Dictionary of medical equipment

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Preface

This dictionary was begun on the basis of the inventory of medical equipment maintained for Liverpool Health Authority, to provide a brief description of all the items in use. However, the list has been extended with the aid of the reference works listed at the the end of the book, and also as a result of comments received from readers of the draft text.

The object has been to provide rudimentary information about equipment which may be found in hospitals, and in medical research and teaching institutions. It is intended to be useful to all those concerned with the use, servicing, or purchasing of medical and scientific equipment.

There are many common terms and trade names which are used for medical equipment. These have only been included where we have found that the terms are frequently used, or, in the case of trade names, that the term is used to refer to a general type of equipment rather than just a single model. The descriptions of equipment are meant as a guide, and are not definitive specifications.

To assist the reader to make best use of the dictionary, Appendix 2 has been created to show entries listed according to subject. For instance, if an item found in a catalogue of medical equipment is not found in the dictionary, other relevant entries may be identified by examining the subject.

It is impossible to cover every item of equipment, and in any case, development, invention, and change in medical practice make it difficult to be truly up to date. However, we believe that all the commonly used items are covered, and that readers will find the information they require, in almost every case. Comments and suggestions, or information about difficulties in identifying equipment, will be gratefully received. The address to write to is The Institute of Medical and Dental Bioengineering, Royal Liverpool Hospital, Liverpool L7 8XP, in the United Kingdom.

Malcolm Brown

Introduction

Supplementary information

Supplementary information is provided in coded form in the following way:

(e.g.) AUDIOMETER n=4 c=2,3,4 r=3

The coded information can be interpreted as follows:

n=4 A typical general hospital (with research and teaching functions) would have about four of these items.

c=2,3,4 These items are available in approximate price bands 2, 3 and 4. Price bands at date of writing given below are as follows

1. 0 – £100 ($150)
2. £100 – £500 ($750)
3. £500 – £1000 ($1500)
4. £1000 – £5000 ($7500)
5. £5000 – £10 000 ($15 000)
6. £10 000 – £50 000 ($75 000)
7. £50 000 – £100 000 ($150 000)
8. over £100 000 – (over ($150 000)

r=3 Extra information about this entry can be found in reference 3 at the end of the dictionary.

The following appendices are also included:

Appendix 1 List of abbreviations and acronyms

Appendix 2 List of entries by subject
Anaesthesia
Audiology and speech therapy
Cardiology
Dialysis
Electrical, electronics and computing
Lung function testing
Ionizing radiation equipment
Laboratory equipment
Miscellaneous
Physiotherapy
Surgery
Ultrasonics

Appendix 3 Useful literature

A

A-Scanner n=3 c=4 r=1

An ultrasonic scanning device employing ultrasonic pulses in the megahertz range is used to detect the depth of reflecting structures within the body. The distance into the body is displayed on the x-axis of a cathode ray tube (CRT) and the returning echoes are displayed as vertical movements (Y-axis), the echo amplitude being shown by the extent of the vertical movement. A-scanners were first used in the 1950s to detect the correct position of the 'midline echo' in the brain, which originates from the falx cerebri. Early A-scanners were converted industrial echo-sounders intended for detecting micro-cracks in metals.

Now, medical A-scanners exist which are intended purely for midline detection and incorporate 'swept gain' correction circuits to compensate for the attenuation of ultrasound which occurs in human tissue. These are used in the casualty or in the X-ray department as a cheap and non-invasive method of identifying the possible cause of concussion where this may be due to the existence of 'space occupying lesions' (tumours, haematomas, etc.) which may be displacing the midline from its normal position.

In addition many other ultrasonic scanners include an A-scan display to show that the 'swept gain' circuit is set correctly and to enable accurate distance measurements to be made between echoes. This measurement facility has proved particularly useful in the measurement of bi-parietal diameter (BPD) in the foetus to establish gestational age.

An A-scanner would normally consist of a single disc piezo electric damped transducer resonating at a chosen frequency between 2 and 15 MHz, a high voltage pulse generator to energize the transducer (at about 1 kHz), a tuned radio frequency amplifier, and the usual CRT drive circuitry. It is only really different from industrial versions by having a circuit to sweep the gain of the R.F. amplifier to compensate for absorption of the ultrasound in tissue.

Absorber n=20 c=2 r=2

Although this term could be applied to an acoustic or liquid absorber it is most commonly used to refer to a carbon dioxide absorber of the type used in rebreathing anaesthetic circuits. It consists of a container filled with soda-lime through which the patient's expired gases are passed. It may take the form of a canister (e.g. Waters canister) mounted between the facepiece and breathing bag so that gas passes through in both directions, or it may be included in a circle closed circuit (see Circle absorber).

