

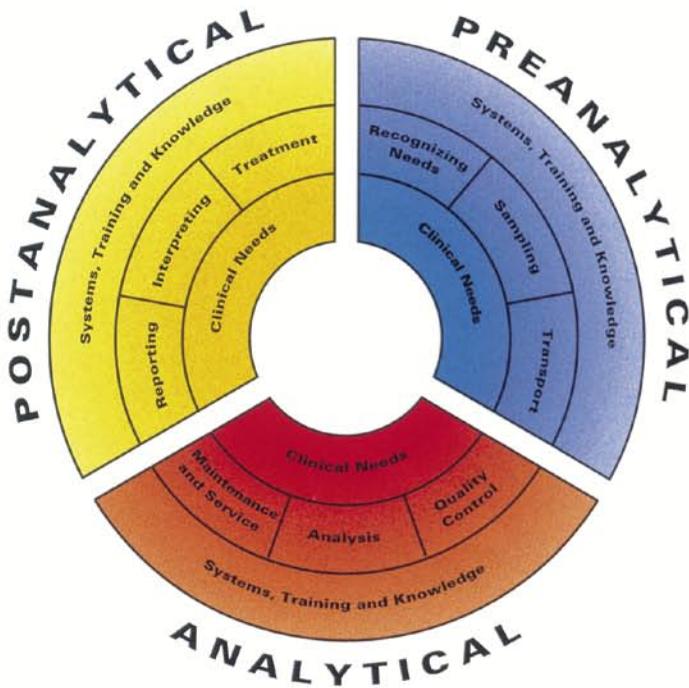
PICO

State of the art

arterial blood sampling

CONTROLLING SAMPLING PROCEDURES - ESSENTIAL

FOR THE ACCURACY OF BLOOD GAS TESTS



Meticulous collection and handling of samples are essential

to the accuracy of the results of blood gas, pH, oximetry,

electrolyte and metabolite analysis. Whole blood testing for

critical care diagnosis is a process which involves three phases:

- In the *preanalytical phase* the decision to collect a sample is made, the sample is collected and in some cases stored and transported.
- In the *analytical phase* the sample is analyzed. The performance of blood gas analyzers should be verified with a Quality Assurance plan to ensure that the analyzer is in control.
- In the *postanalytical phase* the data and subsequent treatment of the patient are facilitated by customized data management and reporting.

This process is repeated for every patient sample. The RADIOMETER

structured approach to the analytical process of blood gas measurement is called the Patient Focus Circle™.

THE HANDLING IN THE PREANALYTICAL PHASE DETERMINES THE QUALITY OF THE BLOOD GAS ANALYSIS

The preanalytical phase is the largest contributor of bias to blood gas measurement and therefore the weak link in the Patient Focus Circle. The wrong sampling equipment and improper handling can cause crucial inaccuracies in blood gas analysis. A few examples of preanalytical errors:

- Air bubbles in the sample significantly change pO_2 values [1].
- The measurement of electrolytes, particularly ionized calcium, can be significantly biased by the heparin used to prevent coagulation of the sample [2].
- If a sample has separated into plasma and red blood cells, ctHb and pO_2 measurements will be biased significantly if the sample is not mixed thoroughly.

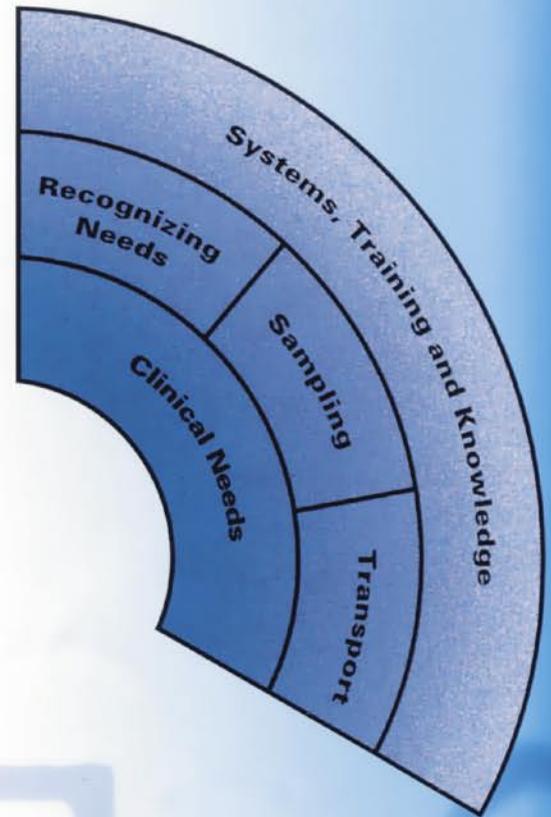
RADIOMETER is committed to provide the solutions to ensure that all the

phases of the analysis are performed optimally. To get the best results in the preanalytical phase a full range of samplers are offered for puncture, catheter and capillary sampling - the PICO and CLINITUBES™ product lines.

