PostScript

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Comparison of measured exhaled nitric oxide at varying flow rates

Altered levels of exhaled nitric oxide (Fe_{NO}) have been well documented in a number of conditions, although it is in asthma that this phenomenon has been most extensively investigated.[1] Raised Fe_{NO} levels in patients with asthma have been correlated not only with other markers of airway inflammation (including induced sputum eosinophil count), but also with airway hyperresponsiveness and response to inhaled corticosteroids.[2] Furthermore, the detection of a raised Fe_{NO} level has been shown to have a positive predictive value of up to 95% for the diagnosis of asthma.[3]

A number of factors can influence the production and measurement of Fe_{NO} including airway calibre, caffeine, smoking and, in particular, respiratory flow rate. A standardised flow rate of 50 ml/s has recently been adopted by both the European Respiratory Society and the American Thoracic Society; however, to date, there has been a discrepancy in the rates used by clinicians and researchers worldwide.[4] The Logan LR 2000 chemiluminescence analyser (Logan Research Ltd, UK) uses a mouth flow rate of 250 ml/s to measure Fe_{NO} while the Niox® Nitric Oxide Analyzer (Aerocrine AB, Sweden) uses a flow rate of 50 ml/s. Both analysers use online measurements to calculate Fe_{NO}, express the results in parts per billion (ppb), and have similar accuracies.

Few data are available to allow direct comparison between the two analysers and hence flow rates. This can make comparison of studies using the different methods difficult. We have prospectively analysed the Fe_{NO} from asthmatic (n = 63) and non-asthmatic (n = 29) adult patients with both devices in a head to head fashion. The geometric mean for the Fe_{NO} using the Niox analyser was 25.6 (95% CI 24.4 to 26.8) ppb for asthmatics and 16.8 (95% CI 15.6 to 18.0) ppb for non-asthmatics ($p<0.01$). With the Logan LR 2000 the values were 6.8 (95% CI 5.6 to 8.0) ppb in asthmatics and 4.4 (95% CI 3.1 to 5.7) ppb in non-asthmatics ($p<0.01$). The pooled data from the Niox and Logan LR 2000 were found to be closely correlated to one another ($r^2 = 0.62$, $p<0.001$). Altman-Bland plots of the data obtained support the suggestion that there is a high level of agreement between the two methods (fig 1). This agreement is retained when subgroup analysis of asthmatics and non-asthmatics is performed. The slightly better discrimination between asthmatics and non-asthmatics at lower flow rates (shown by the well separated confidence intervals) may be partly because of the improved Fe_{NO} plateau at this rate.

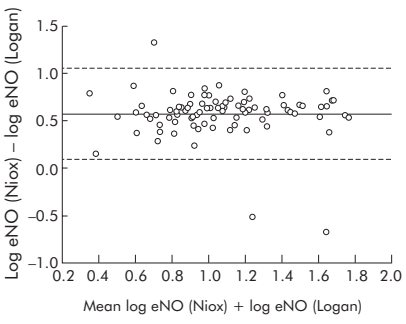

Figure 1 Comparison of eNO values with the Niox and Logan analysers

These results suggest that data obtained using either flow rate are valid, and the methods demonstrate a strong degree of correlation. This is an important confirmatory analysis as it facilitates comparison of results obtained by the two techniques, both previously and in ongoing clinical trials using flow rates which differ from that recently recommended.

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doi: 10.1136/thx.2005.045468

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Local IFN-γ responses in TB

Globally, the tuberculin skin test (TST), smear microscopy, and culture remain central to the diagnosis of tuberculosis (TB) because of the cost and ease of performance. However, TST has poor specificity and reduced sensitivity in settings including HIV and advanced TB,[1] smear microscopy lacks sensitivity, and TB culture (the diagnostic gold standard) takes weeks and is positive in only two thirds of treated cases.[2] TB pleuritis and peritonitis can be particularly difficult to diagnose due to paucity of bacilli and often need invasive or open procedures. In this setting, assays measuring interferon γ (IFN-γ) production by lymphocytes in response to TB antigens may be useful. While most studies have used blood based assays, more clinically relevant information may exist in local fluids such as bronchoalveolar lavage (BAL) fluid and pleural fluid in which much higher responses have been achieved.[3–5]

We investigated a 32 year old Somali man, resident in Britain for 2 years, who presented with a 3 week history of vomiting, diarrhoea, anorexia, and abdominal pain. On examination he was febrile (38.5°C), tachycardic, and tachypnoeic. No lymph nodes were palpable. A BCG scar was noted. He had signs of a right pleural effusion and ascites with peritonism.

