

E) Matériels et Techniques/Respiratory Equipment and Technics

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PERFORMANCE CHARACTERISTICS OF EXPIRATORY BACTERIAL FILTERS FOR VENTILATORS. J. LUMLEY, A. HOLDCROFT, H. GAYA, D. ADAMS and M.M. DARLOW.

Bacterial filtration systems can obviate the need for sterilization of ventilators, provided that an increase in resistance can be prevented from developing in the expiratory circuit.

The resistance characteristics and bacterial efficiency of four makes of expiratory filters were tested. The resistance of each filter was measured at flow rates between 20L and 100L/min. Each filter was subjected to the British Standards Institute Sodium Flame Test and a bacterial challenge of *Serratia marcescens*.

Only three of the filters had acceptable resistances initially and both types of disposable siliconized filters failed the Sodium Flame Test and bacterial challenge. The autoclavable siliconized filter demonstrated no significant increase in resistance after 200 autoclavings and no penetration of sodium chloride crystals. However, there was a slight leak of microorganisms. The disposable heated filter showed similar results after approximately 4,000 hours clinical use.

These results indicate that the latter two expiratory filters can be used in clinical practice, provided that their performance characteristics are fully understood.

HAMMERSMITH HOSPITAL, LONDON and MICROBIOLOGICAL RESEARCH ESTABLISHMENT, PORTON DOWN.

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THE EFFECTS OF HEAT ON THE FLOW AND GROWTH CHARACTERISTICS OF VENTILATOR HUMIDIFIER CONTAMINANTS T. P. Crowley

To study the effects of heat on bacterial contaminants emanating from the humidification system on the Bennett MA-1 volume ventilator, a pigmented, turbid suspension of *Serratia marcescens* was inoculated into the reservoir or "pot" on such a system. The zero concentration in the homogenous mixture of sterile water and inoculum exceeded 10^5 organisms per ml. Samples of the effluent gas were taken every 30 minutes by directing the inspiratory flow through a funnel-shaped cylinder and onto a culture plate located at the base. This output sampler (Aero-Test, Olympic Medical, Seattle, Wash.) has dimensions which permit even gas dispersion over the culture medium (TSA). During the 15 second sampling episode, the ventilator was set as follows: tidal vol. - 2000 ml.; rate - 25/min.; peak flow - 80L/min.; and pressure limit - 80 cmH₂O. These sampling parameters tested 12.5 liters of effluent gas each time. Commensurate samples were withdrawn from the "pot" to verify the efficacy of the inoculum. The Cascade dial settings were advanced at each sampling time to produce an accelerating thermal environment. Temperatures within the "pot" were recorded throughout the experiment.

The gradually increasing thermal environment, coupled with time had a decelerating effect on the concentration of the inoculum. The organism reached a thermal death point between 56.8°C and 63.0°C. Colonial retrieval of *Serratia* followed a similar curve, peaking at 16 colonies at 90 minutes and then tailing off at the higher temperatures. *Serratia* identification was accomplished using the API-E biochemical system. The results indicate that elevated humidifier reservoir temperatures necessary to generate adequately humidified inspired gas becomes an ally in expediting thermal death of existing contaminants.

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MEASUREMENT OF VENTILATORY DISTRIBUTION IN ARTIFICIALLY VENTILATED PATIENTS BY MEANS OF INERT GAS WASH OUT. I. Hensel, R. Schier, H. Burchardi.

Argon clearing curves were analyzed on artificially ventilated patients with normal and inhomogenous ventilation. After breathing a gas mixture containing 8 % argon the patients were switched to air. The argon wash out was analyzed by mass spectrometer.

The clearance function was obtained mathematically by a multiple exponential function. The distribution function of clearance time constants was expressed as the inverse Laplace transform to clearance curve. The inversion formula was calculated by the approximation of Schwarzl and Stavermann.

The coordinates of the peak maximum of the distribution function as well as the shape of the curves was used to characterize intrapulmonary distribution in intensive care patients. The most significant results were described and interpreted.

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Contribution was suppressed.