[1] Biswas CK, Ramos JM, Agroyannis B, Kerr DNS. Blood gas analysis: effect of air bubbles in syringe and delay in estimation. Br Med J. Mar. 1982. Madiedo G, Sciacca R, Hause L. Air bubbles and temperature effect on blood gas analysis. J Clin Pathol, Feb. 1980, Vol. 284, 923-27.

[2] Toffaletti J, Ernst P, Hunt P, Abrams B, Dry electrolyte-balanced heparinized syringes evaluated for determining ionized calcium and other electrolytes in whole blood. Clin. Chem. Oct. 1991, Vol. 37, No. 10, 1730-33

THE RADIOMETER PHILOSOPHY - EDUCATION IS THE WAY TO CONTROL SAMPLE QUALITY



Equipment alone is not enough to ensure sample quality in the preanalytical phase - just as important is user knowledge about how to handle the sample and avoid the errors that bias the results.

RADIOMETER has acknowledged this need and designed a teaching program in whole blood sampling. The necessary procedures and risks of bias have been mapped in cooperation with experienced physicians, laboratory technicians and respiratory therapists. Guidelines such as NCCLS [3] and IFCC [4] have also been used to ensure consistency with official recommendations.

The program consists of RADIOMETER-conducted training sessions, a training video and a pocket-sized sampling handbook. We offer this in order to

assist your hospital in achieving staff skills that ensure a consistent, high sample quality. Ask your RADIOMETER representative for more details.

The handbook in arterial blood sampling is a comprehensive guide to sampling which can be used either as a teaching aid or as a reference.

The contents include:

- Recommendations on how to perform all the practical steps in arterial punctures, arterial line and capillary samples. All the necessary procedures

are described and potential pitfalls are pointed out.

- A description of the potential preanalytical errors that pose a risk of biasing the measurement and the subsequent patient diagnosis.



[3] The National Committee for Clinical Laboratory Standards.

[4] International Federation of Clinical Chemistry.



**BALANCED HEPARIN - THE ELEGANT SOLUTION TO AVOID BIAS
OF ELECTROLYTE RESULTS AND CLOTS IN THE SAMPLES**

It is important to treat blood samples with heparin to stop the coagulation process. Failure to do so may result in blockage of the analyzer or incorrectly measured values without indication of the problem, e.g. if a clot has settled on an electrode. However, whole blood tests of blood gas, oximetry, electrolytes and metabolites are sensitive to dilution errors and electrolyte bias if the wrong type of heparin is used.

THE RADIOMETER SOLUTION -
BALANCED HEPARIN

The RADIOMETER patented electrolyte-balanced heparin [5] has been formulated to compensate for the addition and binding effects that normal heparin has on the measurement of cCa^{2+} , cNa^+ and cK^+ . Since it is a dry heparin it does not impose dilution errors on the sample.



The binding of electrolyte ions to common types of heparin may cause significant errors in the electrolyte results, especially for cCa^{2+} .

An example - bias in ionized calcium with normal heparin:

True value of the whole blood sample:

$cCa^{2+} = 1.15 \text{ mmol/L}$

Final result: 1.08 mmol/L

Absolute error: -6 % [6].

The bias corresponds to 50 % of the reference interval ($cCa^{2+} = 1.15\text{-}1.29 \text{ mmol/L}$)

Assumptions: 50 IU heparin in a 1 mL sample and Hct. = 45 %

Some manufacturers offer low-concentration syringes as a solution to the heparin bias problem. The RADIOMETER arterial blood samplers have a relatively high concentration of balanced heparin (40-60 IU heparin/mL blood) because higher dosages are safer in the prevention of clotting.



A dosage of 50 IU heparin is much more likely to be evenly distributed throughout the entire sample than a dosage of 10 IU heparin.

