfenidone/Nintedanib using % predicted FVC and SR's

As IPF is a disease that affects the lung parenchyma, examination of the TL_{CO} in those ineligible because FVC is >80% predicted, will assess whether those ineligible using current prescribing criteria do have further evidence of a clinical need for treatment. Table 2 demonstrates that of the 45 patients who had FVC greater than 80% predicted, 18 (40%) of them had a TL_{CO} below 50% when using reference values from Miller[14] (these reference values were the best predictor of all-cause mortality in a large UK study[15]). If SR's are used then 32 (47%) out of 68 had a TL_{CO} below 50%.

	Patients with FVC > Upper Limit (80%)	Patients with FVC > -1.65SR's
TL_{CO} >50%	27	36
TL_{CO} <50%	18	32

Table 2. Numbers of patients ineligible for treatment based on FVC >80% and SR's >-1.64 predicted with consideration of TL_{CO}

Whether SR's or % predicted FVC is used a reasonable proportion of patients with a clinical need (based on TL_{CO}) will be left without access to treatment on the NHS. This is because FVC cannot account for the confounding effects of emphysema which spuriously preserve the lung volumes. Univariate analysis of the cohort determined TL_{CO} to be the best predictor of mortality (C=0.752) followed by FVC (C=0.677).

In this cohort, 18 out of 196 patients (9%) are not gaining access to treatment. If this is extrapolated up to the approximate 5000 new diagnoses of IPF made in the UK each year, it could present an equity issue that needs to be addressed.

The purpose of a review of medical technologies by an independent body ensures that, from an economic perspective, NHS resources are limited to

those with the greatest need and likelihood to benefit from the intervention.

From this analysis it could be argued that current guidance is inequitable. Significant improvements could be made by input from respiratory physiology professionals, not just with the design and set-up of trials that use lung function data to determine drug efficacy, disease severity and evidence of progression, but also with scrutinising the data in the technological appraisals held by NICE.

Experts are invited to give opinions at NICE technical appraisals and as the declared professional guardians of respiratory physiological measurements, the ARTP and its members should seek to become more involved.

As previously stated, the outcomes for IPF are worse than many cancers and the knowledge and expertise from respiratory physiologists and the ARTP could contribute to improving outcomes for these patients.

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Tom Kelly
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ON THE BLOWER

Welcome to the latest update from On The Blower. Many thanks to those companies who submitted items for inclusion – we hope you all find them useful and informative.

Manufacturers Survey Revamp

There has been a feeling for some time that the manufacturers survey was due a bit of an upgrade. This annual competition is taken very seriously by all concerned, the companies involved welcome the feedback from the membership and the annual awards are one of the highlights at Conference. Matt and myself had the pleasure to host a meeting of our corporate colleagues recently, where we had the opportunity to get their input into how best to develop the survey.

The revised survey is not quite finished, but we can reveal a couple of things at this point. Firstly, the survey will be online, and secondly it will be sent to the full membership rather than just the heads of department. Going online was a fairly obvious change, but we were a little surprised by how keen the companies are that the responses should come from the full membership, and we are happy to oblige in this instance.

Credit for the nuts and bolts of the new survey goes squarely to Matt Rutter, who has taken snippets of suggestions, and worked some Microsoft Magic to produce a simple yet comprehensive spreadsheet-based application. I think everyone will be impressed with the new version, and of course we are asking a response from every single member. The corporate colleagues did mention something about an incentive during the meeting, so we might be able to toss an attractive carrot or two into the mix, to get as big a response as possible.

Full details of the new survey will be released at the ARTP National Strategy Day in October. **TK**

New NICE Asthma Guidelines

As part of its development of new guidelines for the diagnosis of asthma, NICE recently launched a pilot project to study the potential for shifting asthma diagnosis into the primary care setting. ARTP were invited, along with other stakeholders, to attend a meeting at NICE headquarters where an update on the status of the project was presented.

The pilot began at the end of May and runs for 6 months. It involves primary care practices across the UK implementing the new guidelines for the diagnosis of asthma, and includes both large and small practices, with a wide geographical spread across the country. The guidelines require both spirometry and FE_{NO} testing to confirm the diagnosis. Outcomes will be reported at a second meeting in December, and ARTP has

again been invited to attend.

It is easy to appreciate the thinking behind the drive to primary care – in theory there is easier patient access to services, and these services can be delivered at a lower cost in primary rather than secondary or tertiary care. Of course the decision to leave the EU will sort out the NHS finances pretty quickly, as soon as the millions promised by the politicians are diverted to the NHS. But just on the off chance that the politicians were telling porkies – no that can't be true I hear you say – what does it mean for patients with asthma waiting for a diagnosis?

One aspect of the pilot study is more than a little worrying – those performing spirometry and FE_{NO} testing do not require training or accreditation, either in performing the tests or interpreting the results. If staff look for training, NICE will point them in the direction of ARTP, which is a positive for everybody. [As an aside, NICE say it is difficult to access ARTP spirometry courses, so those centres delivering training might look at least at the possibility of increasing training places should the demand grow out of this process]. NICE will even help with funding of training.

But, and it is a very big but, staff performing these tests DO NOT NEED TO BE TRAINED AND/OR ACCREDITED to take part in the pilot. This is a very strange message to come from NICE. When we asked the NICE representatives about this, we were told that it is 'part of the pilot', which does not really clarify the picture.

ARTP concerns about this aspect of the pilot were raised, but were not answered in any satisfactory manner. When asked about quality control etc., we were told it is 'non-quality controlled spirometry', and when asked for a definition from NICE of 'non-quality controlled spirometry', we were informed it is 'spirometry that has no quality control'! Something of a circular argument……

ARTP's strong objection to this situation was fully supported by the other stakeholders present: medical, nursing, and the support organisations.

While we applaud any initiative that will improve patient services, we should all be concerned about this type of initiative, where once again the value of our members and our profession is undermined and undervalued. We should all keep a very close eye on patient referrals from primary care that have spirometry results attached, examine the poor quality of the primary care testing and let ARTP watchdog know. The more evidence of poor quality testing we can collect, the stronger our voice can be in the future*.

As for FE_{NO} – no, we won't go there today……**TK**

*** We are reliably informed that NHS England are about to adopt ARTP Spirometry Training as the recognised training programme for primary care staff. The joint NHSE Spirometry Group have recently agreed the process which includes ARTP Certification for quality assured diagnosis. GPs may still wish to use "office spirometry", but they are unlikely to be paid for this in the QoF.**

Clicking on the company name will hyperlink to their website

Tom Kelly
Matt Rutter
Alan Moore

ON THE BLOWER

From around the companies

VITALOGRAPH CELEBRATE AT ERS 2016

2016 sees the European Respiratory Society (ERS) celebrating its 26th anniversary. The ERS was born in London in 1990 out of the merger of the Societas Europaea Physiologiae Clinicae Respoiratoriae (SEPCR) and the European Society of Pneumology (SEP).

Having exhibited at every ERS Congress since its inception Vitalograph are delighted to exhibit at this year's Congress as it returns to London for the first time since 1990. During the Congress the celebratory mood will continue as we launch our book '*The Vitalograph Story*', featuring a forward by Mark Levy and Martin Miller. The book charts our history as pioneering developers and manufacturers of cardio-respiratory devices over a period of more than half a century. To enter a draw to win a copy of the book simply e-mail draw@vitalograph.co.uk. . **TK**

DREAMMAPPER. Philips has launched their *DreamMapper* mobile app and website in the UK. *DreamMapper* is a patient engagement platform that connects to a Philips CPAP device and allows patients to view high level information about their therapy compliance, set reminders, give access to coaching tools based on proven motivational enhancement therapy as well as view videos that may reduce troubleshooting calls to their sleep clinic. *DreamMapper* can also upload therapy data to the patient's record in *EncoreAnywhere*. *DreamMapper* completes Philips' patient-inspired *Dream Family* solution, comprising of the *DreamStation* PAP and innovative *DreamWear* minimal contact nasal mask. www.philips.co.uk/dreammapper.

WISP PAEDIATRIC. Inspired by the *Wisp* nasal mask, Philips has launched a new mask designed specifically for paediatrics. *Wisp Paediatric* has a child-friendly giraffe pattern with modified cushion curvature to fit the sizing and bone structure of the smallest patients. To simplify ordering, each mask is supplied with three cushion sizes. There is an accompanying 'Jacky the Giraffe' storybook for parents to read to their child as well as an animated cartoon on YouTube. **TK**

Due to the substantial growth in business, S-Med recently moved to new offices in Redditch and have new staff on-board so they can continue to provide the best service and support available.

SOMNO HD

The new SOMNO HD has additional features to those mentioned in the April edition of *Inspire* including a new function where on-card data can be merged with online data if the signal is lost when the patient moves out of Wireless range, providing seamless analysis data if required. This function is also now compatible with existing SOMNOscreen systems, requires DOMINO version 2.8.0 and is a free upgrade to all customers.

A new 32-Channel EEG Head box is now available (25 x EEG/EOG- 6 x EMG- 1 x ECG) with sampling rates up to 4kHz. This headbox is 30% smaller and lighter than the SOMNOscreen EEG32 headbox.

The SOMNO HD is compatible with the SOMNOmedics Android App which offers a unique method of sending data to the lab from the patient's home so that signal integrity can be verified throughout the night. The SOMNO HD incorporates the highest quality amplifiers ensuring extremely low signal-to-noise ratio for excellent signal quality. The SOMNO HD utilises the latest in technology for real-time Wireless Sleep Diagnostics in both the Sleep laboratory or out in the community. Earlier this year S-Med equipped the largest Sleep Lab installation in the UK with SOMNO HD systems.

Consumables. We have a new range of disposable items, including a nasal cannula, disposable RIP Effort belts and disposable SpO2 sensors compatible with SOMNO HD, SOMNOtouch & SOMNOscreen.

SOMNOtouch

SOMNOmedics recently added a new "Multi Sensor" which is able to record 2 x PLM's, a 3-lead ECG and Abdominal Effort which uses only 1 input port on the SOMNOtouch. This allows an AASM compatible PSG head box to be used making the SOMNOtouch a powerful system whilst maintaining its status as the smallest multi-channel Cardio-respiratory screener available.

The SOMNOtouch RESP is also compatible with the SOMNOmedics Android App utilizing the built in Bluetooth hardware. Data can now be transmitted via Tablet or Mobile to an email address for non-assisted home sleep studies to be monitored, this is a particularly useful function for Paediatric Sleep Studies to ensure good quality signals are recorded and to avoid repeated studies on difficult patients.

DOMINO

Further updates to the powerful sleep analysis software DOMINO version 2.8.0 will provide additional features such as a new "License Server" option. The DOMINO software is installed on to the Hospitals file server rather than individual computers so making every computer in the hospital a DOMINO workstation. In conjunction with the User Manager, an Administrator can assign user rights to specific parts of the software to prevent, for example, settings being changed by unauthorised users. The new DOMINO software can now be used to analyse recording from the SOMNO HD, SOMNOscreen and SOMNOtouch Systems.

PIMS

The Patient and Inventory Management System has had a facelift. The flow of entering data has been streamlined to allow data to be entered all on one page depending on the type of visit the patient is attending for. S-Med continue to work with Resmed to ensure the smooth transfer of machine allocation information directly in to AirView. This saves on the duplication of data entry and prevents data entry errors. S-Med have also implemented HL7 to allow patient demographic data to be imported from the Hospital system in to PIMS simply by entering the patient's hospital or NHS number. **TK**

Clicking on the company name will hyperlink to their website

RemServe Medical is an innovative company drawing on over 30 years of experience both in the NHS and through medical devices companies such as Smith and Nephew, Smiths Industries, Kimal Scientific, and latterly ResMed UK LTD selling to the NHS sector.
Specialising in Respiratory devices and Critical Care products. RemServe Medical uses a select network of companies to offer information, advice and a product compatibility search to match the needs and requirements of the clinician and departments.
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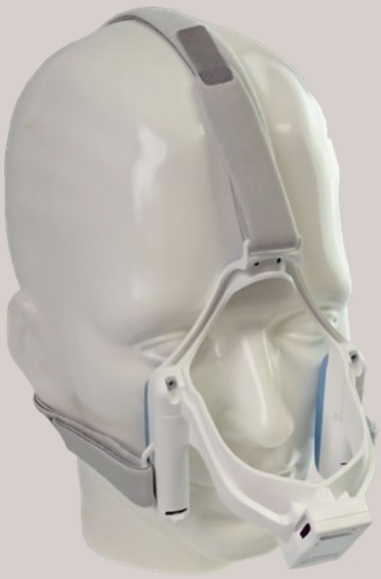
	Email:	marketing@remservemedical.com
	Website:	www.remservemedical.com
	Twitter:	@remservemedical

A new single-user Sleep Apnoea diagnostic device, *BresoDx*®, is being launched at the ERS International Congress in London. This CE marked diagnostic has been shown to have a 94-96% correlation with the current gold standard PSG in several clinical trials. It is manufactured by BresoTec Inc (Canada) and will be distributed exclusively in the UK by Intus Healthcare.

PSG studies can be uncomfortable, inconvenient and expensive which are the three areas that the *BresoDx*® addresses. Its light weight frame is worn over the face



without any tube or wire connections and monitors breathing patterns primarily through patented audio and movement sensors.
The *BresoDx*® will provide sleep clinics with a quick, patient-friendly method of diagnosing OSA with reduced costs and manpower, while still providing accuracy closely comparable to a PSG study.

For more information visit https://bresotec.com or BresoTec's stand at the ERS in September. Alternatively, contact www.IntusHealthcare.eu.

TK

Loewenstein Medical

Loewenstein Medical UK Ltd. is a UK subsidiary of Loewenstein Group and represents Heinen + Loewenstein products.

Loewenstein Medical UK offers a full range of anaesthesia workstations, adult, paediatric and neonatal ventilators, baby warming devices and resuscitation tables as well as sleep diagnostics and therapy devices, including a wide range masks for the UK market.

Loewenstein Group acquired Loewenstein Medical Technology GmbH (formerly Weinmann GmbH) in 2013, one of the 3 largest manufacturers of sleep therapy devices and masks in the world. We have a well-established sales infrastructure and a company strategy which constantly aims to benefit the user. In the future we will continue to produce and sell high-quality state-of-the-art medical devices and systems.

In the next month we will be moving from Chessington to new and larger offices in Bracknell where our service and clinical sales team will be based.

For more information please visit our website: www.loewensteinmedical.co.uk. **TK**

ResMed is committed to providing continuing education for healthcare professionals, and to facilitate this, we have introduced the *'ResMed Academy'*, which is a series of workshops available to healthcare professionals that identify the most recent advances in the field of Sleep Disordered Breathing and Ventilation.