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NOUVEAU MODELE EXPERIMENTAL POUR L'ANALYSE DES RESISTENCES AU FLUX AERIEN. CHULIA, V.; LOPEZ MÉRINO, V.; LLEDO, M. & LLEDO, S.

Nous présentons un modèle original pour l'analyse directe et dynamique des résistances pulmonaires au flux aérien.

Ce modèle a comme avantage sur ceux décrits antérieurement que l'on peut analyser séparément, la participation des structures aériennes grosses ou centrales, et celles minces ou périphériques et pour laquelle il n'est pas nécessaire de pratiquer une thoracotomie. La méthode consiste fondamentalement dans l'introduction rétrograde d'un cathéter de fin calibre dans une bronche de la 7^{ème} ou 8^{ème} génération. Ce cathéter se retire par voie transdiaphragmatique au moyen d'une petite laparotomie. On peut enregistrer la différence de pression trachéo-bronchiale en relation avec les flux, et obtenir une analyse des résistances centrales. On étudie les effets sur les résistances pulmonaires au flux aérien ainsi que d'autres paramètres hemodynamiques et ventilatoires après l'injection de 50 µg/kg. de Prostigmine, sur une série de 10 chiens anesthésiés au pentobarbital sodique et maintenus en respiration assistée. Après on observe les effets de l'injection de 50 µg/kg. d'atropine. On étudie les paramètres suivants: Pression moyenne dans l'artère pulmonaire, fréquence cardiaque, compliance, résistance aériennes totales et résistances aériennes centrales.

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SERVICIO DE ANESTESIOLOGIA-REANIMACION

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EXPERIMENTS WITH THE AB MICATRONE REGULATOR, AN INFANT RESPIRATOR OF A NOVEL WORKING PRINCIPLE. P. Lotz, G. Schöch, H. Reineke

This respirator has the following characteristics: a) time cycled pressure generator, b) decelerating flow, c) variable internal compliance. The pressure is built up in a rigid reservoir under electronic feedback control to an amount sufficient to deliberate the desired tidal volume, when inspiratory valve is unlocked. Internal compliance of the respirator can be varied from 2 to 8 ml/cm H₂O by varying the volume of the reservoir from 2^l to 8 l thus increasing the time constant of the flow deceleration. A prototype of the respirator was tested on the two compartment lung model using resistances of 60, 200 and 600 cm H₂O/l/s and compliances of 2 and 8 ml/cm H₂O. The following results were obtained: a) ventilation of a "slow" compartment (high resistance and/or high compliance) increased, when internal compliance was enhanced; b) ventilation of a "fast" compartment (low compliance and/or resistance) remained unaffected by changing the internal compliance, c) "Pendelluft" volume between a "fast" and a "slow" compartment decreased, when internal compliance was enhanced. In additional animal experiments arterial oxygenation was found higher when at unchanged ventilation the internal compliance was enhanced. From this one can conclude that enhancement of the internal compliance is a favourable possibility to homogenize an uneven distribution of ventilation.

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REGULATION AUTOMATIQUE DE LA FIO₂ AU COURS DE LA VENTILATION ARTIFICIELLE. APPLICATION AU TRAITEMENT DE L'OEDEME PULMONAIRE EXPERIMENTAL. F. TREMOLIERES, MC. BLAYO, A. CHIRICO, JM. VALLOIS, JJ. POCIDALO. Nous avons précédemment proposé un nouveau dispositif permettant la régulation automatique de la concentration inspiratoire d'oxygène (FIO₂) grâce à la mesure continue de la saturation artérielle oxyhémoglobinée (SaO₂) par un oxymètre intravasculaire à fibres optiques; le respirateur utilisé étant le Servo-Ventilator 900 comportant un mélangeur air-oxygène automatique (Crit. Care Med. 1976-4-100) On a utilisé un tel dispositif chez le chien anesthésié; on induit un oedème pulmonaire expérimental par injection d'acide oléique dans l'artère pulmonaire. Dans ces conditions, une hypoxémie sévère s'installe progressivement. Elle est corrigée en faisant varier les grandeurs suivantes: FIO₂, le débit ventilatoire (\dot{V}_I), et le niveau de la pression expiratoire (PEEP). La programmation de SaO₂ a prévu une valeur de cette dernière autour de 90%. On constate les faits suivants: à la phase initiale la saturation prévue nécessite une hausse progressive de la FIO₂. Lorsque cette dernière dépasse 0,9, il est nécessaire d'augmenter \dot{V}_I , puis d'utiliser une pression positive expiratoire croissante. L'augmentation de cette pression est alors adaptée de telle sorte que, pour une SaO₂ = 90%, FIO₂ reste inférieure à 0,7. La mesure concomitante du débit cardiaque (Thermodilution) et du contenu sanguin en oxygène (Lex-O₂-Con) permet le calcul de la quantité d'oxygène transportée. On peut ainsi préciser le meilleur ajustement possible des différentes grandeurs considérées afin que FIO₂ soit minimum, pour une SaO₂ et un débit sanguin d'O₂ suffisant.