A full blood count showed lymphopenia (0.26×10^6/l), normal neutrophils (3.6×10^6/l), hypochromic microcytic anaemia (Hb 10.7 g/dl), and a normal platelet count. Hyponatraemia (129 mmol/l (normal range 135–145)), hypoalbuminaemia (28 g/l (normal range 35–50), and mild hepatitis (aspartate transaminase 121 U/l (normal range 5–40)) were noted. Inflammatory markers were increased as follows: C reactive protein 280 mg/l; erythrocyte sedimentation rate 75 mm/h. An HIV antibody test was negative. A tuberculin skin test was not performed. The CT scan showed a moderate right pleural effusion and small left pleural effusion, small bowel dilation with mesenteric induration, large volume ascites, and small (<1 cm) mediastinal but no abdominal lymph nodes. On abdominal paracentesis, a leucocytosis of 640 cells/ml (75% lymphocytes) with 55 g/l protein and 3.8 mmol/l glucose was found but no organism was identified. The pleural fluid had a protein level of 36 g/l and a glucose level of 6.4 mmol/l.

Bronchoalveolar lavage was performed. Auramine staining of sputum and ascitic, pleural, and BAL fluids was negative. Molecular assays (TB strand displacement assay) were negative from all sites. TB cultures were negative at 8 weeks. The pleural fluid, ascitic fluid, BAL fluid, and peripheral blood were examined for absolute leucocyte and lymphocyte numbers by flow cytometry, as well as lymphocyte phenotypes. The frequency of lymphocytes synthesising IFN-γ in response to purified protein derivative of *Mycobacterium tuberculosis* (PPD) was then measured as described previously.[4] The percentage of lymphocytes in BAL fluid, ascitic fluid, and pleural fluid was 10.5%, 79.2%, and 91.1%, respectively. In CD3+ T cells the CD4/CD8 lymphocyte ratios in BAL fluid, ascitic fluid, pleural fluid, and blood were 1.5, 7.7, 2.7, and 2.1, respectively. In the CD4+ T cell populations the frequency of PPD specific IFN-γ positive lymphocytes in BAL fluid, ascites, pleural fluid, and

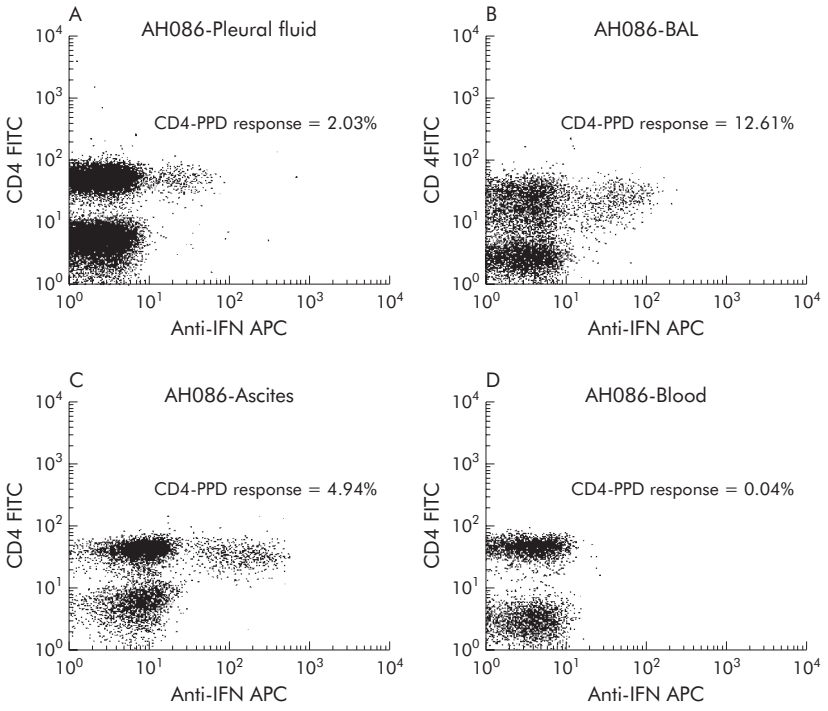

Figure 1 Proportions of interferon (IFN)-γ synthetic CD4+ T cells in response to purified protein derivative (PPD) after 16 hours of incubation in (A) pleural fluid, (B) bronchoalveolar lavage fluid, and (C) ascitic fluid of a patient with acute TB. These cells are virtually absent in the peripheral blood (D). In these flow cytometric assays the CD3+ T lymphocytes are gated and shown in the histograms. Of these, the CD4+ populations contain the IFN-γ positive cells (upper left quadrants) while the CD4− (CD8+) T cells are IFN-γ negative.

blood was 12.61%, 4.94%, 2.03%, and 0.04% (fig 1).