This makes RADIOMETER samplers less sensitive to incorrect sample handling, thereby reducing the risk of having analyzers blocked by clots. RADIOMETER believes so strongly in our samplers' ability to prevent clotting that we offer a guarantee against clotting. Ask your RADIOMETER representative for more details.

FIBER DISC EASES MIXING OF THE SAMPLE

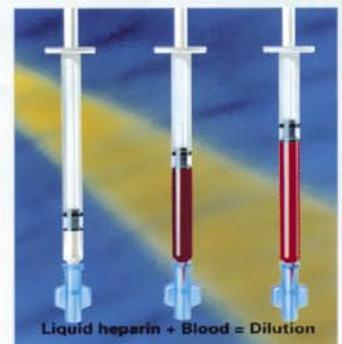
A heparin coated fiber disc is utilized in the PICO 50 and PICO 70 samplers for rapid dispersion of the heparin. The efficient mixing action of the disc makes it easier to mix the sample thoroughly prior to analysis, ensuring accurate cHb measurements.



The disc eases and improves mixing of the sample because it works as a stirring device. This facilitates quick dissolution of the heparin. If the sample has been stored and has settled, the disc makes it much easier to mix it into an homogeneous sample again.

AVOID LIQUID HEPARIN

Liquid heparin dilutes the sample. This causes electrolyte, cHb, pCO_2 and metabolite results that are falsely low in comparison to the true values of the sample. In clinical practice, the dilution percentage varies, because different users invariably leave different quantities of heparin in the sampler and vary the sample volume. This causes unknown random variations in the dilution of the samples which, as a consequence, make it impossible to adjust the measured results accordingly.



Studies report that dilution of blood samples in clinical practice is typically 10 % and in some cases up to 40 % [7]. A 10 % dilution decreases the pCO_2 , cHb and metabolite values by 10 %, and electrolytes by 14 % compared to true values (depending on the hematocrit).

[5] US patent no.: 4687000.

[6] Siggard-Andersen O, Thode J, Wandrup J. The concentration of free ions in the blood plasma 'ionized calcium' (AS79). Copenhagen, Radiometer A/S, Denmark 1980.