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HIGH FREQUENCY TRANSTRACHEAL JET VENTILATION. M. Klain, R.B. Smith

Percutaneous transtracheal ventilation using intermittent jets of oxygen under high pressure at the rate of 12-20/minute, has established itself as an important life support technique. The purpose of this study was to evaluate this technique at higher respiratory rates. In a series of 10 experiments on dogs a 14 g angiocath was placed percutaneously in the trachea and connected to a fluidic oxygen jet ventilator. The anesthetized animals were then ventilated with a minute volume of 17l at respiratory rates between 20 and 200 per minute for a period of 6 hours. All animals recovered uneventfully.

Arterial PO₂ and PCO₂ were maintained at the range of 400 to 575 torr and 20 to 25 torr, respectively. The intratracheal pressures did not exceed 8 torr during inspiration. At rates above 160 a PEEP effect of 2 torr was achieved. With increasing respiratory rates the pulse rate decreased from 220 to 190 and the systolic blood pressure increased from 160 to 180 torr. Cardiac index significantly increased at respiratory rates above 160/minute. At high respiratory rates each jet inflation increased the venous return to the left atrium and produced counterpulsation effect in pulmonary artery.

The results indicate that it is possible to maintain adequate gas exchange at respiratory rates of up to 200 per minute with low tidal volume approaching dead space volume. This was achieved at low inspiratory pressures with no circulatory impairment. For clinical practice, this method may offer an alternative to the conventional artificial ventilation and a new way of ventilatory assist. Synchronizing the jet ventilation with heart beat may augment the cardiac output.

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MESURE DE LA CONCENTRATION SANGUINE EN OXYGENE (CO_2) PAR COULOMETRIE : SCHEMA DE SURVEILLANCE DU "LEX-02-COM".
M.C. Blayo, C. Gaubebout et C. Joubin.

La méthode coulométrique a un intérêt majeur dans les laboratoires de soins intensifs. Cependant plusieurs critiques lui ont été adressées, en particulier l'apparition d'une sous-estimation des CO_2 . Nous proposons ici un schéma de surveillance permettant d'assurer la qualité des résultats en permanence.

De manière inaugurale les critères de bon fonctionnement sont l'absence de courant mesurable pour la ligne de base après désaturation du circuit, et, lors de l'étalonnage à l'air : l'indépendance de la réponse de la cellule au débit du gaz vecteur entre 30 et 50 ml.min⁻¹, la hauteur du pic de réponse, la durée du temps de comptage, la reproductibilité des mesures. Si 2 de ces 5 impératifs ne sont pas respectés la cellule doit être éliminée. Par ailleurs, il est indispensable de vérifier la qualité de la réponse en phase sanguine. Théoriquement, la comparaison des résultats des mesures sanguines à ceux obtenus par la méthode de Van Slyke représente la solution idéale. Mais, en raison de la lourdeur de cette méthode, la détermination de pouvoirs oxyphoriques (PO) suffit, pratiquement, pour tester l'efficacité des cellules en phase sanguine. L'obtention pour des sangs "normaux" d'un PO proche de 1,39 permet d'affirmer que le rendement de la cellule est correct.