The soda-lime absorbs carbon dioxide from the expired gases so that the remainder can be fed back to the patient with a small supplement of fresh anaesthetic gases. This arrangement is economical with the gases used, reduces pollution of the room air, conserves heat and moisture, and does not normally require humidification. Disadvantages are that alkaline dust may pass to the patient, and the canister holding the granules may be a cause of leaks.

The soda-lime usually consists of a mixture of 90% calcium hydroxide, 5% sodium hydroxide, and 1% potassium hydroxide, with silicates to prevent powdering. It is essential for effective operation that moisture (14–19%) be incorporated within the granules. Durasorb is an improved soda-lime which is pink in colour which turns to white when it becomes inactive.

Absorption spectrometer n=1 c=4 r=9

Various chemicals whether in the gas or liquid phase absorb energy from specific regions of the electromagnetic radiation spectrum. Thus infrared radiation passed through two parallel chambers to a detection device may be used to record the difference in infrared absorption. The difference is sometimes detected in a Golay cell which consists of two infrared absorption chambers separated by a diaphragm whose movement is detected by a capacitance change with respect to an adjacent electrode. The infrared radiation is passed through a chopping disc so that each cell in turn receives the radiation causing alternating displacement of the diaphragm in the Golay cell. The diaphragm will be displaced to one side or other depending on the relative quantities of infrared light reaching the absorption chambers. An electronic circuit to amplify, demodulate and linearize the output is connected to the capacitance transducer.

One of the cells is filled with a reference gas while the other is filled with a background gas plus a small flow-through of the gas being sampled. The modification in absorption is used to detect the molar fraction of the sample gases. Problems arise where the absorption spectra of the gases being tested overlap (e.g. nitrous oxide and halothane, carbon dioxide and carbon monoxide). The device requires a long stabilization period and the results will be affected by changes in atmospheric pressure.

Such instruments can be used for the analysis of gases in the lung function laboratory. They may also be called gas chromatographs.

Acoustic booth n=2 c=5 r=8

In hospitals this normally takes the form of a small room or chamber in which audiometric tests are performed. The DHSS (UK) recommendations for the design of ENT departments states that for such tests the maximum ambient noise is 30 dBA and the maximum reverberation time is 250 ms. This can be achieved by suitable construction and treatment of a room or preferably by the installation of an acoustically isolated inner chamber. Acoustic booths found in many hospitals do not meet these standards, and other requirements such as wheelchair access and silent ventilation have often been neglected.

Other names for an acoustic booth may include sound-proof room, audiometric room and anechoic chamber (although this term normally applies to a research installation with more stringent specifications).

Acoustic impedance meter/bridge n=2 c=4 r=3

A device for measuring the integrity of the sound conduction mechanism between the ear drum and the oval window to the inner ear by measuring the acoustic impedance of the ear drum. In the normal ear, sound applied to the ear drum will readily pass through,and a low acoustic impedance is measured. If sound will not pass through easily (due to a defect in the middle ear) then a high acoustic impedance may be recorded. The acoustic impedance is recorded while varying the pressure in the outer ear (typically from +2 kPa to −6 kPa). A minimum impedance is recorded when the pressure in the outer ear is the same as that in the middle ear (i.e. where there is no pressure differential across the ear drum causing it to stiffen), thus allowing the middle ear air pressure to be measured indirectly. In the normal case the middle ear pressure is close to atmospheric whereas in many pathological conditions it is lower.

For clinical use in the ENT or audiology department, the measurements are recorded on an *X–Y* plotter (which may be part of the acoustic impedance meter) on which the Y-axis shows compliance (the inverse of impedance) expressed in equivalent air volume (e.g. 0–4 ml), and the X-axis shows air pressure applied to the outer ear.

The apparatus normally consists of a low-pressure air pump and the necessary controls, a sound source and ear piece, an oscillator (usually about 220 Hz), and an amplifier and metering circuit. The unit may contain or be connected to an *X–Y* plotter.

Actinotherapy apparatus r=10

This term is synonymous with radiotherapy apparatus but its use in medical work is normally limited to equipment delivering electromagnetic radiations up to the ultraviolet range, and is most commonly applied to phototherapy. In some definitions actinotherapy relates to chemical changes brought about by radiation therapy but in physiotherapy this aspect is not usually stressed since the therapy is mainly intended to impart heat to the tissues. See also Short-wave diathermy, Phototherapy, Infrared lamp, and Ultraviolet treatment unit.

Active electrode r=4 c=1 r=4

This is an electrosurgery electrode used for cutting or coagulation of tissue. It may be in the shape of a knife, needle, ball or loop. The electrodes with a small contact area with the tissue are used for cutting and excising sections of tissue, employing the cutting action of high-frequency (0.5-4 MHz) continuous wave currents. Electrodes with large surface areas are used for coagulation, drawing sparks from high-voltage pulses on to the tissue to arrest bleeding.