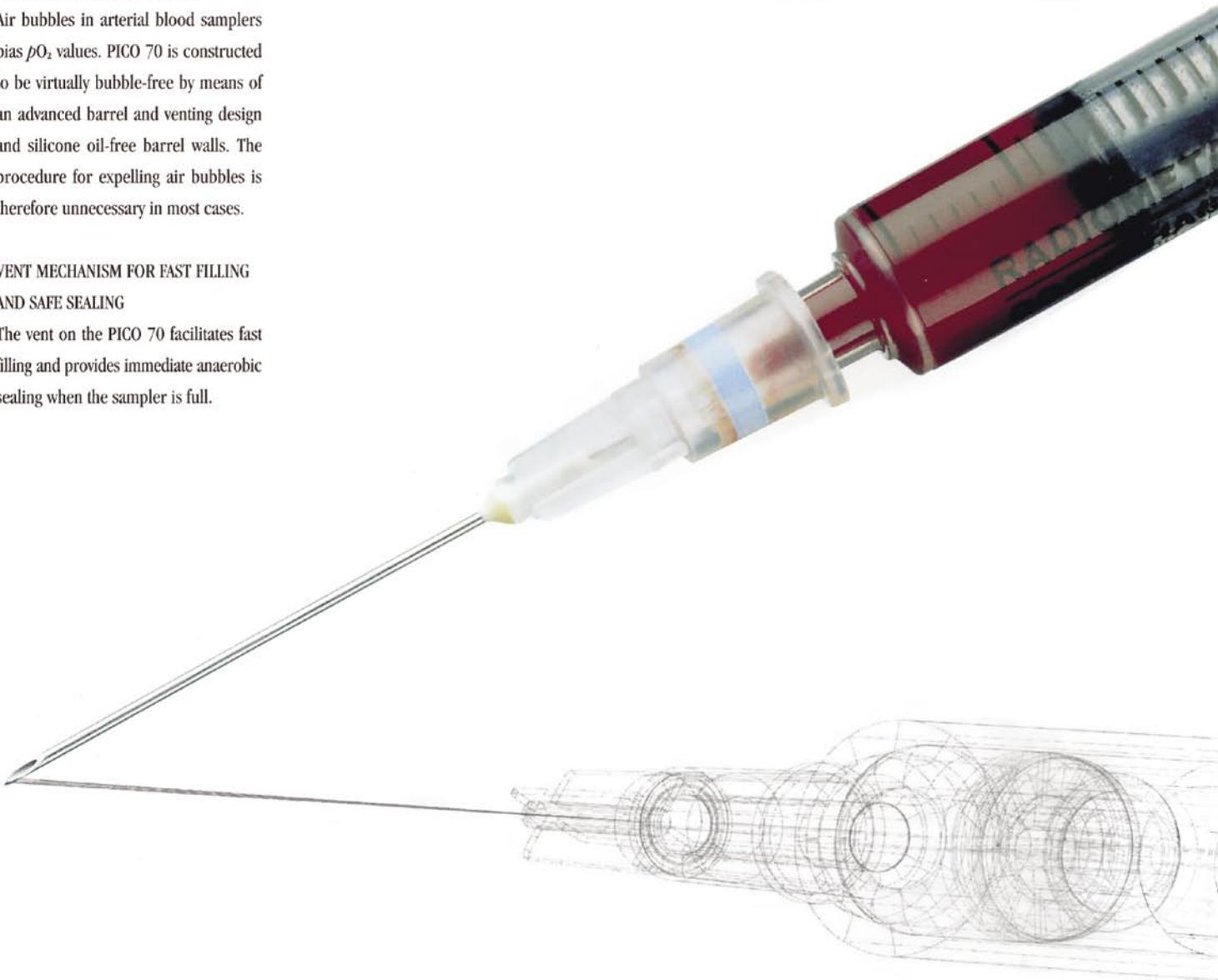
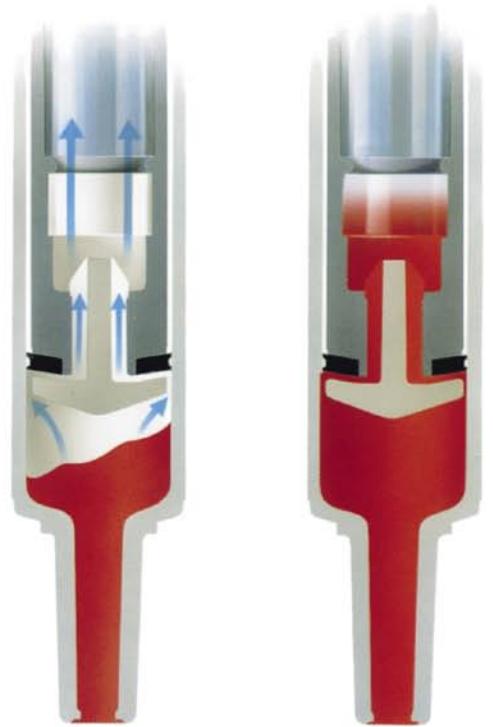
[7] Börner U, Müller H, Höge R, Hempelmann G. The influence of anticoagulant on acid-base status and blood-gas analysis, Acta Anaesthesiol Scand 1984; 28: 277-79. Goodwin NM, Schreiber MT. Effects of anticoagulants on acid-base and blood gas estimations, Critical Care Medicine 1979; 7. Crawford AG. Liquid versus nonliquid heparinization of blood samples. Respiratory Therapy, Sept/Oct 1983. Hutchison AS, Ralston SH, Dryburgh FJ, Small M, Fogelmann I. Too much heparin: possible source of error in blood gas analysis. Br Med J, Oct. 1983; Vol. 287, 1131-32.

PICO 70 - OPTIMIZED DESIGN FOR ARTERIAL BLOOD SAMPLING

The new self-filling PICO 70 is the first sampler where all components are designed specifically for arterial sampling. The design offers a number of advantages that make it easier than ever to collect and analyze a blood gas sample without bias. Using the PICO 70 will add reliability to blood gas, oximetry, electrolyte and metabolite test results.

DESIGNED TO AVOID AIR BUBBLES,
A MAJOR SOURCE OF ERRORS
Air bubbles in arterial blood samplers bias pO_2 values. PICO 70 is constructed to be virtually bubble-free by means of an advanced barrel and venting design and silicone oil-free barrel walls. The procedure for expelling air bubbles is therefore unnecessary in most cases.

VENT MECHANISM FOR FAST FILLING
AND SAFE SEALING
The vent on the PICO 70 facilitates fast filling and provides immediate anaerobic sealing when the sampler is full.