La surveillance quotidienne est double : contrôle du temps de comptage et de la reproductibilité en air d'une part, détermination de 2 ou 3 PO d'autre part. Au cours du temps 2 types de distorsion peuvent apparaître de manière indépendante ou simultanée : soit une altération de la reproductibilité en air avec instabilité du temps de comptage relevant d'un dysfonctionnement du circuit électronique qui doit alors être révisé, soit une baisse progressive de la valeur des PO traduisant une diminution de sensibilité de la cellule qu'il faut donc recharger.

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CUTANEOUS CO_2 PARTIAL PRESSURES OF PATIENTS IN RESPIRATORY INTENSIVE CARE UNITS: A NEW MONITORING PROCEDURE.

S. Eletr, H. Jimison, C. Hill, R. J. Fallat* and H. J. Tucker*

An experimental miniature infra-red transducer was used to measure the partial pressure of CO_2 in equilibrium with the epidermis on the forearms of 40 patients in Respiratory Intensive Care Units. The procedure consisted in analyzing the CO_2 content of a small chamber hermetically surrounding a small patch of epidermis stripped of its stratum corneum. It was possible to sample the cutaneous CO_2 partial pressures once a minute and to generate a continuous plot of the data, in real time, at the bedside. The average experiment lasted about six hours and the longest one spanned a continuous period of 30 hours. In addition, arterial blood was sampled periodically and analyzed by conventional means. The results show that fluctuations in arterial Pco_2 , due to changes in ventilator settings for example, were tracked correctly by similar fluctuations in cutaneous Pco_2 . The offset between the two measurements and the time constant associated with the cutaneous measurement will be discussed and data will be presented. The data show that, in hemodynamically stable patients, cutaneous Pco_2 values are higher than the arterial values by 5.1 Torr with a standard deviation of 1.6 Torr over a range of arterial values that varied from 25 Torr to 65 Torr. The results suggest that cutaneous Pco_2 can be of clinical significance in the managing of hemodynamically stable patients whose ventilation must be monitored and/or mechanically assisted.

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OXYGEN TENSION IN MUSCLE TISSUE OF INTENSIVE CARE PATIENTS
N LUND, L JORFELDT, D H LEWIS, J B LÖFSTRÖM, S ÖDMAN

Purpose: a) To test a scheme for sterilization of a multi-wire surface oxygen electrode (MDO-electrode made by Prof M Kessler, Dortmund). b) To measure muscle surface oxygen tension (m. brachioradialis) in patients (after trauma or in septicemia), and to correlate the findings with cardiac output, regional blood flow measured with Xe^{133} , and pyruvate and lactate.

Method: Tissue oxygen tension can be measured either by the insertion of a microelectrode into the tissue or by placing an electrode on the surface of the selected tissue. To avoid trauma to the tissue we have chosen to work with a multiwire surface electrode. The MDO-electrode enables us to register oxygen tension in eight different points simultaneously. Wide variations in oxygen tension depending on the relation of the measuring points to the capillary system can thus be measured. a) Sterilization: the electrode consists of many different materials, these are disinfected according to the characteristics of the specific material, and thereafter the parts of the electrode are assembled under sterile conditions. b) Studies in man: in local anesthesia (0.25% bupivacaine) an incision was made through the skin, and the surface of the muscle carefully freed.

Results: Sterilization of the MDO-electrode does not change the characteristics of the electrode. In vitro studies and studies on free muscle surface in rats give stable and reproducible results. In critically ill patients clinical signs and cardiac output were poorly related to muscle oxygen tension and thus to muscle blood flow.

Conclusions: Muscle surface oxygen tension is of value in assessing blood flow through the large mass of striated muscle in the human body.

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A SYSTEM OF PaCO_2 and PaO_2 CONTINUOUSLY CONTROLLED VENTILATION S.Künke and V.Schulz

Shock lungs show strong and rapid changes of parameters determining the pulmonary gas exchange. The nowadays conventional method measuring the arterial blood gases is characterized by discontinuous sampling of the data. This procedure does not often make it possible to detect the inherent danger for the patients in time. That is why we developed a feedback control system in which the arterial PaCO_2 and PaO_2 are measured continuously by means of catheter electrodes (PCO_2 -General Electric, PO_2 -IBC) and regulated by changes of alveolar ventilation respectively inspiratory O_2 -concentration to a constant level.