From methods for increasing compliance to advanced ventilation techniques, our educational courses give clinicians everything they need to better manage patients who suffer from SDB and related disorders.

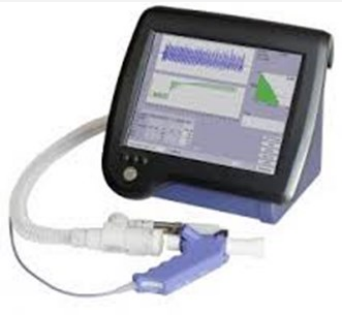
Also available is ResMed Academy Online providing e-learning, product tutorials and videos to support learning.

TK

Clicking on the company name will hyperlink to their website

intermedical

NDD – The *EasyOne PC* and *EasyOne ProLab* has a new software update being released in August. Apart from minor bug fixes and a few small feature changes, the new version will now feature Z-scores. As always, the software update is free of charge.



MIR – The *Spirolab* is now compatible with MIR's *WinspiroPRO* PC software. This allows for data back-up, export of data via various communication protocols, live spirometry and Bronchial challenge testing, data trending and many more features. The *Spirolab* also now has the GLI predicted values and well as Z-scores.

The *Braebon Medibyte* supplied by Intermedical is now able to offer polysomnography. This option is not designed to replace a full sleep lab, but enables departments undertaking domiciliary testing the option of recording a channel each of EEG, EOG and EMG along with automated and manual sleep staging.

Medibyte and *Medibyte Junior* continue as robust small workhorse devices for diagnosis of OSA, snoring, PLMS and bruxism. **TK**

In July 2015 DeVilbiss Healthcare was acquired by Drive Medical. Drive Medical has a significant business in the UK in the pressure area care, beds, bathroom care, mobility and daily living aid markets.

Earlier this year we announced the planned integration of the Drive owned companies. By the beginning of 2017 the integration will be fully complete and will be operating as Drive DeVilbiss Healthcare.

The additional resource and investment will allow the newly formed Drive DeVilbiss to increase our presence and focus within our specialities in the UK market.

NEXT STEPS

DeVilbiss Healthcare customers will see some exciting changes over the coming months; starting with the new branding, the introduction of a larger dedicated sales and support team, and the transition of the respiratory portfolio and resource onto the new website www.drivedevilbiss.co.uk

For the moment, there will be no change to customer ordering processes and invoices for DeVilbiss will remain separate at this time. We will communicate more about the changes that affect DeVilbiss customers in the near future.

If you have any questions regarding the company integration please forward to questions@drivedevilbiss.co.uk

TK

MGC DIAGNOSTICS CORPORATION
350 OAK GROVE PARKWAY
ST. PAUL, MINNESOTA USA, 55127-8599

MGC DIAGNOSTICS®

To all ARTP Members,

About 24 months ago, MGC Diagnostics acquired Medisoft, a Belgium-based cardiorespiratory diagnostic medical device company. Since that time, we have been working to improve the service, support and overall product line for Medisoft. MGC Diagnostics has a long history of success in the UK, working with Nick Chapman and the team at Medical Graphics UK. For the past several years, our Medisoft product line has been sold by Vitalograph. Since our acquisition of Medisoft, we have evaluated every distributor and in most countries were able to consolidate distributors down to one, which carry both MGC Diagnostics and Medisoft product lines. Our main goal is to improve service and support for our customers.

At the end of 2015, we notified and formalized an agreement with Vitalograph in which we would begin to transition the Medisoft product line away from them. That agreement allows for Vitalograph to continue to sell and service customers until Oct 31st 2016. Beginning June 2016, Medisoft will now sell their product line directly in the UK through our UK Sales Channel led by Kevin Hogben. All service will now be provided by the authorized distributor for all MGC Diagnostics products, Medical Graphics UK.

We want to thank Vitalograph and their entire team for all of the support they have given to the market for the Medisoft product line. Please feel free to call me, Kevin Hogben or Fred Gavage if you have questions or concerns.

Sincerely,

Matt Margolies

President
MGC DIAGNOSTICS
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Medisoft is a long established provider of flexible solutions covering a wide range of applications for cardiorespiratory departments. Recently Medisoft decided to change their distribution strategy by selling directly with local support from Medical Graphics UK ltd providing service and administration services.

- Sales contact Kevin Hogben on 07760172507
- Service contact MGUK on 01452 617150

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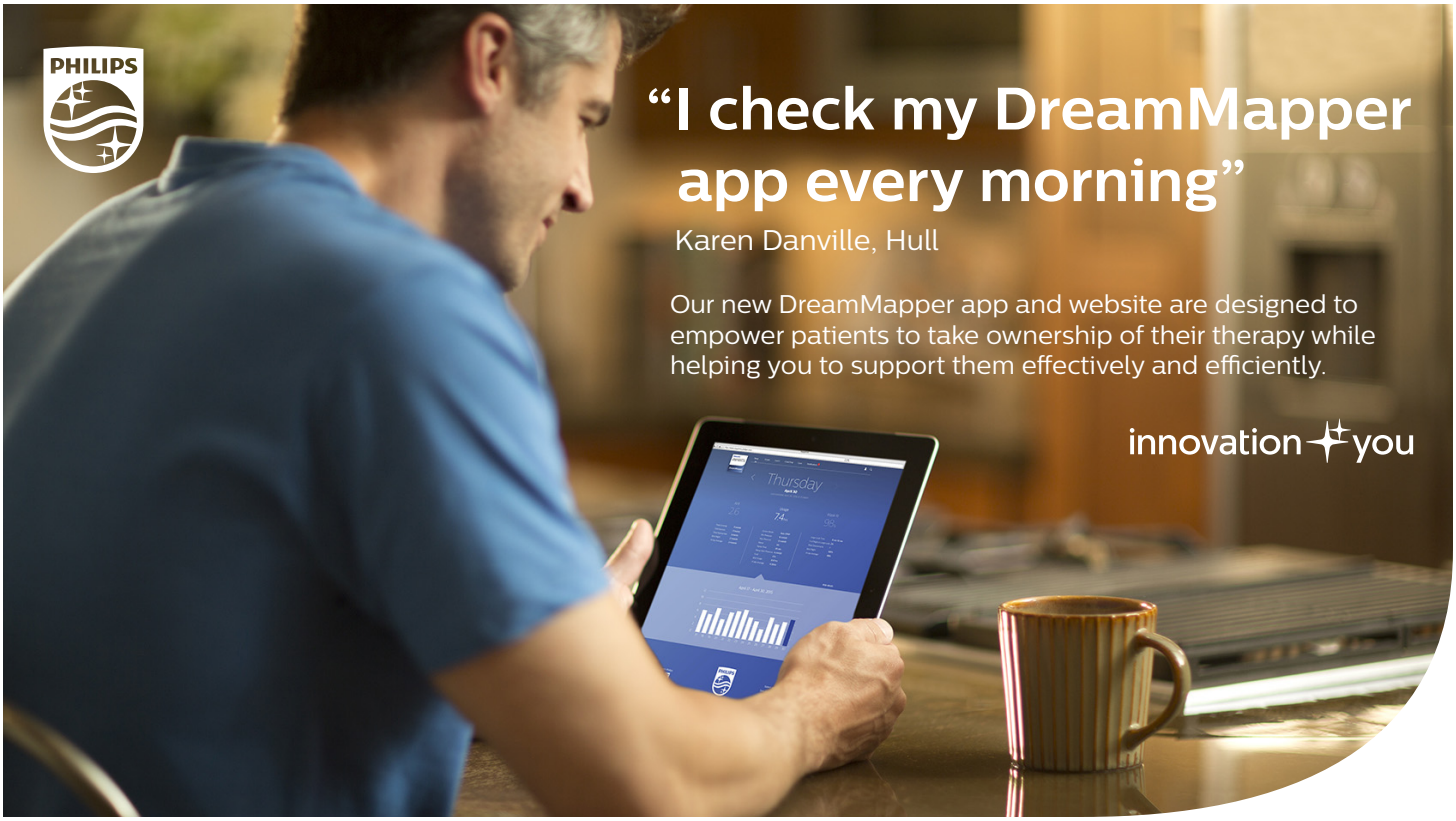

DreamMapper – patient engagement software

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And finally, a very big thank you to Alan for the final piece…

'I'm not a scientist or a physicist Mr Spock ……'

For those amongst you who have followed the famous sayings from the various Star Trek series, this is a quotation from Dr Leonard McCoy, 'Bones', in the episode Metamorphosis, first aired in 1967. Those of you who have watched the odd episode over various series will be familiar with the hand held medical Tricorder which he placed in proximity to a patient and vital signs, etc. were immediately available to him.

There were also the scanning beds which seemed to be able to detect and cure almost anything.

Well, back in 1967 this was, of course, pure science fiction. Funnily enough, there are now a number of these devices which are in existence. For example:

- The food replicator used by Captain Jean Luc Picard used to make his Earl Grey tea. We now have 3D printers like fab@home which can't make tea but which can print food.
- The universal translator which decoded what aliens said in real time. Still fiction? Actually, no! There is an app called Voice translator from Talir Apps which understands and translates 71 languages (though not Klingon at this time).
- Tablet computers and mobile phones with their apps which we all marvelled at 50 odd years ago but which now are everyday items.
- Whole body non-contact scanners. We now have CT and MRI

So, where is this sci-fi waffle going? Has Manufacturers Liaison gone extra terrestrial? Some may well argue that we've been off the planet for years but that's another issue. We are beginning to see almost another 'industrial' revolution in the way that technology is advancing and particularly medical applications. Those ARTP members who attended the joint meeting of IARS and ARTP in Dublin in October 2011 listened to Dr Brian Kent outline the assessment of sleep-disordered breathing using a non-contact bio-motion sensor using a system called SleepMinder(TM). This was the result of research and development at a spin out from University College, Dublin called Biancamed which was founded in 2003 to commercialise research undertaken in the School of Electrical, Electronic and Mechanical Engineering.

Resmed purchased Biancamed in July 2011, reputedly for several million Euros, having previously contributed to the initial and second rounds of venture capital funding. Now, it is not unknown for major players in any field to buy up new technologies and bury them; petroleum companies do this routinely. Resmed, however, did no such thing. As evidence of this one can find papers published in peer reviewed journals based on measurements using the system[1]. GE also had an interest in similar technology at this time but they concentrated on using the application for home security system purposes.

So, when is this technology going to hit a sleep service near you? Well, its not for the time being. However, you are, no doubt, going to see it and hear of it from some of your prospective patients because it has been launched in a commercial device being sold through John Lewis and Amazon called the Resmed S+ and yours for only £129.99. Have Resmed lost their senses? Well, actually, no they haven't.

Let me stress that, at this time, the Resmed S+ is not a medical diagnostic device. The non-contact bio-motion sensor technology from the Biancamed venture has metamorphosised into an interesting device which, according to Resmed, *"is a consumer sleep tracking device designed to enhance the sleep experience. It is designed to help analyse and improve sleep from the very first night of use. If sleep is not improving, it is possible that the cause is a sleep disorder and a healthcare professional should be consulted for advice".*

The device measures movements using ultra low power radio waves (less than 1/10 of Bluetooth®). The basic principle is similar to the echo location system used by bats to hunt insects. It transmits a short pulse of radio waves at 10.5 GHz and then listens for the echo of the pulse. As you move, the phase of the echo changes and is converted into a signal that reflects your movement. Apparently clothing and blankets are almost transparent to radio waves at the frequencies used. The echo signal is mostly generated by reflection from your body – as far as radio waves are concerned, apparently we're all large watery objects.

The technology's ability to accurately measure sleep patterns has been published in 10 scientific papers, and has been tested and proven against expert manually scored patient sleep data gathered in several accredited sleep laboratories.

So, if the technology is so good, why has it been put into a consumer lifestyle device rather than a serious diagnostic device? Well, there is no answer to that question at this stage. Maybe Resmed's marketers saw a niche market to exploit. Consumer lifestyle devices are huge sellers and low margin, high volume sales makes nice reading for the profit/loss account usually. No doubt that the diagnostic capabilities of the technology are not many months or years away from being demonstrated in your laboratory.

What this device is though is a sign of what is to come. It is not the only contactless technology around in the sleep world and some very interesting developments using sonic techniques are just around the corner.

As Dr McCoy famously never said in any of the series (it was in the song Star Trekkin'), '**It's life Jim, but not as we know it**'.

AM

References

1. Zaffaroni A, Kent B, O'Hare E, Heneghan C, Boyle P, O'Connell G, Pallin M, de Chazal P, McNicholas W: Assessment of sleep-disordered breathing using a non-contact bio-motion sensor

Journal of Sleep Research, Volume 22, Issue 2, pages 231–236, April 2013

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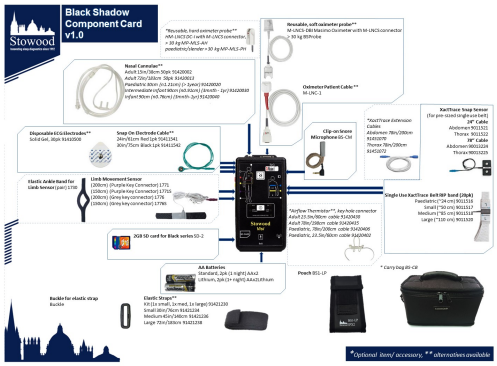

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HEALTHY **LUNGS** FOR LIFE

ERS ELF

TIME FOR THE CAPITAL TO TAKE A DEEP BREATH

Healthy Lungs for Life campaign puts spotlight on lung health and air quality during the ERS London 2016

As London gets ready to host the largest respiratory conference in the world, the European Lung Foundation (ELF) is preparing a clean sweep of publicity aimed at emphasising the importance of clean air on the health of our lungs. They will be focussing on the importance of smoke and pollution free air at home, at work and during exercise.

There are several excellent publicity events planned for the public, commencing with 3 giant 'clean air bubbles' floating in the London sky above Trafalgar square. Visitors to the square will be able to see real -time updates on local air pollution levels and learn about improving the quality of air they breathe.

There is going to be spirometry available for members of the public. You may well have previously seen a call on the forum for physiologists to help out at this event so you may see some ARTP members doing what they do best - performing high quality spirometry.

These spirometry events will be available at different locations throughout the conference. See the list opposite.