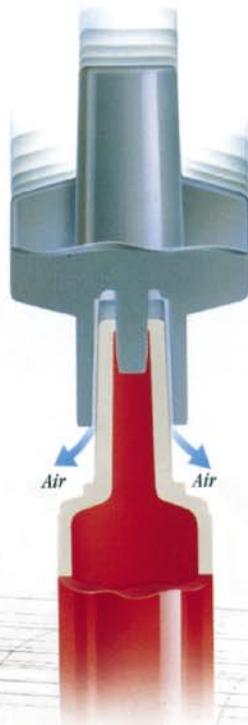
The advanced barrel and venting design of the PICO 70 ensures that all air bubbles are forced out of the syringe before the sample is automatically sealed off by the vent in the plunger. In addition, the vent material is not exposed to the sample, but is hidden behind the plunger top. This eliminates the risk that unrepresentative blood and/or vent fragments are aspirated from the vent when analyzers with probe-type analyzer inlets are used.



THE SILICONE OIL-FREE DESIGN IMPROVES ANALYZER PERFORMANCE
PICO 70's special sealing-ring and barrel design [8] ensures the smooth and easily controlled movement of the plunger, so there is no need for silicone oil on the inner walls of the barrel. This eliminates the danger that silicone oil will coat tubings and electrode membranes, which would reduce analyzer performance and the lifetime of the electrode membranes.

THE SMALL-VOLUME BARREL OFFERS USER COMFORT AND CONTROL
The sample volume is 0.3 to 1.5 mL, the ideal amount for whole blood tests. This means that only one type of sampler is needed for all applications.

PICO 70 tip cap



Special air channels in the PICO 70 tip cap prevent air from entering the syringe when sealing the sample. An ordinary tip cap will always force an air bubble into the sample when it is being closed.

Normal tip cap



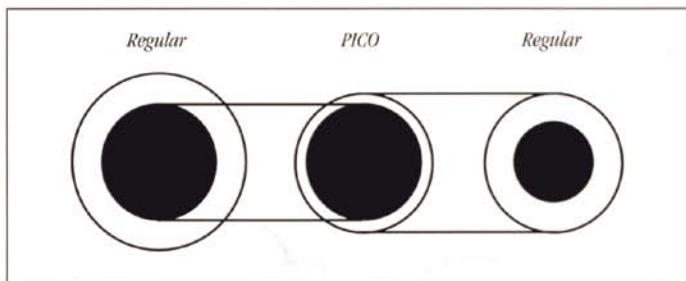
TIP CAP DESIGNED TO AVOID AIR BUBBLES

Normal tip caps have always had the disadvantage that they force an air bubble into the sample when they are mounted. The air bubble biases the sample, particularly if it is released into the sample during the mixing procedure or transported through a pneumatic tube system.

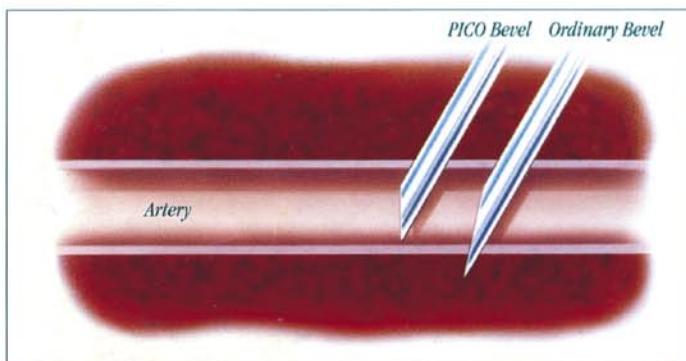
This problem has been eliminated with the new PICO 70 tip cap that is designed so it does not force air into the sample. The tip cap attaches securely, reducing the risk of blood spillage.

SHARP, HIGH-QUALITY NEEDLES FOR REDUCED PAIN AND FAST FILLING

PICO samplers for puncturing are provided with high-quality preattached needles specifically suited for arterial blood sampling.



PICO's superthin needle-wall design allows an improved blood flow without increasing the outside diameter.



The PICO short bevel and needle sharpness are designed for smooth arterial penetration and proper positioning in the arterial lumen.

THIN WALL - FAST FILLING

PICO samplers feature superthin needle-wall technology. This means improved flow through a smaller-size needle and a faster filling time - resulting in less patient discomfort.

PICO SHORT BEVEL - EASY POSITIONING IN THE ARTERY

PICO samplers are supplied with special short-bevel needles that are easy to position in the lumen of the arteries. Many brands of samplers are supplied with ordinary bevel needles that are really designed for injection and which make it more difficult to puncture the artery correctly.