The transient behaviour of PaCO_2 proves that the regulator works in the way of a PT-regulator. By temporal delay PaCO_2 led to a value corresponding to the chosen set point in a aperiodic deadbeat. The transient function of PaO_2 occurs in the form of a periodic deadbeat during set point shifts. The delay time for proper control amounts to $11,1 \pm 4,1$ min (for PaCO_2) and $18,4 \pm 4,0$ min (for PaO_2) on average. The maximum overshoot during the regulatory course does not exceed more than $11,7 \pm 3,2$ mm Hg (for PaO_2) on average. The positional error is calculated $2,0 \pm 0,5$ mm Hg (for PaCO_2) respectively $3,6 \pm 1,5$ mm Hg (for PaO_2).

This system presented by us 1975 was used in long-term ventilation of 24 patients with ARF. The time while the system was working without failure (no recalibration of electrodes necessary) was 22 h on average. A complete control and regulation of the pulmonary gas exchange under the condition of a long-term ventilation is granted.

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PROBLEMS OF CONTINUOUS paO_2 -MONITORING BY MEANS OF INDWELLING INTRAARTERIAL ELECTRODES

G. Goeckenjan, H. Duré, W. Lenz

In continuous intraarterial pO_2 -monitoring by means of indwelling polarographic electrodes several problems are to be expected: thromboembolism, haemorrhage, infection, difficulties concerning electrical safety, complicated handling, instability of calibration, dependency from flow, pressure, temperature, pH, pCO_2 and response time. Own experience are based on in-vitro-examinations of IBC-electrodes and on paO_2 -monitoring with the same probes in 50 intensive care patients (monitoring periods from 2 to 362 h). Serious complications did not occur. Electron microscopic scanning of the electrode surface showed only slight fibrin and blood cell deposits. 369 comparisons of continuous and discontinuous pO_2 -measurements proved a correlation coefficient of 0.95 (S.E.E. 20 mm Hg). The mean over-all in-vitro-drift was $\pm 1.7\%/h$ (including errors in bench analyzer measurements). The deviations of IBC electrode measurements from calibration can be ascribed in part to changes in pH ($-1.2\%/0.1$ pH) and in temperature ($1.3/^\circ\text{C}$). The effect of pCO_2 changes seems to depend only on the concomitant pH changes. There is a low flow dependency of the electrode. The response time (at first 60-100 a for 90%) rises significantly with the duration of the monitoring. Thus, after 2-3 days, fast changes of pO_2 often are not recorded in full extent.

If the specific properties of the polarographic electrode and the contraindications (severe haemorrhagic diathesis, chronic occlusive arterial diseases) are taken into account, the continuous pO_2 measurement by means of indwelling intraarterial electrodes has proved to be a valuable, safe, and simple technique in monitoring especially short-termed trends of arterial pO_2 .

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IN-VIVO PO_2 MONITORING AFTER OPEN-HEART SURGERY

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Rapid, serial, arterial blood-gas studies in patients after open-heart surgery indicated that there were wide, rapidly changing and apparently random variations of 6.6-13.3 kPa in PaO_2 . In order to study these changes more critically a miniaturized Clark-type polarographic oxygen electrode mounted on the tip of a double-lumen umbilical artery catheter was inserted into the left atrium at operation in 20 patients undergoing open-heart surgery. Blood sampling, left atrial pressure measurements and infusion of fluids were carried out via one lumen, while the electrode was connected to a battery operated current-to-voltage amplifier and panel meter via the other lumen. The electrode has a linear output of $\ln A/1.33$ kPa of increase in oxygen tension to about 40 kPa and an optically coupled isolator conveys the amplifier signal to a chart recorder for continuous recording.

Although there have been minor faults with the monitor and some electrodes have failed to function their performance has been good, correlating well with the PO_2 of blood sampled at the same point and measured in the conventional way ($r=0.928$, $p<0.001$). Further recalibration has been required after 2-3 hours use of some electrodes and thereafter they have been stable, remaining in situ for 20 hours-16 days. In vitro testing of electrodes using a pump-oxygenator system indicates good performance at varying flows, temperatures, pH and haematocrit with both blood and saline.