- **Trafalgar Square** Friday & Saturday 2 & 3 September, 10:00 – 18:00
- **Waltham Forest Bus Station** Sunday 4 September, 13:00 – 17:00
- **Canary Wharf, Canada Square Park** Tuesday 6 September, 07:30 – 19:30
- **Battlebridge Basin, Camden (near to King's Cross)** Wednesday 7 September, 08:00 – 20:00
- **OnBlackheath Festival, Lewisham** Saturday & Sunday 10 & 11 September
- **Islington** Thursday 22 September

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HEALTHY LUNGS FOR LIFE
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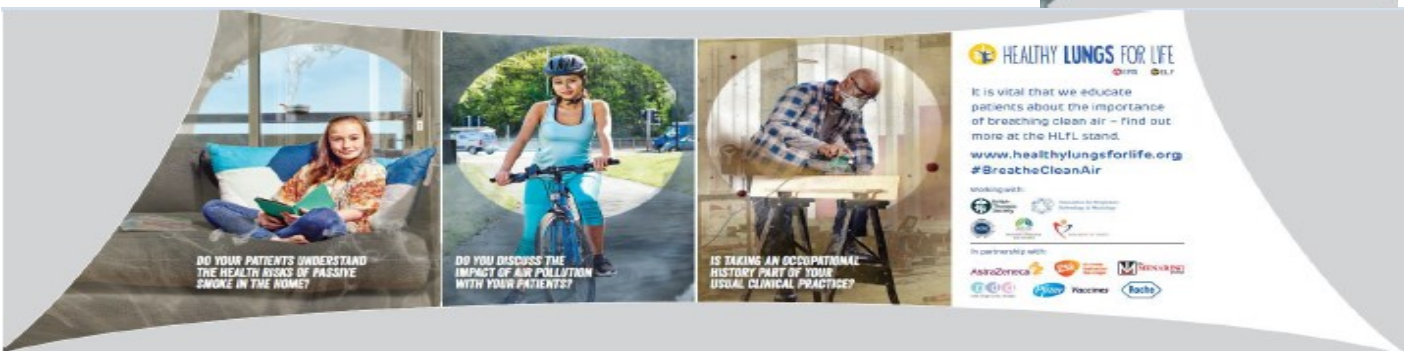
There is a 'Meet the expert' session being held on the 5th September by the Royal College of Physicians (RCP). The aim of this will be to invite the public to ask questions about lung health and air quality to a range of high profile experts. This will take place between 6-8pm.

There will be a range of posters placed at the DLR stops and on tube panels, which will be advertising the conference and making the public aware of the Trafalgar square events. Other posters will be placed on the way to the Excel and through the congress, which will be aimed at professionals attending the conference. These will have professional messages.

The ELF has the aim of bringing together patients and public with respiratory professionals to positively influence lung health. These events are an excellent way to do this. If you are fortunate enough to be attending the ERS congress or are in the area, please pop along and show your support.



The Role of Respiratory and Sleep Physiology in the preoperative risk assessment of patients undergoing elective surgery

Adrian H Kendrick, Department of Respiratory Medicine, University Hospitals, Bristol, & Department of Applied Science, University of the West of England, Bristol

Part I: Lung function Tests

Summary

This review has outlined the case for the role of both the lung function and sleep services in the assessment of patients undergoing elective surgery.

In terms of resting lung function, the FEV_1 and the DLco are the two primary indices used in the assessment of patients for lung resection. Whilst there are other indices, including arterial blood gases, non-invasive blood gases and measurements of static lung volumes, the evidence for these indices is, in most cases, not supportive of their routine use. However, this should not preclude from being used in some groups of patients. For instance, the measurement of static lung volumes may be appropriate in patients who have significant obesity, and blood gas measures may be useful in patients within known airflow obstruction.

In terms of exercise testing, the test of stair climbing, shuttle walk test, 6-minute walk test and CPET have all been assessed as part of the overall assessment of patients, with the simpler tests generally being more available away from specialist centres. In lung resection, there is strong evidence of the role of exercise testing using the different modalities. New evidence from other surgical procedures, away from lung resection perhaps need further investigation , but the available evidence points to the use of a number of indices, some of which might be specific to a particular organ.

Finally, sleep constitutes about one-third of our day, and the prevalence of obesity leading in many to obstructive sleep apnoea is an important component of the pre-operative assessment. This should not be overlooked as there is evidence that sleep apnoea may present some difficulties in the post-operative phase.

In conclusion, the role of respiratory and sleep departments in the pre-operative assessment of patients is here to stay, and will only increase in the demands placed upon these services. There will be challenges, which will include the assessment of an increasingly older population who wish to have surgery and this should be the case. None of the test we undertake should be seen as preventing patients from having surgery, more they should be seen as advising the patient about the likely risks of having the surgery and possibly to explore appropriate alternatives.

Background

Lung function testing as we know it today stems from the original work of Hutchinson (1846), who very carefully and cleverly assessed the dynamic function of the lungs in a wide range of normal healthy subjects as well as diseased patients. Hutchinson's Vital Capacity, coupled with Tiffeneau and Pinelli's FEV_1 (1947) has, for many years formed the backbone of the simple assessments of lung function as applied to pre-operative assessments. Added to this, and following on from the original work of Krogh (1914) and subsequently Ogilvie *et al* (1957) we have the measurement of CO Diffusion, hereafter referred to as DL_{CO}. Coupled with this, we have always had an interest in exercise capacity and its assessment from a simple stair walk test (Sounders, 1961), 6 minute walk test (Butland *et al*, 1982), through to the complex cardiopulmonary exercise test (CPET). To add to this already complex range of assessment tools, we have to add our understanding of the impact of sleep breathing disorders (American Academy of Sleep Medicine, 2014), principally obstructive sleep apnoea on the risks that a patient may therefore face when requiring surgery.

Over the last 170 years, therefore, we have come a long way and one topic that concerns us is how we assess sensibly and cost effectively a patients' suitability for surgery. We need to be able to advise the patient and their family of the risks of having a procedure and the possible outcomes, which may be generally assessed at 30 days and 90 days post-surgery. *Can we reliably predict this*?

In assessing potential risks, we can pre-operatively advise the anaesthesiologists and the surgeons what the risks are and then can decide, with advisement from the patient, how best to manage each patient before, during and after surgery. If we know from evidence-based practice, how to predict their likely 30 day and 90 day mortality, l*et al*one their survivability to one year, we can advise, within limitations, each patient and their family members. It is also important to be aware of the likelihood of occurrence of post-operative complications, and how these may or may not have an adverse effect on the survivability of patients.

The purpose of this review is to outline why respiratory physiology and respiratory-sleep physiology are an absolutely essential part of this pre-operative assessment. Along the way of answering the many questions that arise, this review will provide some historical aspects to the development of the testing and assessments used, as well as putting into context why we make the measurements, what a potential meaning of an FEV_1 less than 0.80 litres means for risk management, to demystify the illusion that specific numbers are the be all and end all of risk assessment and finally to try and bring into context why the guidelines become more interesting with an ageing population.

Definitions

There is no standardized definition of pre-anaesthesia evaluation. One definition defines pre-anaesthesia evaluation as "*the process of clinical assessment that precedes the delivery of anaesthesia care for surgery and for nonsurgical procedures*" (American Society of Anesthesiologists, 2012). This is not to be confused with "perioperative", which refers to the care surrounding operations and procedures. The pre-anaesthetic evaluation is clearly the responsibility of the anaesthesiologist.

Pre-anaesthesia evaluation requires the bringing together of information from many sources, including

the patient's own medical records, face-to-face interview, physical examination, and the findings from a range of medical tests and evaluations. As part of the pre-anaesthesia evaluation process, the anaesthesiologist may choose to consult with other healthcare professionals to obtain information or services that are relevant to perioperative anaesthetic care. Often a Multidisciplinary Team (MDT) approach is used to discuss the patients, both in general and more specific terms relating to the proposed surgery.

Preoperative tests, as part of the pre-anaesthesia evaluation, may be indicated for a number of reasons, including -

- Discovery or identification of a disease or disorder that may affect perioperative anaesthetic care
- Confirmation or re-assessment of an already known disease, disorder, medical or alternative therapy that may affect perioperative anaesthetic care
- Formulation of plans and alternatives for perioperative anaesthetic care.

Systematic Reviews

Over the last 20 years, a number of systematic reviews, not all of which have included lung function testing or sleep assessments as part of pre-operative assessments, have been published. The timeline for these updates is outlined below.

1997: A Health Technology Assessment (HTA) review assessed the evidence for preoperatively testing of healthy subjects who had been admitted for elective surgery (Munro, Booth, Nicholl, 1997). This review did not include lung function testing or sleep assessments, but did include the ECG and chest radiographs. There was a strong suggestion that even if some abnormality in these tests were to be found, management of the patient was probably not going to change. This, perhaps, slightly odd conclusion was similar to two earlier reviews from Sweden (Swedish Council for Technology Assessment in Health Care, 1991) and by the Basque country (Osteba, 1995).

2002: The American Society of Anaesthesiologists (ASA) published a practice advisory[a] with a similar conclusion to the 1997 HTA document (American Society of Anesthesiologists, 2002a). In their follow-up, they changed their stance slightly, with the use of selective preoperative testing possibly being helpful where the tests have been selected on the indications of history and examination (American Society of Anesthesiologists, 2002b).

2003: The National Collaborating Centre for Acute Care published a document centred on - Evidence, Methods & Guidance in 2003. In this document, the section on Lung Function Tests stated that *"pulmonary function tests should not be considered as generic preoperative testing"*. Instead the document concluded that *"any pulmonary function tests requested should be at the discretion of the surgeon or anaesthetist"*. The tests reviewed were PEF, FEV_1 and FVC. There were too few papers to draw any real conclusions and there was no data available on the use of PEF. This review covered ASA Grades 1 – 3, where Grade 1 is a normal healthy patient, Grade 2 is a patient with mild systemic disease and Grade 3 is a patient with severe systemic disease (Dripps, 1963).

The document also reviewed the issue of assessing arterial blood gases, and with the exception of

[a] A Practice Advisory is a term used when statements being made are not supported by the scientific literature to the same degree as documents referred to as "standards" or "guidelines" due to the lack of sufficient numbers of adequate controlled studies

"patients who have a severe systemic disease that is constant threat to life" (ASA Grade 4), arterial blood gases were not recommended. The use of pulse oximetry was preferred as being safer, and much more pleasant for the patient.

2012: A further HTA was undertaken which primarily focused on ASA Grades 1 and 2, which are normal subjects or patients will mild disease issues, but added issues of comorbidities (Czoski-Murray, et al, 2012). In terms of the lung function tests, the reviewed tests were spirometry, respiratory mechanics, transfer function, exercise testing and blood gas analysis. The review identified a single study by Roukema et al (1988) which related the benefits of lung function testing. This study showed, in a pseudo-RCT form, that only 4.8% of patient in ASA Grades 1 and 2 had an abnormal result, which did not lead to a change in management.

In terms of reported adverse events from spirometry, 6 case reports were identified with the adverse events being pneumomediastinum (Krasnick, 2001; Nemet et al, 2004; Manço JC, Terra-Filho J, Silva GA, 1990), mediastinal and subcutaneous emphysema (Varkey, 1973), incarceration of known inguinal hernia (Patel, Raju, Wollschlager, 1992) and bilateral dislocation of the temporomandibular joint (Oliphant et al, 2008). All patients recovered. None of these studies are UK based, and there was some degree of bias potentially noted due to different healthcare funding systems used with the different studies.

The HTA included a survey questionnaire was used to assess pre-operative assessments used in clinical practice. There was a 17% response rate with only 12% of respondents indicating that they would use lung function tests, but only in ASA Grade 2 patients who had respiratory comorbidities and were having either minor or intermediate surgery.

In their revision to their 2002 practice advisory, the ASA, updated their statement (American Society of Anesthesiologists, 2012). They noted that a number of studies reported abnormal findings in 14.0% to 51.7% of asymptomatic or nonselected patients (Category B), but that any changes in clinical management were not reported (Appleberg et al, 1974; Kocabas et al, 1996; Pereira et al, 1999). For selected or indicated patients, an abnormal test results was reported in between 27% to 66% (Durand et al, 1993; Jacob et al, 1997; Vedantam & Crawford, 1997), with abnormal spirometry findings in 42% of patients (Category B; Kispert et al, 1992). Changes in clinical management were not reported.

The conclusion from this review, based on the limited evidence, i.e. Category B, is that anaesthesiologists need to balance the risks and costs of these evaluations against their actual benefits. Clinical characteristics to consider include type and invasiveness of the surgical procedure, the time interval from previous assessment, treated or symptomatic asthma, symptomatic COPD, and scoliosis with restrictive function capabilities.

2015/2016: The National Clinical Guideline Centre (2015) undertook a review of routine preoperative tests for elective surgery, which is currently in consultation, with the final version to be published in 2016. From the viewpoint of this document, key relevant areas to be covered are cardiopulmonary exercise testing (CPET), polysomnography and lung function tests. Each of the groups were further assessed using the ASA Grades 1 – 4 criteria and the surgery grade of minor, intermediate and major/ complex.

To put this new guidance into context, there is concern that excessive testing can cause unnecessary anxiety to patients, delays in treatment and unnecessary costs (Asua & Lopez-Argemedo, 2000; Klein & Arrowsmith, 2010). In terms of the latter, in the 2012/2013 it is reported that the NHS in England undertook 10.6 million operations as compared to 6.61 million in 2002/2003. Undertaking, therefore, an unnecessary test will add to the financial burden placed upon the NHS in England, especially if that test adds nothing or very little to the management of the patient (Munro et al, 1997; Smetana & Macpherson, 2003).

Preoperative tests do provide benefit if they present additional information that cannot be obtained from a patient history and physical examination alone, and importantly where they:

- Help to assess the risk to the patient and inform discussions about the risks and benefits of surgery
- Allow the patient's clinical management to be altered, if necessary, in order to reduce possible harm or increase the benefit of surgery
- Predict postoperative complications
- Establish a baseline measurement for later reference where potentially abnormal postoperative test results cannot be adequately interpreted in isolation (Harris et al, 2006).

These criteria are now applied in a much more targeted manner. In the past, a battery of tests were undertaken in preparation for the anaesthetist to review just prior to surgery.

In today's set-up we have purpose designed Pre-Operative Assessment Centres (POAC) where a much more structured approach of protocol driven examination and history are obtained, and decisions made as to how to manage the patient made well in advance of the planned or proposed surgery. These protocols are developed by anaesthetists, often working with specialists in other areas, such as lung function and sleep [Anaesthetists of Great Britain and Ireland, 2010; Carlisle & Stocker, 2012).

With the development of POAC's, nurse led preoperative assessments can determine the functional status of the patient, which is a major determinant or perioperative risk (Chassot et al, 2002) and appears to reduce the number of investigations needed (Kinley et al, 2002). What these guidelines do not include are children, cardiovascular procedures or neurosurgery.

Lung Function Tests: The use of lung function tests was considered in a much wider range of patients, including those in ASA Grades 1 – 4, a range of procedures and included subjects who were obese. Only four studies were identified under the criteria used for selecting studies [Farina et al, 2012; Hamoui et al, 2006; Jeong et al, 2013; Huh et al, 2013). All presented low grade evidence of the benefits of undertaking lung function testing before either bariatric (Farina et al, 2012; Hamoui et al, 2006) or gastric surgery (Jeong et al, 2013; Huh et al, 2013). There are no economic evaluations available.