VISUAL INDICATOR HUB

PICO needle hubs are transparent so blood flash is clearly visible to verify arterial penetration. PICO is available with a wide selection of needle diameters and lengths. The needle hubs are color-coded to ensure easy identification of the needle gauge if several types are used.

CLINITUBES - CONTROLLING THE PREANALYTICAL PHASE IN CAPILLARY SAMPLING

RADIOMETER offers a wide choice of capillary sampling systems

providing accurate, safe and easy sampling procedures.

RADIOMETER capillary sampling means:

- Accurate pH, blood gas, oximetry, electrolyte and metabolite results
- Small sample sizes, matching exactly the volume required
- Timesaving
- Safety for patients and staff

The RADIOMETER capillary sampling system consists of sturdy and homogeneously preheparinized capillary tubes, CLINITUBES, patented [9] vented capillary caps, mixing wires and a specially designed magnet. CLINITUBES are supplied in a wide variety of volumes in order to exactly match the volume requirement of your analyzer. This is important because analyzers are specified to aspirate an exact volume for capillary samples in order to perform a correct measurement.

AVOID CLOTTING AND ANALYZER DOWNTIME

CLINITUBES are preheparinized in a special process to ensure a homogeneous heparin coating of the tubes. This, together with the high heparin concentration, prevents clotting in the blood sample and in the analyzer, ensuring a homogeneous sample quality. Versions for electrolyte analysis are heparinized with electrolyte-balanced heparin.

CONTROL AIR BUBBLES AND PREVENT pO_2 BIAS

RADIOMETER's specially vented capillary cap is designed to facilitate correct anaerobic sampling, storage and transport of the sample. The capillary caps prevent air bubbles from

entering the tube during mounting. Bias of pO_2 is consequently prevented.

EASY HANDLING

CLINITUBES are easy to use and do not require time-consuming preparation. CLINITUBES are supplied in a glass vial dispenser which releases only one tube at a time. The dispenser secures hygienic storage and transport in the hospital. The vial protects the tubes from dust, blood and other liquids, thereby maintaining the integrity of the homogeneous heparin coating.

SAFE SAMPLING

CLINITUBES are made of strong glass to minimize the risk of breakage. The ends of the capillary tubes are rounded to increase the safety of patients and staff. The specially designed capillary cap secures a correct and safe sealing of the capillary tube. The cap's vented design allows it to be mounted on the capillary tube before the sample is taken, avoiding blood spillage.



PICO 30 AND PICO 50 - ASPIRATORS FOR EASY, ACCURATE AND COST EFFECTIVE CATHETER SAMPLING

PICO 30 and PICO 50 are quality samplers for aspiration from catheters. Both products are heparinized with balanced heparin for accurate electrolyte measurements. The samplers have standard luer tips and can therefore be used with all types of arterial and venous lines. The syringes come with tip caps for correct anaerobic storage and safe transportation of the sample.



PICO 30

PICO 30 is a dedicated sampler for pediatric and neonatal patients. The small barrel diameter and the detailed scale make it easy to control small sample volumes, which is important when preservation of a limited blood volume is a priority. PICO 30 is a 1 mL sampler supplied with a preattached tip cap and heparinized with 60 IU of balanced heparin.

PICO 50

PICO 50 is a general purpose aspirator, a cost effective alternative to using self-filling samplers from arterial lines. Clinical experience with the product shows that it is easy to remove the air bubbles that are always formed in aspirators. After sample collection, the removal of air bubbles from the PICO 50 takes only a few seconds. The smooth plunger movement makes it easy to control aspiration of the sample and injection into the analyzer.

PICO 50 is available in two versions:

- 1 mL version with 50 IU of balanced heparin
- 2 mL version with 80 IU of balanced heparin

PICO SAMPLERS COME STERILIZED IN CONVENIENT PACKAGING

The PICO samplers are supplied in convenient dispenser boxes of 100 individually wrapped syringes. PICO samplers do not require time-consuming preparation. All that is needed is to remove the sampler from the package and it is ready for use - sterile and with the right concentration of heparin. Needles are preattached on PICO 70 and all PICO samplers come with tip caps. The ready-to-use samplers increase flexibility and minimize the risk of errors in busy, daily routines.

Symbols on the packaging make it easy to identify the sampler version; ideal when your hospital uses several needle versions or self-filling samplers and aspirators.