The information continuously obtained by this technique has confirmed our previous observations of unexpected variations in PaO_2 . These are not only the results of recognised physiological variations or the quality of patient care but may be a reflection of apparently cyclical variations in oxygen tension. This technique of continuous PO_2 monitoring has also been valuable in the management of patients undergoing mechanical ventilation.

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SIMULTANEOUS IN VIVO MONITORING OF BLOOD PARAMETERS WITH IN SITU SENSOR CALIBRATION. K. Jank, E. Musoglu, J. Hicquet, M. Demeester.

The simultaneous in vivo measurement of several arterial blood parameters is of unquestionable importance for patients in intensive care. The sensors currently available on the market (P, t° , pO_2 , pCO_2 , pH, etc) can hardly be used simultaneously except at the cost of perforating several vessels, and never all in the same region of the circulatory system; furthermore, the need for miniaturization always poses problems of ruggedness, performance and cost. The prospect of a miniaturized multisensor being developed still seems remote.

This paper described a disposable support which permits the simultaneous in vivo measurement of numerous parameters in one location, the use of non miniaturized biosensors and the calibration of sensors in situ.

This apparatus has been developed so far as a support for oxygen tension, oxygen saturation and pH sensors to be used in our computer-aided system for monitoring cardio-respiratory function.

The inclusion of sensors for the measurement of blood velocity and temperature allows continuous correction of the signals received from flow-dependent and temperature dependent sensors.

The shunt permits the development of automated function tests based on the analysis of the rate and amplitude of changes in blood gas levels following, for instance, transient perturbations of inspired gas concentration or an increase in positive end expiratory pressure in patients who are mechanically ventilated.

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CONTINUOUS MONITORING OF TISSUE PO_2 IN CRITICALLY ILL PATIENTS K. Takeda, K. Kanno, T. Minami and K. Katsurada

In order to clarify the relationship between tissue PO_2 and arterial PO_2 in normal and critically ill condition, the following experiments were performed in clinical materials using a mass spectrometer (Medispect II). On comatose, intubated patients who were suffering uncomplicated head injury, arterial and muscle PO_2 were monitored simultaneously, while FiO_2 was altered among 0.2 and 1.0. Thus nearly normal $\text{PtO}_2/\text{PaO}_2$ relationship curve was obtained. The above experiments were extended to post resuscitative period of shocked patients. Some of them showed a impairment of pulmonary function, but the response of tissue PO_2 to increased FiO_2 was more remarkably disturbed than that of PaO_2 . These findings were well related to decreased A-V oxygen content difference.

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A NEW DEVICE FOR MEASURING O_2 CONSUMPTION. G. Plichi, G.C. Canducci, A. Giannoni, G. Manzella, P. Pagani, R. Ruggeri, M. Vanzi, G. Zingaretti.

The new device presented is capable of measuring O_2 consumption automatically in patients with spontaneous respiration or assisted ventilation. The measuring principle is based on the analysis of the inspired and expired gases. This process is carried out using the measurement given by a micro fuel cell sensor, in addition to the measurement of the respiratory volume. The volume of the respiratory gases, collected in an elastic container, is calculated on the basis of the time it takes to empty by means of a rigorously constant flow. The instrument consists of: a pneumatic unit, which also contains a micro pump for sampling of reference gas, room air or another mixture inspired by the patient; an electronic unit, containing a section with logic control of the various operative phases of the instrument and an arithmetic section which elaborates the measurement data, with a final display of the O_2 consumption and the pulmonary ventilation. The time it takes for the expiratory gases to collect can be seen from several tests between 1' and 15". The complete duration of the test, including the time for elaboration and restoration, does not exceed 2' 30". This duration is conditioned essentially by the time constant of the fuel cell. The accuracy of the instrument is around $\pm 5\%$ in the reading of the O_2 consumption. Comparative tests demonstrate that the accuracy and the repeatability are comparable to that of complex apparatus utilized for research in this field.