Using a Delphi technique, where no clear-cut consensus based on the literature review, showed that with the exception of ASA Grades 3 and 4 in patients with respiratory comorbidity, undergoing major/complex surgery, there was a clear consensus that routine preoperative assessment using lung function tests was not appropriate. It was also highlighted that where advice from a senior

anaesthetist was involved, that lung function tests may be appropriate.

There was no overall consensus on the use of blood gases regardless of ASA grade or co-morbidities, although, as with lung function tests, if a senior anaesthetist requested them, then they would be warranted.

Cardiopulmonary Exercise Tests (CPET): In the preoperative setting, CPET can be used to assess a patients' functional capacity and to allow prediction as to whether they will tolerate the physiological stress of surgery. One key advantage of CPET is the integration of the assessments of cardiac, respiratory and metabolic variables in a situation that mimics surgery. The potential downside of CPET testing is that it involves specialised facilities that not every centre has available, essentially requires an hour-long appointment, so may be regarded as time-consuming, and requires a skilled practitioner (Senior Physiologist/ Scientist or anaesthesiologist) to perform and analyse the test. There is a degree of uncertainty about the predictive value of CPET on perioperative morbidity and mortality, and about how CPET results should be used in the clinical environment to inform preoperative optimisation and perioperative management.

A single article provided low grade evidence from a retrospective cohort analysis (Goodyear et al, 2013). There was some evidence of a decreased length of stay and reduced 30-day mortality, but it was noted that there may be bias and imprecision in the data as this was not a true RCT.

There were sixteen observational studies covering abdominal aortic aneurysm (Barakat et al, 2015; Carlisle & Swart, 2007; Grant et al, 2015; Hartley et al, 2012; Prentis et al, 2012), lung resection surgery (Bruneli et al, 2009; Bruneli et al, 2012; Licker et al, 2011; Torchio et al, 2010), colorectal surgery (West et al, 2014), pancreaticoduodenectomy (Ausania et al, 2012; Junejo et al, 2014) and other surgery (Junejo et al, 2012; McCullough et al, 2006; Prentis et al, 2013; Snowden et al, 2010). These articles will be reviewed later under the CPET testing section, with generally all the evidence being classified as low grade. The evidence for using anaerobic threshold (AT), oxygen uptake (VO_2), peak VO_2 and the ventilatory equivalent for carbon dioxide (VE/VCO_2) as predictors is unclear and is regarded across all forms of surgery as of low quality for predicting mortality at 30-days, 90-days or 3 years. Furthermore, postoperative complications were not that well predicted, based on the assessment criteria used. The guideline group arrived at the conclusion that *"based on the evidence, there is not enough robust evidence to recommend or not recommend CPET testing before surgery".*

Polysomnography: It is interesting to note that this review focused on this complex, laboratory based test, which I suspect many centres would not use, rather than choosing initially to screen with either only pulse oximetry or a limited home-based study. Furthermore, in the POAC or lung function service, attempts at identifying potential OSA sufferers will be determined by simple questionnaires. The questions posed are very limited to those patients, whom are obese and undergoing major/complex elective non-cardiac surgery. However, it must also be remembered that not every patient who has OSA is overweight or obese. There are many patients, who are of normal weight, but have other features, such as retronagthia, which increase the potential for narrow upper airways and hence the risk of having OSA. There was a single study included in the initial assessment

(Chung et al, 2008), which included 416 adult patients, a mixture of ASA grades and a range of surgical procedures.

The evidence was regarded as very low quality, and no clear answer to the question of clinical or cost-effectiveness was attained. This single study is based in Canada where the funding system is fundamentally different to that of the UK and where, in general terms, laboratory based studies would be performed. In terms of predicting prognosis, again a single article was used (Weingarten et al, 2011). The authors concluded that in obese patients undergoing bariatric surgery, using polysomnography the severity of OSA was not associated with the rate of perioperative complications. These results cannot determine whether unrecognized and untreated OSA increases potential risk.

On the basis of these two studies, the conclusion is that polysomnography cannot be recommended, despite *"being the definitive preoperative test to diagnose OSA".* The committee did consider other tests that were quicker and cheaper. The research questions, therefore posed instead is whether or not polysomnography a) represents an efficient use of NHS resources, b) does preoperative screening at risk of SDB/OSA with polysomnography identify those at higher risk of postoperative complications and c) does treating OSA perioperatively improve outcomes.

Conclusions: These statements and reviews show that there is paucity of quality literature as defined under Category A evidence. Should we take much note of this document? There are clearly published guidelines, for instance in thoracic surgery, which present evidence as to why we undertake lung function studies and cardiopulmonary exercise tests in selected groups of patients before surgery. Risk management in this group of patients is important. There is evidence that for the obese patient, having been identified with sleep disordered breathing/obstructive sleep apnoea (SDB/OSA) that the outcomes are better in many cases.

One has to ask whether this document really adds much to our understanding of what tests are needed, in which groups, and what the outcomes are likely to be. Doubtless management will cling onto this document and perhaps try to limit the application of known national and international guidelines! **Your role is to understand the evidence that is available and to make your own conclusions as scientists. Whilst the remainder of this document will present much of the evidence that is out there, you will need to read the final published document to make up your own minds.**

Resting Lung Function Tests

Lung function testing consists of both resting studies, blood gas analysis and exercise testing. Within each section, where data is available, specific disease groups will be discussed. Lung function tests have been used to evaluate the risk for postoperative complications since the mid-1950's (Gaensler et al, 1955; Miller, Grossman & Hatcher, 1981; Olsen et al, 1975). Severe abnormalities detected using these tests generally indicate an increased risk for surgery and should prompt the POAC team to consider further assessments (Zibrak, O'Donnell & Martin, 1990).

What is historically interesting is the comments of Pasteur (1910) which highlighted then what has become our understanding now in terms of the aetiology of postoperative pulmonary complications. He noted that -

"when the true history of postoperative lung complications comes to be written, active collapse of the lung, from deficiency of inspiratory power, will be found to occupy an important position among determining causes."

Postoperative pulmonary complications are known to develop as a result of changes in lung volumes. These changes occur as a result of dysfunction of the respiratory muscles and changes in the mechanical properties of the chest wall. Abdominal and thoracic surgical procedures can result in large falls in VC as well as falls in the FRC. These decreases in FRC have been known for many years as probably the single most important lung volume measurement involved in the aetiology of respiratory complications. Although no consistent changes occur in FRC after non-abdominal, non-thoracic surgery, FRC decreases after lower abdominal operations by 10 to 15%, by 30% following upper abdominal operations, and by up to 35% after thoracotomy and lung resection. There are, of course, other factors, which will result in decreases in FRC, and include the supine position, obesity, the presence of ascites, the development of peritonitis, and rather obviously - general anaesthesia.

The scene is therefore set!

Mittman (1961) identified that lung volume measurements, using nitrogen washout, may be helpful, with an increase in the RV/TLC ratio (gas trapping) of > 50% being associated with a higher incidence of post-operative complications. In those patients with an RV/TLC ratio of < 40%, complications were fewer. Using the N2-washout curve as a guide, there was a higher mortality when this curve was abnormal.

Boushy et al (1971) observed in a group of patients undergoing surgery for bronchial carcinoma, that patients who did badly (40%) were those who were generally over the age of 60 years and had an FEV_1< 2.0 litres. Therefore this should represent the minimum level of absolute FEV_1 in this group of patients.

Kristersson et al (1972) studied the ability to predict post-operative FEV_1 based on the use of ^{133}Xe-radiospirometry in patients undergoing pneumonectomy. The authors state that a number of their patients had a post-operative predicted value of FEV_1 "*close to what they would consider the lower limit of operability, i.e. FEV_1 < 1.0 L".* There was no real direct evidence for this – more it appears a personal opinion than anything based on hard scientific evidence.

Olsen et al (1974) using ^{99m}Technetium scans, studied a number of patients to predict lung function post pneumonectomy. They chose a predicted postoperative FEV_1 ($ppoFEV_1$) of 0.8 litres as one that would preclude resection. This was based on both their personal clinical experience and that in patients with an FEV1 < 0.8 L, an increased incidence of hypercapnia is observed (Segall & Butterworth, 1966; Olsen et al, 1975). Boysen et al (1977) took a very similar approach and observed a mortality rate of 15% at ≤ 30 days postoperatively.

Ali et al (1980) using ^{133}Xenon assessed the relationship between pre- and postoperative FEV_1 and the predicted value in a group of patients undergoing either pneumonectomy or lobectomy. They found a good correlation between actual measure and $ppoFEV_1$ in patients who had at least 3 segments removed, whilst those who had fewer segments removed, the prediction was not as good.

Comment: One of the important assessment tools is the prediction of the FEV_1 postoperatively – the

predicted postoperative FEV_1 ($ppoFEV_1$). As outlined above, this is obtained by using computerized perfusion and ventilation scans to preoperatively assess the functional contribution of the lung tissue to be resected.

Alternatively, this can be estimated from the FEV_1 and the ratio of the number of segments remaining after surgery to the total number of segments (n = 19), as described by (Wernly et al, 1980). Although a $ppoFEV_1$ of 0.8 Litres may be regarded as an acceptable risk of mortality and complications, it does suffer from the issue of taking an absolute value. This takes no account of the patients' age, sex, and size. However, where the $ppoFEV_1$ value is related to age, height and sex, using standard reference values, the absolute value 0.8 Litres approximates to somewhere between 30 to 35% predicted normal FEV_1.

On the basis of this, Gass and Olsen (1986) suggested, in their review of the different cut-off points, that a $ppoFEV_1$ of ≥ 30% predicted can be regarded as a suitable cut-off for surgery. So, for example, if the right upper lobe is to be removed, this would account for 3 segments[b]. If the pre-surgical FEV_1 was 48% predicted, then the $ppoFEV_1$% is 48 x 16 ÷ 19 = 40.4%, which is above the accepted limits for potentially proceeding to surgical lung resection.

Markos et al (1989) used the $ppoDL_{co}$ and the DL_{co}% as markers of outcome, which appeared to provide additional useful predictive power when the $ppoFEV_1$ was < 40% predicted. This study suggested a minimal value of 40% is required for safe resection, and it was noted that there were no post-operative complications or mortality in their group (n = 47) of patients.

Comment: We know that airway function is easily measured by the use of dynamic lung volumes and that the use, in particular of the FEV_1 is widely used, But why use DL_{co}? We know that the DL_{co} is a standard test used routinely in most lung function laboratories and should be part of the preoperative evaluation of patients undergoing lung resection surgery. Studies show there to be a clear relationship between a low DL_{co} and poor postoperative outcome after lung resection. A low DL_{co} will identify patients with significant emphysema, and a reduced pulmonary capillary vascular bed.

The mechanisms that would predispose the emphysematous lung to develop pulmonary oedema, include -

- Barotrauma from ventilation of the lung (Carlton et al, 1990),
- Hyperperfusion of a diminished pulmonary microvascular bed leading to endothelial damage from increased shear (Ohkuda et al, 1978),
- Sequestration of activated neutrophils and platelets (Molad et al, 1993),
- Postoperative pulmonary hypertension due to the decreased pulmonary vascular bed following lung resection (Reichel, 1972). Poor right ventricular-pulmonary arterial vascular coupling as a result of resection of part of the pulmonary vascular tree, loss of vascular compliance due to over distension of the remaining vessels by hyperperfusion, and occlusion of the pulmonary capillary bed by activated neutrophils and platelets, may impair cardiac function and may lead to arrhythmias (Nishimura et al, 1993; van Wagoner, 1993).

[b] For the purposes of calculations of both $ppoFEV_1$ and ppoDLco, the numbers of segments are RUL – 3, RML – 2, RLL – 5, LUL – 3, LL – 2, LLL – 4, totally 19 segments.

In the study of Holden et al (1992), the ppoFEV$_1$ was 1.17 ± 0.17 Litres in the survivors, compared to 1.11 ± 0.19 Litres in the non-survivors, these differences being non-significant.

Converting the absolute values into %predicted values for the two groups, similarly showed no significant differences (41 ± 11% vs 32 ± 6%), which may simply reflect the small population sizes of this study. However, what this study also highlighted was that in a group where the ppoFEV$_1$ was all > 0.8 Litres, the 30-day mortality was 6%, rising to 31% at 90-days. This simply illustrates the fragility of using one single index to predict an outcome, albeit that this is part of the current European and American lung cancer guidelines (see later).

In looking at the role of these assessments, Pierce et al (1994) reviewed the relationships between a various indices including the FEV$_1$.

They also included in their analysis measures of DL$_{co}$ and reviewed the ppo values for both FEV$_1$ and DL$_{co}$. Those patients who survived had a ppoFEV$_1$ of 60 ± 24%, whereas in those who died the value was 39 ± 11% (p = 0.015). This study also related the ppoFEV$_1$% and the ppoDL$_{co}$% values into a composite index – the predicted postoperative product (PPP) which is simply the product ppoFEV$_1$% x ppoDL$_{co}$%. This interesting composite index, in theory, combines aspects of ventilation, perfusion and gas exchange.

The potential usefulness of this index, which has a cut-off of 1650 (Figure 1), is that where a patient fails to

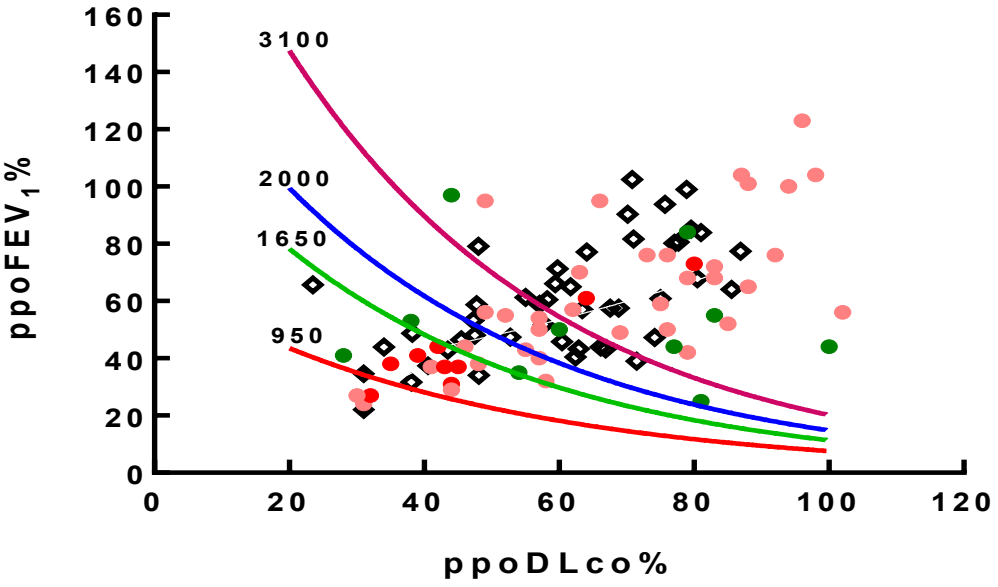


Figure 1. Relationship of the ppoDLco% predicted versus ppoFEV1% predicted. Data from Pierce et al (1994) shown as circles, where red are those patients who died, green those that had no complications and pink the remaining patients. The triangles are data from Markos et al (1989). Pierce recommended a cut-off of 1650, which is one of the four isopleths shown on the relationship.

achieve the required cut-off (40% predicted) for one index, say ppoFEV$_1$% = 35%, whilst the ppoDL$_{co}$% = 48%, this would give a PPP of 35 x 48 = 1680, which would suggest that this patient is probably just about fit for surgery.