A presumptive diagnosis of tuberculous peritonitis was made. The patient was too unwell for exploratory surgery. Empirical antituberculosis treatment with rifampicin, isoniazid, ethambutol, and pyrazinamide was commenced with adjunctive corticosteroids which resulted in rapid resolution of his symptoms and signs. Corticosteroids were tailed off over a few weeks. He continues on rifampicin and isoniazid and remains well.

Although we were unable to obtain histological or microbiological confirmation of the diagnosis in this case, clinical and radiological evidence combined with the treatment response were highly suggestive of TB. The patient had marked lymphopenia which, in HIV negative TB patients, has been associated with advanced TB as well as decreased rates of smear positivity, an increased rate of extrapulmonary disease, and an attenuation of skin test reactivity.[6] Hence, in a setting where traditional diagnostic tools are least effective, blood based immune assays are also likely to be suboptimal due to low CD4 counts and diminished response to antigens. The demonstration of high frequency lymphocyte responses in BAL fluid, pleural fluid and ascitic fluid, despite a negligible response in the blood as observed in our patient, is therefore of great clinical importance. We believe that this case highlights the potential usefulness of immune assays in TB with tissue fluids other than blood. Investigation of a larger patient cohort is warranted to delineate the responses seen in different stages of infection (such as latent and treated TB) and to determine clinically relevant cut off points which will allow these assays to be used as a diagnostic tool.

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doi: 10.1136/thx.2005.045302

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Tannic acid in plant dust causes airway obstruction

Occupational or environmental exposure to plant dusts has been shown to increase the risk of obstructive lung diseases, primarily by non-immunological activity.[1] However, the causative agents and the underlying mechanisms have not been established. We have recently suggested that the polyphenolic fraction of hydrolysable tannins in plant derived dusts, with tannic acid (TA) as the main constituent, may contribute to airway constriction.[2] Here we present experimental evidence that TA causes acute airway obstruction by non-competitive inhibition of the constitutive endothelial isoform of nitric oxide synthase (eNOS) in the tracheobronchial epithelium, which is reported to provoke airway hyperresponsiveness and bronchoconstriction.[3]

Organ bath experiments were performed using the trachea and main bronchi of non-sensitised guinea pigs. The tracheobronchial tree was dissected out of CO_2 sacrificed guinea pigs of either sex weighing 300–450 g and cut into rings of 3–4 cartilage segments wide. Isometric contractions were recorded as described previously.[4] Briefly, individual rings were mounted in organ baths containing 10 ml carbogen aerated Tyrode solution (pH 7.4, 37℃), kept at a preload of 25 mN, left to equilibrate for 60 minutes, and precontracted by addition of 25 μmol/l prostaglandin $F_{2\alpha}$ to 30–40% of their individual isometric maximum (100%).

NO release was determined in real time by an amperometric microsensor as described elsewhere.[4] Briefly, the tracheal and bronchial rings were opened longitudinally and kept in Hepes-Krebs solution (10 ml, pH 7.4, 25℃). The sensor was placed onto the luminal surface at a distance of 200 μm. After 30 minutes of equilibration, individual NO reactivity was assessed by addition of 15 nmol/l substance P.

Tannic acid (penta-*o*-digalloyl-β-D glucose; Fluka, Seelze, Germany) produced an immediate concentration dependent contraction of the tracheobronchial rings (lasting 30–60 minutes) with a mean EC_{50} of 0.19 μmol/l (95% CI 0.10 to 0.35) and a maximal response (E_{max}) of 85.0% (95% CI 76.6 to 93.4). The threshold concentration of TA eliciting a significant contraction ($p = 0.05$) was 0.7 nmol/l (corresponding to 1.2 mg/m^3). The contraction was completely abolished in epithelium denuded rings and by pretreatment with an unselective NOS inhibitor. It was not affected by the presence of an inhibitor of the neuronal and inducible isoforms of NOS (fig 1A), indicating that the TA mediated contraction in non-sensitised guinea pig was entirely due to inhibition of eNOS in the airway epithelium and that TA does not elicit direct effects on tracheobronchial muscle. The contractions were not blunted by addition of the NO synthase substrate L-arginine, which suggests a non-competitive eNOS blockade by TA (fig 1B). This finding also agrees with a biochemical