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THE ARTIFICIAL RESPIRATION ADAPTED TO THE ACTUAL OXYGEN CONSUMPTION St. Schmidinger, G. Diedert, M. Schwab, S. Stummer

The monitoring and indication of the artificial respiration is usually the sanguineous or transcutaneous measurement of the bloodgases. The actual measurement of oxygen uptake $\dot{V}O_2$ and oxygen utilisation $\Delta(F_{I}O_2 - F_{E}O_2)$ make it possible for a rapid and dynamic adjustment to the real oxygen consumption. A new clinical practicable method was described to measure $\dot{V}O_2$ and $\Delta(F_{I}O_2 - F_{E}O_2)$ in the airway. The critical relation of $\dot{V}O_2$, $\Delta(F_{I}O_2 - F_{E}O_2)$ and \dot{V}_T , was typed to avoid the hypoxia in several cases of acute breathing failure. These calculated correlations indicate a dynamic and exact artificial respiration adapted to oxygen consumption and metabolism.

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RESPIRATORY MONITORING BY INDUCTIVE PLETHYSMOGRAPHY C.D. Hanning, H.C. Smith, I.McA. Ledingham

The transducer of the Inductive Plethysmograph (IP) is a coil incorporated in an elastic vest around the trunk and is the inductive element in a simple oscillator. The change in frequency with thoracic movements is demodulated to give a d.c. output. The transducer has been modified for use in ITU. It can be easily applied and is machine washable. The demodulator has been modified reducing movement artefacts and improving baseline stability. The IP signal was linear up to 70% of V.C. in adults of varying size. Calibration was constant for the supine, prone and lateral positions but was reduced by 20% in the reclining position both for spontaneous and IPPV. Calibration did not vary by more than 10% over a 12 hour recording period. IP has been used in ITU to provide a quantitative respiratory monitor. The transducer is calibrated with a pneumotachograph. Respiratory waveforms are displayed and respiratory rate, tidal volume and minute volume displayed digitally. Recalibration is required if the transducer is disturbed or the patient's position altered significantly. IP is most useful in weaning from ventilation and gives an early indication of patient deterioration

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MESURE DE L'EAU EXTRAVASCULAIRE PULMONAIRE PAR L'ANALYSE INSTANTANEE D'UN COLORANT ET DE L'EAU LOURDE. G. Basset, M. Scaringella, F. Moreau, J. Marsac, M. Ceccaldi, F. Botter.

La mesure du passage transcapillaire et du volume de distribution extravasculaire pulmonaire de l'eau (EVLW) pourrait avoir des applications pratiques en pathologie humaine notamment pour l'identification et le contrôle des œdèmes pulmonaires si l'on disposait de méthodes simples, rapides, répétables; aucune des solutions jusqu'alors proposées ne remplit pleinement ces conditions. En étudiant pour cette mesure les possibilités d'utilisation de l'eau lourde couplée à un colorant, nous avons mis au point un dispositif permettant l'analyse en continu de l'eau lourde dans le sang circulant par spectrométrie infra-rouge. Les résultats obtenus chez le rat ($n = 13$ EVLW ml kg⁻¹ = $2.21 \pm P; 35$) et chez l'homme normal ($n = 13$ EVLW ml = $202 \pm 41,9$; EVLW ml cm⁻¹ = $1.22 \pm 0,23$) sont en bon accord avec les valeurs habituellement observées. Le coefficient de variation pour 4 mesures successives chez un même sujet est de 7%. Cette solution permet de concevoir un instrument analytique spécialement adapté à ce projet, permettant d'obtenir dans des délais très brefs des informations sur l'eau extravasculaire pulmonaire et la perméabilité capillaire.

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MEASUREMENT OF EXTRAVASCULAR LUNGWATER WITH THE DOUBLE INDICATOR-DILUTION METHOD; USE OF A RANDOM WALK MODEL.
J. Bogaard, S. Smith, D. Rijkman, G. Bos, C. Hesse, F. Hagemeyer

A local density random walk function (LDRW) was applied as a model for the interpretation of indicator-dilution measurements. The accuracy and gain in information from the curves by this approach was compared with the classical semi-logarithmic extrapolation (SLE) method.