Pierce et al (1994) assessed static lung volumes using body plethysmography, but this added nothing to the predictions of patients likely to have either respiratory or cardiac complications.

Pierce et al (1994) included measures of arterial blood gases essentially to estimate the $PaCO_2$, $AaPO_2$ and the SaO_2. We know that patients who have hypoxaemia and hypercapnia are at an increased risk for morbidity and mortality after thoracotomy (Drings, 1989). The data from the study, showed that the $PaCO_2$ was slightly raised in patients who had complications compared to no complications (4.84 ± 0.48 vs 4.36 ± 0.52 kPa, p = 0.016). In predicting cardiac complications, the most significant blood gas measure was the end of exercise (step test) SaO_2, with lower values being more associated with complications than no complications (91.1 ± 1.1% vs 94.2 ± 2.1%, p = 0.010). There were small differences in resting SaO_2, $PaCO_2$ and PaO_2. Although these observations were useful, and important, blood gases generally were unhelpful in relation to assessing either surgical or respiratory complications.

Boursamra et al (1996) assessed the effects of a reduced DL_{co}% (≤ 60%) and noted this was not associated with a higher mortality rate, but there were a higher proportion of patients with respiratory complications. Furthermore, long-term morbidity was associated with the low DL_{co}%.

Kocabas et al (1996) assessed the role of spirometry to predict postoperative pulmonary complications in patients undergoing upper abdominal surgery. Whilst a proportion of patients had an FEV_1% < 50% (<1.25 L) there was no difference between patients who had complications and those who did not. Although spirometry alone did not provide any clarity in predicting complications, the authors demonstrated that when combined with other aspects of the individual patient – age, smoking history, ASA class etc, then there was improved sensitivity of prediction.

Body plethysmography was compared to spirometry in the assessment of thoracotomy patients by Scholz et al (1996). Whilst spirometry was possibly useful in the patients studied, measurements from body plethysmography (FRC and R_{aw}) added nothing of note to the assessment.

Barisione et al (1997) asked a simple, yet provocative question – does a lung function test exist to predict severe postoperative complications? One of the structures potentially most compromised by upper abdominal surgery is the diaphragm and if the surgery is close to this structure, the FVC and the FRC may well be compromised (Simonneau et al, 1983; American College of Physicians, 1990). They measured FEV_1 and FVC, along with TLC, RV and DL_{co}. The highest proportion of serious respiratory complications (SRC) occurred in patients with obstructive airways disease (35/79 – 44%). In terms of lung function indices, an FEV_1% < 71%, a DL_{co}% < 76% and an RV > 3 litres accounted for the majority of patients in whom an SRC occurred. One key component was the presence of current mucus hypersecretion, which is often associated with COPD, and would be consistent with the findings of the lung function studies in this study.

Ninan et al (1997) identified that patients with a resting SaO_2 of < 90%, or where there was a desaturation of ³ 4% during exercise were significantly predictive both increased morbidity and mortality, and included longer ITU stays in post-pneumonectomy patients.

Bartels, Stein and Siewert (1998) were one of the first groups to try and produce a method of predicting the risks of, and hence postoperative outcomes of surgery in this oesophagectomy patients. They observed that for a VC > 90% predicted and a PaO_2 > 9.3 kPa, the risk

was low, but when the VC < 90% predicted and the PaO_2 < 9.33 kPa, then the patients were severely impaired. They combined lung function with hepatic, cardiac and the general status - Karnofsky index (Karnofsky & Burchenal, 1949) and mental status to produce a weighted composite score. The minimum composite score is 11 and the highest score, and worst potential outcome is 33. Those patients with a score of 11 – 15 had a 30-day mortality of 3.6%, whereas as those patients with a score of 22 – 33 had a 28% mortality at 30 days. The authors also used the PaO_2 in combination with the VC to predicted outcome.

An interesting development of the work of Pierce et al (1994) was to create a further composite index that used the PPP as its basis.

Melendez & Barrera (1998) included the AaO_2 in the calculations and weighted the respective components. This Predictive Respiratory Complication Quotient (PRQ) was used to predict the probability of pulmonary morbidity and mortality in thoracic surgical patients. A PRQ value of < 2200 is associated with an increased risk of pulmonary complications and mortality. The equation is -

$$PRQ = (ppoFEV_1\%) \times (ppoDL_{co}\%)2/AaPO_2$$

So for a $ppoFEV_1$ = 45%, a $ppoDL_{co}$ = 65% and an AaO_2 of 7.5 mmHg, the PPP = 45 x 65 = 2,925 and the PRQ = 45 x 652/7.5 = 25,350, both of which do not suggest significant issues. Where the $ppoFEV_1$ = 45%, the $ppoDL_{co}$ = 33% and the AaO_2 = 24 mmHg, the PPP = 1485 and the PRQ = 2042, both these values indicate significant potential problems.

Fuso et al (2000) reviewed the role of spirometry and arterial blood gases in predicting complications after abdominal surgery. They assessed 480 patients and

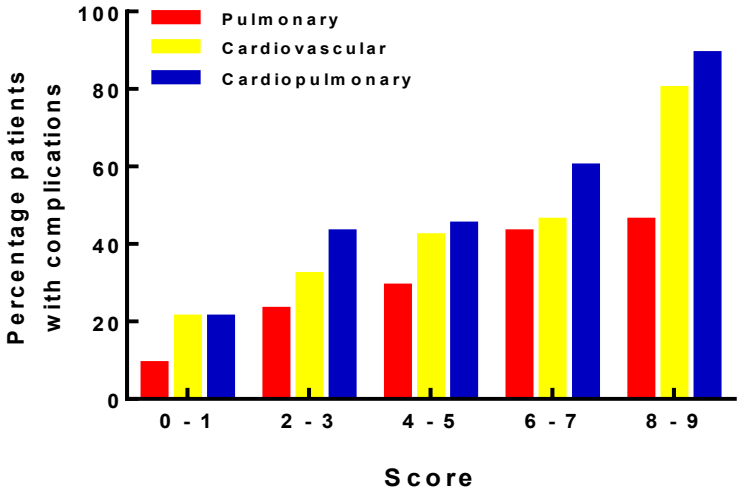


Figure 2. Incidence of pulmonary, cardiovascular and cardiopulmonary complications in relation to the predictive score. Re-drawn from Ferguson & Durkin, 2002.

were particularly interested in pulmonary complications, which had been reported previously as being between 5% to 75% (Lawrence, Page & Harris, 1989; Kocabas et al, 1996). In this study, pulmonary complications were 18%. The principal determinants for predicting these complications, using multi-variant regression, was an FEV_1% of < 61% (OR = 16.86) and a PaO_2 < 9.33 kPa (OR = 6.42). The authors concluded that in patients with moderate to severe AWO and hypoxaemia, there was a significantly increased risk of pulmonary complications and assessment would be appropriate.

Ferguson and Durkin (2002) investigated the risk of pulmonary complications after surgery. In statistically assessing a range of patient characteristics and laboratory findings, the authors concluded that three parameters were useful, namely age, performance status and FEV_1%. The age component was based on aged 51 – 60 years (+1 point), 61 – 70 years (+2), 71 – 80 years (+3) and > 80 years (+4), whilst the FEV_1% was 80% - 89.9% (+1), 70% – 79.9% (+2), 60% - 69.9% (+3) and < 60% (+4). Indices of arterial blood gases and DL_{CO} were not statistically important. The performance score was simply added to the overall score. So for a patient who is aged 66 years, with an FEV_1% of 68% predicted and a performance score of +1, the total score would be 2 + 3 + 1 = 6. From Figure 2, this would suggest there is a 40% chance of pulmonary complications and slightly higher risks for cardiovascular and cardiopulmonary risks.

What was interesting was that the authors also attempted to determine which factors might be important in suggesting the presence of potentially poor pulmonary function results (defined as < 90% predicted), and hence indicating the need for pulmonary function testing. In this group of patients, three factors were regarded as important – 1) weight loss, 2) alcohol use and 3) BMI < 20 kg.m-2.

Brunelli et al (2002a) reviewed the morbidity of patients with and without airflow obstruction, defined as an FEV_1% < 70%. In those patients with an FEV_1% > 70%, the most useful predictor of morbidity was the $ppoFEV_1$, whilst in those patients with an FEV_1 < 70%, no specific index was useful, and therefore the use of the $ppoFEV_1$% in this group of patients was questioned. The interesting aspect of this study, is that if you remove part of the lung, i.e. a lobectomy, there appears to be a *"lung volume reduction effect"* which occurs when the resection of

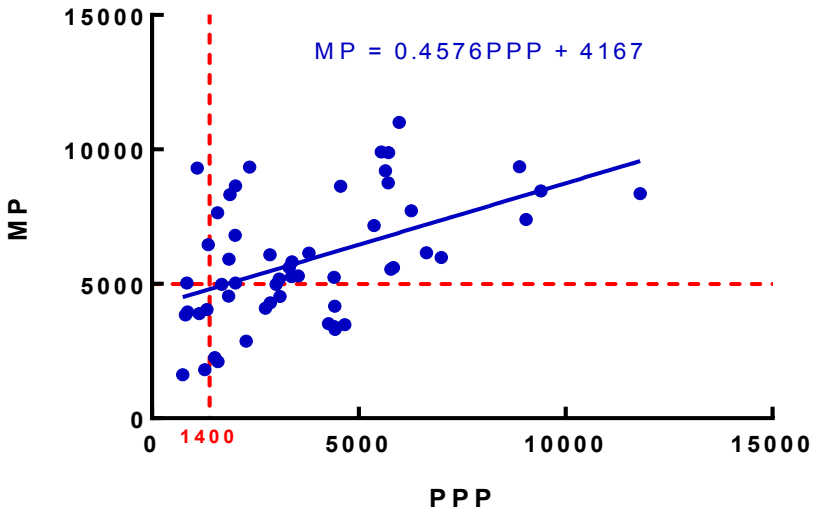


Figure 3. Relationship of Predicted Postoperative Product (PPP) and Measure Product (MP) assessed by Wang (2003b). The raw data is taken from Pierce et al (1993) on 54 subjects. For a value of 1400 on PPP, the approximate equivalent on MP was 5000. The relationship is shown and has an r = 0.4854, p = 0.0002.

the most affected lung parenchyma appears to result in improvements in elastic recoil, with a reduction in airflow resistance and with improvements in pulmonary mechanics and V/Q matching. Hence there appears to be a *"minimal loss"* of lung function in

some patients an actual improvement in lung function post-surgery in others.

As with Boursamra et al (1996), it was similarly noted by Wang (2003a) that in patients with complications there was a lower DL_{co} and a lower K_{co}, when compared to those with fewer complications. A DL_{co}% of 70% was regarded as the best functional predictor of postoperative complications, with a complication rate of 94% in those patients with a DL_{co}% < 70%, whilst in those patients with a DL_{co} >70%, the complication rate was 27%. DL_{co}% did not appear to predict mortality, albeit that only 8/151 died.

Wang (2003b) revisited the PPP (Pierce et al, 1994) in a large group (n = 151) of patients and also created an additional index – the measured product (MP). This was calculated from the product of the measured pre-operative FEV_1% and DL_{co}%. Using the raw data of Pierce et al (1994), the relationship between the PPP and the MP is illustrated in Figure 3. Patients with complications had a PPP < 1400, which equated to an MP of 5000. He also noted that complications were higher in those patients with a low FEV_1 and low $ppoFEV_1$.

Fujui et al (2003) analysed 356 consecutive lung resections and reviewed the complications in terms of respiratory and "other" and related them to various indices including FEV_1 and DL_{co}. Pneumonectomy, preoperative chemotherapy and advanced stage were key risk factors for postoperative deaths. Patients who underwent lobectomy with a FEV_1 < 1.5 L did not die of respiratory complications, whilst patients undergoing a pneumonectomy did not die if their $ppoFEV_1$ < 800 $mL.m^2$ – where the volume is adjusted for body surface area (BSA in m^2). In those patients who had both a $ppoFEV_1$% and a $ppoDL_{co}$% of < 40% - they died. Using multivariate analysis, the $ppoFEV_1$% was the significant independent factor associated with

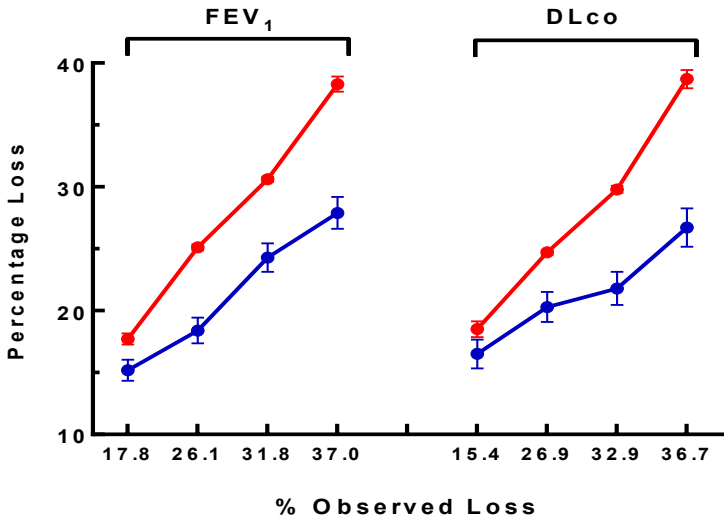


Figure 4 Comparison between observed and estimated FEV_1 and DLco using conventional (blue lines) and equation (red lines). Data are shown as mean ± SEM at each of the mean, observed points. Data from Brunelli et al, 2005.

[c] The COPD Index is the sum of ratio of the preoperative FEV_1% and the preoperative FEV_1/FVC. For example if the FEV_1 is 0.859 and the FEV_1/FVC is 0.716, then the COPD Index is 1.575

postoperative death. Furthermore, where chemotherapy is undertaken before surgery, the authors recommend measured of DL_{co} to ensure an acceptable DL_{co}%, as values < 40% appear to be associated with increased risk of death.