PICO 50 comes in peel packaging that is transformed into water and carbon dioxide on combustion.



Sales subsidiaries

Australia:
RADIOMETER
PACIFIC PTY. LTD.
P.O. Box 47
Nunawading, Victoria 3131
Tel: +61 3 9259 2222
Fax: +61 3 9894 8362
e-mail: sales@radiometer.
com.au

Denmark:
RADIOMETER DANMARK A/S
Valhøjs Allé 176
DK-2610 Rødovre
Tel: +45 38 27 28 29
Fax: +45 38 27 27 12
e-mail: rdan@radiometer.dk

France:
RADIOMETER SAS
Z.A. la Fontaine du Vaisseau
8, rue Edmond Michelet
F-93360 Neuilly-Plaisance
Tel: +33 1 49 44 35 50
Fax: +33 1 43 09 81 41
e-mail:
marketing@radiometer.fr

Germany:
RADIOMETER GMBH
Linsellesstrasse 142
D-47877 Willich
Tel: +49 2154 818-0
Fax: +49 2154 818 184
e-mail: info@radiometer.de
www.radiometer.de

Japan:
RADIOMETER TRADING K.K.
Nishi-Shinbashi Tokyu Building
16-11 Nishi-Shinbashi 3-
chome
Minato-ku, Tokyo 105-0003
Tel: +81 3 5777 3500
Fax: +81 3 5777 3501
e-mail:
salesdep@radiometer.co.jp
www.radiometer.co.jp

The Netherlands:
RADIOMETER
NEDERLAND BV
Postbus 233
Chroomstraat 6
NL-2718 RR-Zoetermeer
Tel: +31 79 361 4593
Fax: +31 79 361 4599
e-mail: info@radiometer.nl
www.radiometer.nl

New Zealand:
RADIOMETER PACIFIC LTD.
Unit A
10-20 Sylvia Park Road
P.O. Box 12416, Penrose
Auckland
Tel: +64 9 573 1110
Fax: +64 9 573 1106

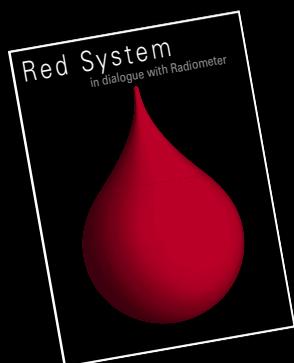
Spain:
RADIOMETER IBÉRICA, S.A.
Avda. de Castilla, no 2
Parque Empresarial
San Fernando
Edificio Japón 1
E-28830 San Fernando
de Henares, Madrid
Tel: +34 91 655 9950
Fax: +34 91 655 9955
e-mail: resp@radiometer.es

Switzerland:
RADIOMETER GMBH
Zürcherstrasse 68
CH-8800 Thalwil
Tel: +41 1 723 38 60
Fax: +41 1 723 38 65
e-mail: info@radiometer.ch
www.radiometer.ch

United Kingdom:
RADIOMETER LTD.
Manor Court
Manor Royal, Crawley
West Sussex RH10 9FY
Tel: +44 1293 517 599
Fax: +44 1293 531 597
e-mail: sales@radiometer.
co.uk

USA:
RADIOMETER AMERICA INC.
810 Sharon Drive
Westlake, OH 44145-1521
Tel: +1 800 736 0600
(toll-free)
Fax: +1 800 736 0601
(toll-free)
e-mail:
info@radiometeramerica.
com
www.radiometeramerica.
com

Other countries:
INTERNATIONAL SALES
DIVISION
Åkandevvej 21
DK-2700 Brønshøj
Tel: +45 38 27 38 27
Fax: +45 38 27 27 11
e-mail: rint@rint.dk



Radiometer helps hospitals worldwide with quality and cost-effective STAT testing solutions for diagnosis of critically ill patients. To achieve this we have developed a systematic approach where we analyze your needs before we suggest a customized solution. This approach is called Red System.

For further information contact your local Radiometer representative or see Radiometer's homepage www.radiometer.com

Data subject to change without notice.
PICO™, CLINITUBES™, Red System™, Patient Focus Circle™ and Radiometer™ are trademarks of Radiometer Medical ApS Denmark.

RED SYSTEM™
IN DIALOGUE WITH RADIOMETER



Radiometer Medical ApS
DK-2700 Brønshøj

www.radiometer.com

RADIOMETER
COPENHAGEN