In vitro studies with the aid of a circulation model showed that with random noise, superimposed on indicator-dilution curves SLE gave a positive bias in the estimates of area under the curve and mean transit time; this bias was not found when fitting the curves with the LDRW function. Random noise with a mean amplitude of 6% of the peak height of the curves gave with the SLE method a mean error of about +10 till +40% and a much larger standard deviation than the LDRW method. A theoretical explanation for this difference could be given.

Random noise occurs in indicator-dilution measurements with radio-active tracers; therefore we used both methods for the interpretation of 72 curves from double indicator dilution measurements with THO as the diffusible and ^{131}I albumin as the intravascular indicator. With the results obtained we could verify our results from the in vitro experiments.

We defined the difference between the plasma colloid osmotic pressure and the pulmonary capillary wedge pressure as critical pressure (effective filtration pressure). From the relationship between this critical pressure and the quotients of the LDRW parameters λ (Skewness parameter) for THO and ^{131}I albumin respectively it turned out that in pulmonary edema conditions together with low cardiac output the double indicator technic is not feasible.

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2. Circulation/Circulatory Function

A) Insuffisance coronaire aiguë/Acute Coronary Failure

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HAEMODYNAMIC PATTERNS AND PROGNOSIS IN ACUTE MYOCARDIAL INFARCTION. G. Domenighetti, G. Turini, Th. Grandjean, Cl. Perret.

The purpose of this study was to evaluate the prognostic significance of different hemodynamic variables in acute myocardial infarction. 88 patients (75 men and 13 women) aged 27 to 77 with AMI underwent bedside catheterisation according to Swan-Ganz technique. Patients were subdivided in 4 groups according to initial mean pulmonary wedge pressure (PW) and cardiac index (CI). Group I (PCW \leq 18 mm Hg, CI $>$ 2,2 l/min/m²) included 45 patients; group II (PCW \leq 18, CI \leq 2,2): 12 patients; group III (PCW $>$ 18, CI $>$ 2,2): 16 patients and group IV (PCW $>$ 18, CI \leq 2,2): 15 patients. Hospital mortality rate was 2, 8, 25 and 67 % respectively. Group I corresponds to minimal or mild ventricular dysfunction; group IV to severe ventricular failure or shock with a mean stroke work index (SWI) of 16 gm-m/m²/beat. In group III, despite a higher CI and SWI, mortality rate was threefold that observed in group II. When dividing patients according to their initial PW, regardless of CI, mortality rate was 45 % when PW was $>$ 18 mm Hg, compared to 4 % in patients with PW \leq 18 mm Hg (P $<$ 0,001).

In conclusion SWI has no prognostic value except when below 20 gm-m/m²/beat. Similarly, a low initial CI has no prognostic significance when not associated with clinical signs of shock. Prognosis is better related to initial PW, the critical value being between 18 and 20 mm Hg.

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PROGNOSTIC FACTORS IN ACUTE MYOCARDIAL INFARCTION B.M. KENNELLY AND B. MARGOLIS.

The hospital course of 882 consecutive patients admitted with acute myocardial infarction to the coronary care unit (CCU) has been evaluated. Their course after discharge from the CCU was assessed with reference to the following serious complications occurring during their CCU stay: ventricular tachycardia or fibrillation, 2nd or 3rd degree heart block, pulmonary oedema, cardiogenic shock, persistent sinus tachycardia, persistent hypotension, atrial flutter or fibrillation, or infarct extension. Among the 494 patients (56%) with one or more of these complications, 38 (8%) died of cardiac causes in hospital after transfer from the CCU. Among the 388 uncomplicated patients (44%), only 2 (0.5%) died of cardiac causes after transfer from the CCU. The same patients were classified according to the Coronary Prognostic Index (CPI) of Norris. None of the 54% of patients with a CPI \leq 6 units died in hospital after transfer from the CCU. It is proposed that uncomplicated patients with a CPI \leq 6 units could safely be discharged from hospital earlier than is customary.

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