Abunasra et al (2005) showed that a combination of advanced age, tumour location and the FEV_1 (absolute or %predicted) as good predictors of death following surgery in this group of patients. The model showed that the risk of operative death increased by 50%, for each 20% decrease in the FEV_1, confirming the importance of this measurement in the assessment of this group of patients.

Varela et al (2006) assessed the predicted versus observed FEV_1 in the immediate postoperative period following lobectomy by measuring FEV_1 for the 6 days immediately following the surgery. It has been previously shown that The FEV_1 measured in the immediate post-operative period is severely reduced, but gradually recovers (Bastin et al, 1997), with the FEV_1%/ppoFEV_1 improving from 0.60 to 0.90 at discharge (Furrer et al (1997). In this study, the FEV_1%/ppoFEV_1 was 71.2 ± 16.1 on day 1, rising to 92.8 ± 18.6 by day 6. Clearly, here is a degree of underestimation of the ppoFEV_1 compared to actual function loss, which is of concern in terms of risk assessment in patients undergoing lung resection.

Brunelli et al (2005) undertook a series of studies to understand the reduction effect after lung resection in the early time period post-surgery. From their analysis, two regression equations were produced, that more accurately reflect changes in both FEV_1 and DL_{co}.

These equations are –

$$FEV_1 = 21.34 - 0.47age + 0.49FPR + 17.91CI$$

$$DL_co = 35.99 - 0.31age - 36.47FEV_1/FVC + 0.33DL_{co} + 0.54FPR$$

where FPR is the % functional parenchyma removed and CI is the COPD index[3] calculated according to Korst et al, 1998. In comparing, these regression

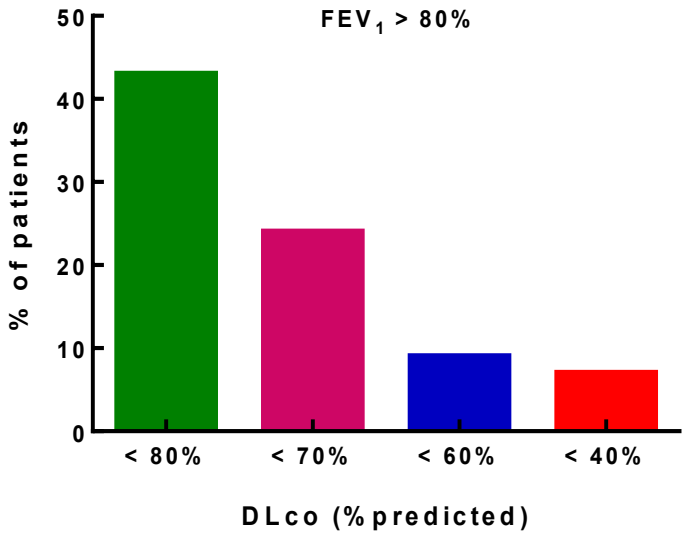


Figure 5 The FEV_1-DLco relationship in a large cohort of patients. The data represents patients in whom the FEV_1 was > 80% predicted, and demonstrates that there is a significant proportion of patients who have abnormal gas exchange but with normal airway flow dynamics, based on the FEV_1. Data from Brunelli et al (2006).

equations to actual measurements, it was noted that the estimated loss, as compared to the observed losses were no different for the equation, but were for the conventional estimation of loss (Figure 4).

Schröder et al (2006) further assessed patients within the disease group. They, like Ferguson noted that three factors were important – age, general status and pulmonary function (FEV_1, FVC, $PaCO_2$ and PaO_2) as risk factors with an increased OR of 1.56 (1.01 – 3.04). They also used a combination of $PaCO_2$ of < or > 6.0 kPa and a PaO_2 of > or < 9.3 kPa in combination with VC and FEV1 as part of a weighted composite index to predict outcome in oesophageal patients.

With the increasing rise in obesity and the increasing use of bariatric surgery, Hamoui et al, (2006) reviewed the usefulness of lung function testing in patients undergoing open laparotomy.

We know that increased weight will affect the ERV and can be assessed using the W/Ht ratio (Ray et al, 1984). In this study, 27/146 patients had complications, and it was observed that in this small group of patients, the VC, FVC, FEV_1, PaO_2 and the AaO_2 were significantly different, the VC and FVC being the most significant, and probably reflecting the altered physiology observed in these patients. The authors make the point that this data only applies to open surgery and not that undertaken using laparoscopic gastric bypass surgery.

Brunelli et al, (2006) noted that in many centres, DL_{co} was not routinely measured, and generally only appears to be measured in patients with airflow obstruction. In a report, quoted by Brunelli, only 25%

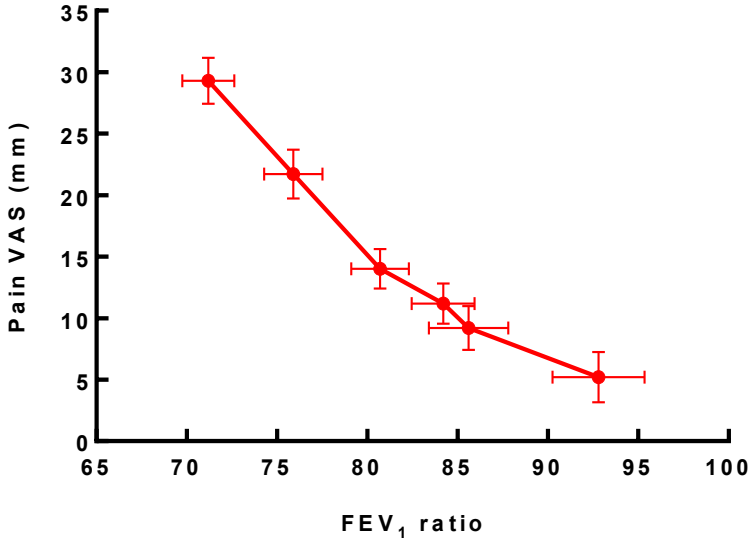


Figure 6. Relationship of the FEV_1 ratio (FEV_1%/ppoFEV_1%) to pain score using a VAS score. Data are obtained over 6 consecutive days, with the highest pain score on Day 1. All patients had undergone lobectomy. Data points are mean ± SEM. Data from Varela et al, 2006.

of > 3400 lung resections had had DL_{co} or ppoDL_{co} performed (Berrisford et al, 2005). This possibly reflects statements within published guidelines (Lim et al, 2002; Beckles et al, 2003). As Brunelli et al (2006) point out, the FEV_1 and the DL_{co} measure two different components of respiratory physiology – that of airflow dynamics and that of gas exchange. Whilst these two indices may well be related in some patients, this, as we know from our own clinical observations is not always the case, and indeed, in the

absence of airflow limitation, it is possible to have an abnormal DL_{co} and K_{co}, reflecting changes at alveolar level.

In this retrospective data analysis of a large cohort (n = 872), the correlation coefficients between FEV_1-DL_{co} were at best around 0.4 (r2 » 0.15) regardless of subset assessed. The distribution of DL_{co} in relation to FEV_1 > 80% predicted is shown in Figure 5. The data missing from this, and indeed most studies is the $FEF_{75\%}$ ($MEF_{25\%}$) which might inform us about any

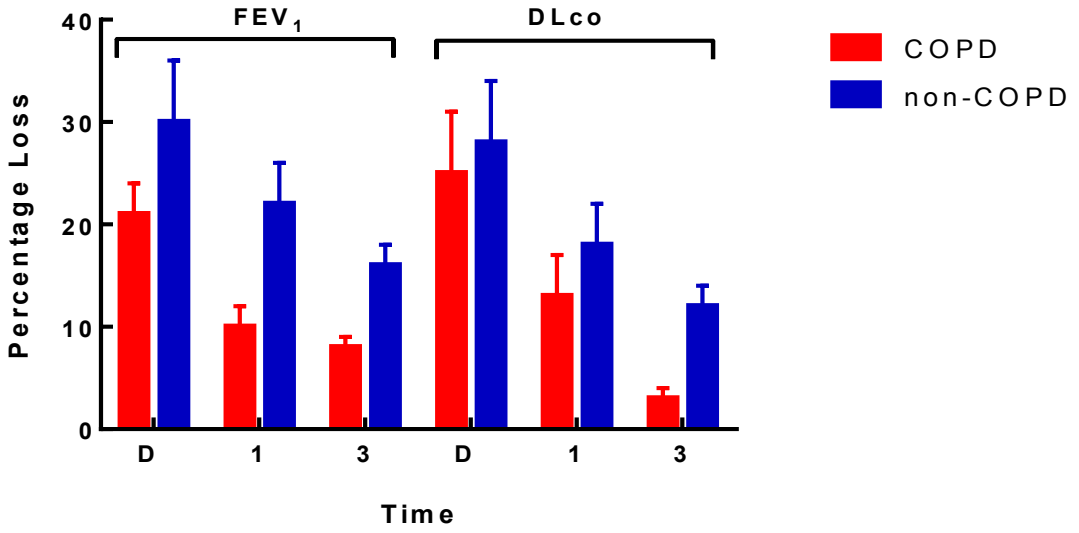


Figure 7. Percentage loss in FEV_1 and DLco at discharge (D), 1-month (1) and 3-months (3) post surgery in patients with COPD (n = 47) and non-COPD (n = 133) after lobectomy and compared to pre-surgical values. Data from Brunelli et al (2007).

abnormalities of small airway function, and hence provide a better understanding as to why there is a potential reduction in the DLco.

Baltayiannis et al (2006) reviewed the usefulness of the calculations of $ppoFEV_1$ and reassessed the application of the calculation of Juhl & Frost (1975), which is $ppoFEV_1$ = preoperative FEV_1 x (0.0526S), where S is the number of segments removed.

Interestingly, this formula is based on only 18 observations. The authors noted that in pneumonectomies' and lobectomies the percentage changes in FEV_1 at 6 months were 7.72% and 32.53%. Based on their observations, and using n = 112, the authors derived two equations;

lobectomy –

$$ppoFEV_1 = 0.00211 + 0.89666FEV_{1,pre\text{-}op}$$

and for pneumonectomy –

$$ppoFEV_1 = 0.145 + 0.65318FEV_{1,pre\text{-}op.}$$

These two equations showed a good relationship to the actual measured data and should be able to predict the $ppoFEV_1$ at 6 months.

Varela et al (2007a) confirmed the findings of Brunelli et al (2005), who demonstrated that the %loss in FEV_1 on the first post-operative day was lower in patients where the COPD Index was low. On the first day post-operatively, the FEV_1% was 44.9 ± 13.3 compared to the $ppoFEV_1$% of 64.8 ± 16.4. The authors used a complex audit tree analysis to determine outcomes, which determined that the most important index in terms of cardiorespiratory complications was the

FEV_1% (Day 1). One of the potential issues in obtaining accurate measurements of FEV_1% (Day 1) must be pain. In the previous study of Varela et al (2005), it was noted that the highest pain score, as assessed using VAS, was 29.3 ± 21 mm on day 1, falling to 5.2 ± 14.9 on day 6. It is known that there are issues of pain and discomfort that anyone undertaking the measurement of dynamic lung volumes needs to take into account, and this may be regarded as a relative contra-indication for the performance of spirometry – but not an absolute contra-indication (Cooper, 2011). Indeed what their 2005 study demonstrated was that there was an inverse relationship between reported pain score and improvements in the FEV_1%/ppoFEV_1% (Figure 6).

Varela et al (2007b) assessed a series of 185 patients undergoing lobectomy. The 30-day mortality was 1.1% and the cardiorespiratory morbidity was 20%. Patients who had lower pre-operative volumes tended to have a poorer outcome. One component of the prediction of outcome was the COPD Index. The authors concluded that a poor COPD Index had a direct independent correlation with the decrease in postoperative FEV_1-Day 1.

Brunelli et al (2007a) further assess patients with COPD, defined as FEV_1 < 80% + FEV_1/FVC of < 0.70). They observed that in these patients there was a significantly lower loss of both FEV_1 and DL_{co} when compared to non-COPD patients. In this group of patients, there was recovery in resting lung function in both the COPD and non-COPD patients at 1 and 3 months post-surgery (Figure 7). In terms of improvements in COPD patients, the FEV_1 at 3-months showed a 27% improvement, whilst the DL_{co} showed a 34% improvement.

As a further contribution to this issue, Brunelli et al (2007b) compared the actual to predicted ratio (apo/ppo) for FEV_1 and DL_{co} at discharge, 1- and 3-months. In lobectomy patients, the ratios were 0.89, 0.99 and 1.06 for FEV_1 and 0.88, 1.02 and 1.10 for DL_{co}, whilst in patients having a pneumonectomy, the ratios were 0.94, 0.94 and 0.98 for FEV_1 and 0.92, 1.0 and 1.17 for DL_{co}.

These results indicate that whilst the ppoFEV_1% and ppoDL_{co}% provide a guide, they underestimate the actual ppo values. This needs to be taken into account when risk stratifying patients for lung resection who have COPD.

As highlighted in the invited commentary of this paper (Jordan et al, 2007), the greater increased in DL_{co}, with less increases in FEV_1 after pneumonectomy would suggest that there is perhaps better redistribution of pulmonary blood flow when compared to patients having lobectomy. The one index that might have assisted in our understanding of this, which is rarely used in this context would have been the K_{co}.

Following on from both the work of Brunelli and that of Varela as outlined above, Brunelli et al (2007c) attempted to create a model that predicted the immediate post-operative (Day 1) FEV_1. This model, based on n = 136 and to develop an equation using multiple regression analysis and subsequent bootstrap on another 136 patients provided a validated regression equation –

FEV_1(D-1) =

-2.648 + 0.295age + 0.371FEV_1

+ (8.216 x epidural analgesia)

- (0.338 x %of non-obstructed segments removed during surgery)

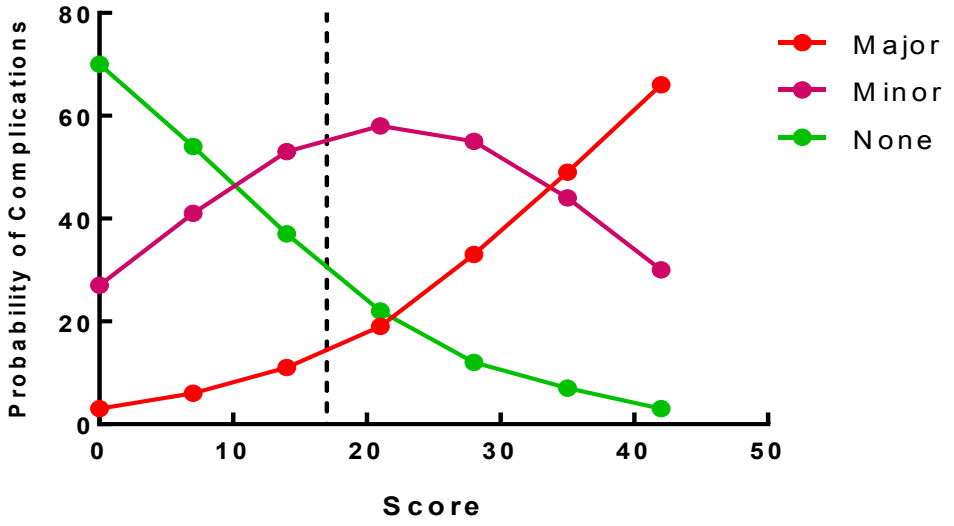


Figure 8. Inter-relationship of the probability of No, Minor and Major complications in relation to total score. For instance, if a patient is aged 60 (+4), has had a myocardial infarction (+5) and an FEV_1 of 2.0 litres (+8), will have a total score of 17 (dashed line). This suggests that the probability of major complications is about 15%, minor complications is about 55% and no complications is about 30%. Data originally from Legarde et al, 2008.

In comparing the actual FEV_1 measured on Day-1 in the second group of 136 patients, there was observed a close relationship between the predictive equation and the actual data.

Why is this actually important? The $ppoFEV_1$ is the most widely used index for patient selection before lung resection. Most of the published guidelines will consider this index essential to decide whether further testing is needed, such as CPET or in the worst case advising patients against the planned surgery.

The problem with the $ppoFEV_1$ or $ppoFEV_1$% is that although it correlates reasonably well with residual FEV_1 at 3 and at 6 months post-surgery, it appears to overestimate the actual FEV_1 measured on the day after the surgery by up to 30%. Risk analysis is about trying to ensure that risks are minimised as much as possible. If, therefore, we wish to stratify patients, not only do we need to know the 30- and 90-day mortality prediction, we also need have better predictors of risks in the immediate post-operative period, where there is potentially increased risks of complications. In essence therefore, measuring the FEV_1 on day-1 post surgery would be ideal, but in reality there is increased levels of pain (Figure 7) which makes undertaking such testing difficult and potentially suboptimal. Being able therefore to predict – within the limits of accuracy of any prediction equation, the likely FEV_1-D1 will potentially improve the process of risk stratification in this group of patients. The approach by Brunelli et al (2007c) is a step in the right direction, but does have its limitations, as identified by the authors. Patients submitted for extended lung resections involving the chest wall or diaphragm were excluded from the analysis, so the model may not accurately predicting FEV1-D1 in these patients.

Greillier et al (2007) assessed resting lung function and aspects of quality of life (QoL) assessments – one of the few papers that does this. They assessed 30-day and 90-day mortality and long-term mortality in 94 patients. They assessed QoL using the EORTC QLC-C30, the LC13 and the PGWBI questionnaires. In terms of complications, the lung function indices that

showed significant differences were VC, VC%pred, TLC%pred and K_{co}. FEV_1 and ABG's did not contribute the defining complications. In relation to survival, those patients who had a higher FEV_1%, TLC, TLC% remained alive. The QoL questionnaires added nothing and were not related to lung function tests at one month and 3 months. The authors concluded that whilst lung function studies are able to predict morbidity and mortality, QoL assessments are poorly related to these measures and should be regarded as a separate but essential assessment.

Ferguson & Vigneswaran (2008) undertook a retrospective data analysis of > 1000 patients who had a COPD status and DL_{co} measures. The FEV_1% and DL_{co}% were significantly lower in patients with COPD compared to those without COPD. Undertaking a univariate analysis to assess predictors of pulmonary morbidity and operative mortality showed that the single key predictor was DL_{co}%. Overall complications were related to ppoDL_{co}% only in the COPD group. The overall conclusion from this study was that DL_{co} should be measured in all patients undergoing lung resection, regardless of whether the spirometry is normal, noting that spirometry is generally defined as the measurement of FEV_1 and not from other indices obtained from the flow-volume curve, which may help understand why DL_{co}% may be reduced.

Lagarde et al (2008) also looked at pre-operative prediction in oesophageal cancer and created a nomogram. Age (30 = 0, 80 = 10), cerebrovascular accident/transient ischaemic attack (CVA/TIA; No = 0, Yes = 11), medical history of myocardial infarction (No = 0, Yes = 5), FEV_1 (Litres; 6 = 0, 1 = 10), ECG changes (No = 0, Yes = 7) and the degree of complexity of surgery (score 0 or 9) were all included in the classification. The rates of complications in relation to the total score are shown in Figure 8.

This nomogram was validated further by Grotenhuis et al (2010) and shown to be appropriate. The authors did, however, note that "*preoperative prediction of complications in individual patients remains difficult, most likely due to the complexity of mechanisms causing these complications".*

Grigorakos et al (2008) reviewed the potential issues of post-operative complications in patients undergoing upper abdominal surgery. In this small study (n = 28), 50% of the patients were deemed to have mild COPD, with all patients having an FEV_1 > 1.5 L. Age was noted to be a key risk factor, which in view of the known ageing effects on lung function is perhaps not surprising. None of the patients had an FEV_1 of < 1.0 L which is a known contraindication in this type of surgery (McAlister et al, 2003).

Pneumonia and acute respiratory failure was noted in those patients with more COPD and a smoking history. The authors advised, based on their data, that prehabilitation of subjects was important, and should include cessation of smoking, chest physiotherapy and the use of bronchodilators (Qassem et al, 2006; Lawrence et al, 2006).

Fernando et al (2011), in reviewing the 30- and 90-day outcomes of sublobar resection in NSCLC as a Phase III study observed that the FEV_1% was a significant predictor of adverse events (AE) at 30 and at 90 days, with higher values resulting in less AE's. In terms of DL_{co}%, a value of < 46% was predictive an "any" AE and of a respiratory AE, and further confirmed that even when spirometry is normal, the DL_{co}% appears to be an independent predictor of mortality. This observation is in agreement with the previously published data from Ferguson & Vigneswaran (2008).

Puente-Maestú et al (2011) reviewed the algorithms of Bolliger et al (1998) as validated by Wyser et al

(1999), whereby of the FEV_1% and DL_{co}% should both be > 80% to consider proceeding to pneumonectomy, otherwise a staged approach which included CPET testing is required (see later in review). They wished to revise the algorithm to include patients who had a ppoFEV_1% and ppoDL_{co}% between 30% and 40%, so long as the ppoVO_2,peak was > 10 $mL.min^{-1}.kg^{-1}$. To do this, they reviewed to 30-, 60-day mortality and the 2-year survival. Including patients who had poorer lung function compared to the validation by Wyser et al (1999) produced a 30-day mortality of 6.4% (Wyser had a mortality of 1.5% with stricter criteria). Importantly, from the viewpoint of the authors, the 2-year survival was better when compared to those patients who were not operated on (136 vs 42 weeks, $p < 0.01$). The authors concluded that when either the ppoFEV_1% or ppoDL_{co}% are < 40% or both are between 30% to 40%, then it was acceptable to proceed to surgery, albeit with a slightly increased rate of mortality of 13.5%, so long as the ppoVO_2,peak is > 10 $mL.min^{-1}.kg^{-1}$.

Farina et al (2012) looked at the role of spirometry in severely obese patients (n = 146), undergoing biliopancreatic surgery. Using spirometry and arterial blood gases, the majority of their patients (n = 84) had normal results and a mean hospital stay of 6.3 ± 2.70 days. They identified only 6 patients with a suspicion of a restrictive ventilatory defect, who had a reduced PaO_2 (10.36 ± 2.2 kPa) and a slightly raised $PaCO_2$ (5.57 ± 0.6 kPa) compared to the normal subjects. These patients were slightly older and had a slightly higher mean BMI and stayed slightly longer in hospital (7.1 ± 3.0 days). Overall, in this study, spirometry and arterial blood gases added very little to the outcomes of the surgery in terms of respiratory complications.

Ferguson et al (2012) assessed the relevance of DL_{co} in predicting long-term survival in lung cancer patients.

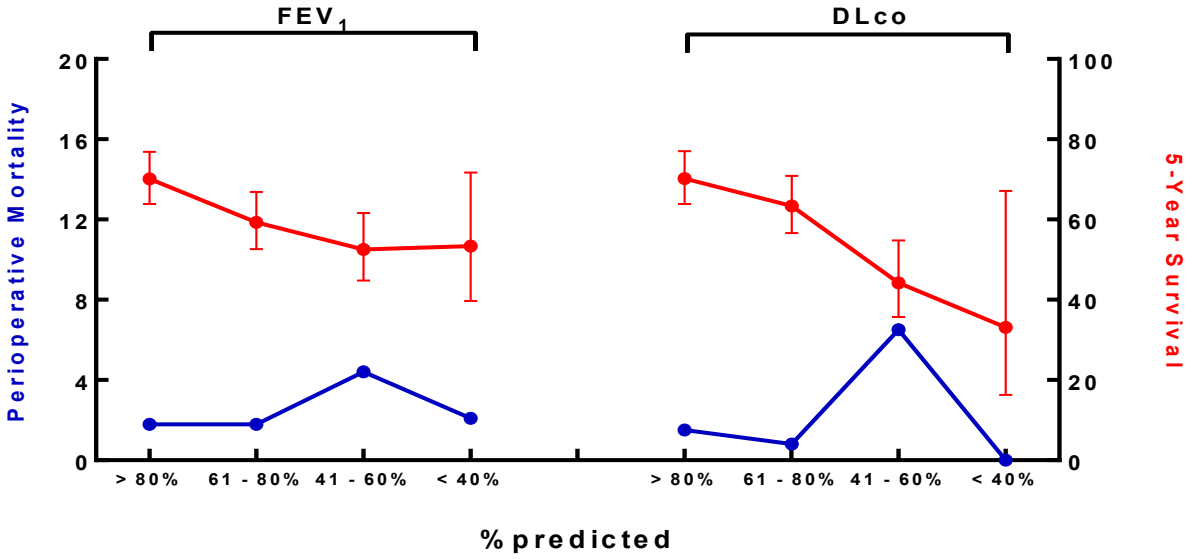


Figure 9. Perioperative mortality (blue line) and 5-year survival (red line) according to different levels of %predicted for FEV_1 and DLco. Based on data from 972 patients undergoing lobectomy for NSCLC Stage 1. Data from Berry et al, 2015.

Using multivariable analysis, DL_{co} was an independent predictor of long-term survival for all patients. This index may therefore be helpful in improving the selection of patients for lung resection and balancing the operative risk with long-term outcomes.

Arterial blood gases are recommended as part of the workup within one recent set of guidelines (Brunelli et al, 2013). ABG's preoperatively is potentially important in order to try and prevent subsequent respiratory insufficiency. Hypercapnia, defined as a PaCO2 > 6 kPa has been considered an exclusion criteria for pulmonary resection (Celli et al, 1993; Zibrak, O'Donnell & Marton, 1990). Hypercapnia and hypoxaemia (PaO_2 < 8 kPa or SaO_2 < 90%) are apparently risk factors for postoperative complications.

What is interesting to note is that the British Thoracic Society guidelines point out that hypercapnia alone is not a predictor of increased complications as such, and patients may well be excluded on the basis of their postoperative FEV_1 or DL^{co} being < 40% (Armstrong et al, 2001). In the current set of guidelines, no mention appears to be made of ABGs (NICE, 2011). Up until this point in time, it has not been reliably established that ABGs indicating abnormality are indeed predictors of prognosis in patients undergoing lung resection. Interestingly though in the latest review, there was not 100% agreement in the Delphi process (National Clinical Guideline Centre, 2015).

Huh et al (2013) assessed the relevance of spirometry in predicting pulmonary complications in a group of elderly patients (³ 60 years) undergoing laparoscopy-assisted gastrectomy (LAG). They reviewed four indices - FEV_1, FVC, PEF and $FEF_{25-75\%}$. The premise of this study was that it is known that age is one factor in this type of surgery, which has a reported mortality rate of between 12 to 58%. The study found that when using LAG, the only predictor or pulmonary complications was age, and that unlike previous studies (Barisione et al, 1997; Grigorakos et al, 2008), spirometry was not helpful. This may simply reflect the procedure type compared to the previous studies.

Jeong et al (2013) reviewed the usefulness of pre-operative spirometry in relation to operative risk in patients undergoing gastric cancer surgery. This study followed the review by Lawrence et al (1989) where significant flaws in previous studies were noted. The surgical groups were LAG and open gastrectomy and within these groups the subjects were divided into those with COPD and those without. In those patients with abnormal spirometry, there was an increased incidence of both surgical and systemic complications. The authors concluded that pre-operative spirometry is simple and useful in predicting postoperative morbidity in patients undergoing gastric surgery, and that patients should be screened pre-operatively.

In the study of Stanzani et al (2014), using the American College of Physicians algorithm, noted that spirometry was useful in all 239 patients. In those patients (n = 76) who had DL_{co} measurements, in some patients with a $ppoDL_{co}\%$< 40%, their $ppoFEV_1\%$ was > 40%. In general, the authors noted that a low $ppoFEV_1$ and COPD were two key factors in identifying pulmonary complications, whilst it appeared that $ppoDL_{co}\%$ was not useful. The authors concede that they probably have got a small subgroup of patients (76/239) of patients who had DL_{co} measures, and that this may be reflected in this unexpected finding.

Ferguson et al (2014) assessed the relationship of long -term survival in relation to $ppoFEV_1$ and $ppoDL_{co}$ in patients with NSCLC.

Pre-operative lung function was poorly associated with long-term survival, whereas $ppoFEV_1$ and $ppoDL_{co}$ were strongly associated with mortality. Lung function studies using ppo outcomes and their relation to survival should be taken into consideration when

deciding and planning the course of action and planned resection.

Drakou et al (2015) reviewed the spirometric changes following lobectomy for bronchial carcinoma. They observed in their 30 patients that the pre-operative FEV_1 decreased from 2.55 ± 0.66 to 1.97 ± 0.59 at 1 month and increased to 2.15 ± 0.62 at 6 months postoperatively. There was clearly differences between the actual measured data and that predicted by Juhl & Frost (1975) and other equations, although no formal direct comparison was undertaken.

Berry et al (2015) assessed the impact of lung function measurements on long-term survival after lobectomy in Stage 1 NSCLC patients who did not have induction therapy prior to surgery. They assessed the usefulness of both FEV_1 and DL_{co} in terms of perioperative mortality and the 5-year survival. Long-term survival is clearly greater where the DL_{co} and FEV_1 are > 80% predicted, with survival becoming poorer as one or both of the indices decline to below 80% (Figure 9). The results of this study concur with other studies (Ferguson et al, 2012; Ferguson et al, 2014).

Mizugchi et al, (2016) has attempted to address these issues by assessing the long-term survival risk associated with abnormal preoperative ABGs in patients with Stage 1 NSCLC. An abnormal ABG was defined as any one of a) $PaO_2 \leq 10.7$ kPa, or b) $PaCO_2 \leq 4.7$ kPa, or ≥ 6 kPa or c) pH ≤ 7.35 or ≥ 7.45. In this study there were 269 patients with a normal ABG and 145 with an abnormal ABG. The authors observed that there were no significant differences between preoperative comorbidity and postoperative complications between the two groups. It has previously been shown that perioperative complications are not influenced by preoperative hypercapnia (Kearney et al, 1994; Harpole et al, 1996). The risk of mortality increased by 1.61 times when comparing a normal ABG to abnormal ABG. The pH and PaO_2 appeared not to affect survival, whereas when the $PaCO_2$ was either low or high, survival rates were lower compared to patient with a normal $PaCO_2$.

Effects of Drug Therapy: One interesting aspect of the assessment of patients with NSCLC is the use of chemotherapy or radiotherapy. The study of Matsubara et al (2005) showed that in those patients who had received induction therapy, which was then followed by surgery, and who then died of ARDS within 30 days had normal spirometry, but a significantly reduced DL_{co}% compared to the surgery only group (64.8 ± 17.2% vs 91.7 ± 13.7%, $p < 0.0001$), even after adjustment for the lower [Hb].

Even when changes in DL_{co} are subclinical, this test may be regarded as a sensitive indicator of lung damage as a result of chemotherapy (Leo et al, 2004). There are a number of reports indicating the effects of both radiotherapy and chemotherapy toxicity resulting in a reduced DL_{co} (Hsai, 2002; Takeda et al, 2006; Ferguson, Reeder & Mick, 1995). What would compound further the function loss, would be the resection of the lung tissue, which would not be the case in non-thoracic surgery for cancer.

It is also interesting to note that in Takeda's study there was a statistically significant improvement in the FEV_1 after induction therapy (2.28 ± 0.61 to 2.40 ± 0.62, $p = 0.0385$). Whilst the improvement may not be necessarily clinically significant ($DFEV_1$ = + 5.3%) this may reflect the known improvements observed in other studies by reducing the bronchial obstruction (Miller et al, 2003; Gopal et al, 2003). Again, in this study, Matsubara showed that the DL_{co}% significantly decreased after induction therapy from 90.3 ± 18.3% to 71.1 ± 12.5% ($p < 0.0001$). This confirms previous

reports of induced pulmonary toxicity in relation to DL_{co} (Roberts et al, 2001; Stamatis et al, 2002; Miller et al, 2003; Gopal et al, 2003; Horning et al, 1994).

There are known similar affects from variety of chemotherapeutic agents – bleomycin (Horning et al, 1994), mitomycin-C (Castro et al, 1996), gemcitabine (Maas et al, 2003), cisplatin (Mass et al, 2003; Bhalla et al, 2000), carboplatin and paclitaxel (Rivera et al, 2009, Cerfolio, Talati & Bryant, 2009).

It is therefore important to ensure that where a patient is to undertake induction therapy before surgery, that DL_{co} is assessed and then reassessed afterwards, but prior to actual surgery itself, if that is the plan. In assessing the ppoDL_{co}% where lung resection is planned, the post-induction therapy, pre-surgical value of DL_{co} should be used, as this will reflect the gas exchange ability of the lungs post-surgery.

Assessing this further, there is very little data on why DL_{co} would be significantly reduced, although it is known that the subdivisions of DL_{co} may be affected by the drugs used. We know that bleomycin affects both membrane capacity (Dm) and pulmonary capillary blood volume (Vc), whilst etoposide only appears to affect Dm (Sleijfer et al, 1995).

Conclusions: The role of resting lung function testing in the assessment of patients preoperatively, has since Gaensler et al (1955), developed into an important part of the pre-operative assessment of patients undergoing surgery. The importance of this process has been expertly reviewed, in terms of the changes in respiratory physiology by Davies (1991).

Predominately the use of the FEV_1 and the DL_{co} are used to assess potential outcomes in lung resection and to provide a guide to the assessment teams as to whether or not more complex testing is required.

In essence, in lung resection surgery, measurement of the FEV_1 is essential along with the FVC to characterise airway function.

There is also good evidence that the DL_{co} should also be measured in lung resection patients, as a significant proportion of patients may have an abnormal DL_{co}, despite having a normal FEV_1. This may simply reflect the overdependence on a single number – the FEV_1 rather than reviewing the whole of the expiratory flow -volume curve, thereby making use of information regarding small airway dysfunction. Arterial blood gases and static lung volumes may provide, in some patients, useful additional information, but this may be more appropriately selected by the referring pre-operative assessment team.

The prediction of morbidity and mortality at 30-, 60- and 90-days and the long-term survival of patients following lung resection is dependent, to some extent on the procedure – lobectomy vs pneumonectomy – and there perhaps remains more work required to predict what the likely remaining lung function (FEV_1 and DL_{co}) is going to be once the procedure has completed. The measurement of FEV_1-D1 on the first day postoperatively is technically possible and may be a good predictor of outcome.

Finally, in this group of patients, it should be regarded as both essential and logical to assess the suitability of patients for surgery using FEV_1 and DL_{co}, and where patients are advised to proceed to induction therapy, the measurements should be repeated post therapy and pre-surgery, and it is the presurgical values that should be used to predict outcome in these patients. The same should also apply to those patients who perhaps need to undertake pre-habilitation before

surgery, with measurements made pre- and post-rehabilitation to assess the positive benefits of the pathway and to ensure that the most appropriate results are used to predict outcome from surgery.

In terms of upper abdominal surgery and bariatric surgery there is some evidence to suggest that measurements of FEV_1 are useful, with perhaps DL_{co} less useful. In the morbidly obese, we know that the lung mechanics will be compromised and this should be assessed using static lung volume measurements. Based on a good clinical history, the pre-operative assessment team should select patients in whom they feel that these measurements are appropriate.

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Part II, Exercise testing, will follow in the next issue of 'Inspire'.

Any thoughts or comments on the article (or the series) please email at inspire@artp.org.uk

Association of Respiratory Technicians & Physiologists

FROM THE ARCHIVE:

ARTP members can view archive issues of Inspire/ Breath at: http://artp.org.uk/en/members-area/inspire-journal/inspire-archive/index.cfm

ISSUE No. 5: September 1977

NEWSLETTER

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Association of Respiratory Technicians & Physiologists

The First Year of the Association

By Len Smith

It is now just over a year since the inaugural meeting of the Association took place. At that meeting an Executive Committee was elected to pursue the objectives of the Association. This Committee, along with co-opted members, has met regularly with good attendance, even though this has meant some members travelling many miles. During the many hours of discussion, we have been fully aware that members not directly involved could be excused for thinking that scientific meetings and a Newsletter are the full extent of our achievements. Any lack of communication, I must add, should not be laid at the feet of Spike Clay, who has travelled regularly to London from Cardiff to report for the Newsletter. The fact that the notes are in Welsh and the Editor cannot translate is beside the point!

As we are now approaching an Annual General Meeting on 8th October, I feel as Chairman that it is time to give a brief summary, through the medium of the Newsletter, of what the Executive and co-opted members have been trying to achieve on behalf of the members. Apart from the scientific meetings, which form a major part of our Association, it was obvious that within the Health Service and research establishments there were small groups of specialist scientists and technicians who were bewildered at the rapid rate of change taking place and, what is more important, had little means of influencing this if they so wished.

These groups formed themselves into the Federated Associations of Medical technology (FAMT), and our first objective was to join

this Federation. This we achieved and were accepted as founder members. Other groups have since applied to join and the total membership at present is around 2,500. it is obvious that the DHSS welcomed this Federation, and in its short life its views have been sought on many topics; there is little doubt that the Federation will play a prominent part in shaping the future scientific and technical services. Membership can only be through an affiliated association, and a Newsletter is soon to be sent to all members.

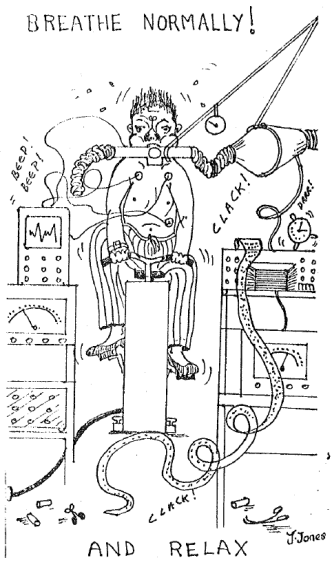
A meeting took place (see Newsletter, January 1977) between the DHSS Senior Scientific Officers and ARTP representatives to ascertain the views of the DHSS on the Zuckerman consultative document and to put forward the various points raised by members. It was felt that the meeting was well worthwhile and the door has been left open for further discussion.

With the introduction in the late seventies of the new technician education and training courses, it has been necessary to spend much time discussing the modules of in-service training of technicians who may undertake respiratory work. A first draft has been prepared to be submitted through the FAMT to the DHSS but owing to the time factor it has not been possible at this stage to ask all members for their views. It is worth noting that one of our members is now discussing the whole question of education and training of technicians directly with the DHSS as a member of the FAMT delegation, and will therefore also submit our proposed training programme direct.

There are obviously many other matters that we have discussed which are much too numerous for me to mention in this summary, so why not come to the AGM in October and express any other points you would like to put forward then. If you cannot do this, why not write or even telephone.

Before finishing this summary, I would like to thank all who have given so much time to the Association, and I am particularly grateful since this time has to be given in addition to their normal duties.

** ** ** ** ** **



As the AGM is being held at the London Chest, Jane Jones has sent us this diagram to let us know what to expect.

JOIN ARTP

MEMBERSHIP BENEFITS

The ARTP ...

- is the sole professional organisation in the UK for practitioners working in respiratory physiology and technology.
- develops training strategies, training materials, organises and runs its own national training course and meetings for members.
- holds a major national annual conference. (preferential rates for members)
- provides the only national professional examinations for practitioners in; (1) spirometry and (2) respiratory function testing.
- produces 'Inspire' - the official journal of the ARTP.
- circulates national job vacancies.
- publishes guidelines and standards for good practice.
- funds grants to enable members to attend important national / international meetings and courses.
- works closely with lung function equipment manufacturers and respiratory pharmaceutical companies.
- works in conjunction with the British Thoracic Society to produce national guidelines and standards for good practice in the performance of respiratory measurement.
- works closely with the NHS Executive & the Department of Health in formulating policy and in the strategic direction of the profession.
- is a founder member of the Conference of Clinical Scientist's Organisation's (CCSO) and is a member of the Association of Clinical Scientist's.
- is a founder member of the Institiute of Physiological Sciences (IPS) and the Federation of Healthcare Scientists (FedHCS).
- has close involvement with Assembly 9 of the European Respiratory Society.
- Free European Society membership

GRANTS AVAILABLE

ARTP currently offer grants for attendance at the following meetings:

Meeting	Grant available	Number available	Application Deadline
ARTP Conference	Registration only	5	tbc
BTS Summer Meeting	Up to £300	5	20th May 2016
ERS Congress	Up to £1000	5	5th August 2016

ARTP MEETINGS

Year	Date AGM	Venue	Town/City
1975		Inaugural Meeting King College Hospital	London
1976	12/06/1976	“General Meeting" Brompton Hospital	London
1977		NO MEETING?	
1978		Spring Meeting, Derbyshire Royal Infirmary	Derby
1978		AGM. Charing Cross Hospital	London
1979		Spring:	
1979		AGM;	
1980		Spring: Harefield Hospital	London
1980	04/10/1980	AGM, Walsgrave Hospital	Coventry
1981	04/04/1981	Spring: Hope Hospital	Manchester
1981	10/10/1981	AGM. Derbyshire Royal Infirmary	Derby
1982		Spring:	
1982	16/10/1982	AGM: Harefield Hospital	London
1983	16/04/1983	Spring: Royal Liverpool Hospital	Liverpool
1983	08/10/I 983	AGM: Kings College Hospital	London
1984	06/04/1984	Spring: Stoke Mandeville Hospital	Aylesbury
1984	06/10/1984	AGM: Lodge Moor Hospital	Sheffield
1985	20/04/1985	Spring Leeds General Infirmary	Leeds
1985	05/10/1985	AGM 10th Anniversary Papworth Hospital	Cambridge
1986		Spring	
1986	31/10/1986	AGM:York District Hospital	York
1987	04/04/1 987	Spring: City Hospital	Edinburgh
1987	31/10/1987’	AGM: Manor Hospital	Walsall
1988		Spring ??? With BTS?	Newcastle
1988	14/10/1988	AGM:City Hospital	Edinburgh
1989		Spring Meeting, St Thomas’ Hospital	London
1990	08/12/1990	AGM. Kensington Town Hall	London
1991	30/11/1991	AGM: Queen Mary Westerfield Hall	London
1992		Spring	Stirling
1992	21/11/1992	AGM: B’ham General Hospital	Birmingham
1993		NO MEETING	
1994	18/02/1994	Spring:North Staffs Hospital	Stoke on Trent
1994	26/11/1994	AGM: Stirling University	Stirling
1995		Summer:QMC	Nottingham
1995	24/11/1995	AGM: Pontefract General Infirmary	Pontefract
1996	04/07/1996	Summer:University of Warwick	Warwick
1996	22/11/1996	AGM: Park Hotel Fazakerley	Liverpool
1997	03/07/1997	Univ of Loughborough	Loughborough
1998	22/01/1998	AGM:ICC "25th Anniversary"	Birmingham
1999		AGM:Racecourse/Moat House	Doncaster
2000	10/02/2000	AGM:Hanover International	Daventry
2001	22/02/2001	AGM:Hilton	Blackpool
2002	17/01/2002	AGM:Hilton	Blackpool
2003	16/01/2003	AGM:Moat House	Stratford upon Avon
2004	28/01/2004.	AGM:ICC	Telford
2005	24/02/2005	AGM-Moat House 30th Anniversary	Glasgow
2006	26/01/2006	AGM Hilton Metropole	Brighton
2007		AGM-Moat House	Glasgow
2008		AGM Hinckley Island Roundabout	Hinckley
2009		AGM Hinckley Island Roundabout	Hinckley
2010	28/01/2010	AGM Park Inn Hotel	Heathrow
2011	03/03/2011	AGM Marriott Hotel	Glasgow
2012	26/01/2012	AGM Hinckley Island Roundabout	Hinckley
2013	07/02/2013	AGM Hinckley Island Roundabout	Hinckley
2014	30/01/2014	AGM:Hilton	Blackpool
2015	22/01/2015	AGM:Hilton	Blackpool
2016	14/01/2016	AGM Russell Hotel 40th Anniversary	London