Acupuncture apparatus n=1 c=3,4

Various items of equipment exist for the acupuncturist. These include electrical stimulators, electrical impedance meters, and low-power infrared lasers. The electrical impedance meter is used to locate low impedance points on the skin, which are thought to correspond to acupuncture points. The electrical stimulators are similar to other low-power types used for pain relief and may be used to apply electrical stimulation to the acupuncture points via needles, or via point or plate electrodes. Low-power lasers are used to stimulate the acupuncture points and are claimed to have similar therapeutic effects.

Such devices might be found in the physiotherapy department or in an acupuncture or pain relief clinic.

ADC/DAC interface

Electrical signals from a piece of medical laboratory equipment or clinical equipment may be processed by a digital computer and returned to an analogue output device (e.g. pen recorder) using an ADC/DAC. The ADC (analogue to digital converter) examines incoming voltage at regular intervals (e.g. every microsecond up to every second) and converts the voltage to a binary number. The computer can then use this binary number or a series of them to make calculations and to identify trends. The results of the calculations can be returned to the output device through a digital to analogue converter (DAC) which produces a voltage representing the binary number given by the computer.

Many medical instruments incorporate ADCs and DACs without any external presentation of the digital form in which the calculations are performed. If a commercial computer or microcomputer is used then an external device may be required to perform these functions. In this case the computer controls the sampling rate and timing of the calls for the input of information and meets the requirement for timing and scaling of the output information.

Air bed n=5 c=3,4

Patients who are immobile for long periods may develop pressure sores. These can be avoided by repeatedly moving the patient so that different parts of the skin are supporting the body weight. An alternative method is to use a ripple bed/mattress which can be water or air filled. The air-filled types have an air pump which alternately inflates and deflates cells in the mattress over a period of a few minutes (e.g. 10 minutes).

Air embolus detector r=9

Whenever fluids are infused into the blood stream it is important to prevent the passage of air into the body. Air bubbles are undesirable and a large quantity of air reaching the heart can interfere with its pumping action.

All devices which could cause air to pass into the body should employ warning and fail-safe circuits to prevent this happening. The problem is most important in the use of infusion pumps where a disconnection or exhaustion of the fluid reservoir could lead to the pumping of air. Also when blood is removed from the body for oxygenation or dialysis it is essential that blood is returned to the body free from air bubbles.

There are two main types of air embolus detector which may be separate devices or incorporated into the parent instrument. These employ optical transmission, providing a warning when there is a sudden change in transmission. Alternatively, an ultrasonic device may be employed and this may also be monitoring the flow velocity within the tube if it is carrying blood. Doppler ultrasonic flow-meters calculate the blood velocity from the back-scattered ultrasound from the blood corpuscles. Air bubbles produce echoes which are several orders of magnitude greater in intensity than is received from the blood. The appearance of these very large echoes is used to identify the presence of air in the tube. Very small bubbles can be detected by this method.

Air entrainment valve

Also called an air inspiratory valve, this comprises a knife-edge seat, a disc and spring, and operates in an anaesthetic breathing circuit in the opposite way to a pressure relief valve, i.e. for the valve to open it requires a very small negative pressure to be exerted which causes the disc to lift allowing air to be entrained. The entrainment valve would operate if the patient was in spontaneous respiration and there was an obstruction in the fresh gas to the patient (e.g. a kink in the gas feed tube), or after the operation of an oxygen failure warning device which cuts off the the gases. Entrainment valves are incorporated in some anaesthetic machines ventilators, and oxygen failure devices.

Air Viva respirator/resuscitator c=1 r=2

This is a bag, expiratory valve and facepiece for emergency resuscitation. The bag is inflated in its resting state so that after squeezing to inflate the lungs it automatically re-inflates with fresh air. Oxygen may be fed in via a narrow tube and a small valve. It is generally similar to the Ambu resuscitator.

Airway r=4

This normally refers to a device (tube) to keep the tongue from blocking airflow to the lungs during resuscitation, anaesthesia, or positive pressure ventilation. It may be passed through the nose (nasopharyngeal airway), the mouth (oropharyngeal airway) or through a tracheostomy.

AIUM test object n=1 c=2 r=1

This is a device for testing the performance of ultrasonic scanners and consists of two parallel plates of Perspex between which there are a number of steel or nylon threads. It may be a closed system containing a fluid with a velocity of sound transmission equal to that of tissue (usually 1540 m/s) or it may be an open frame intended to be immersed in a bath of suitable fluid. This fluid can be a special mixture of ethyl alcohol in water at room temperature or water may be warmed to 47°C at which the transmission velocity is correct.

There are four rows of wires in the frame as follows:

1. A row of equally spaced wires down the frame to give an indication of variation of the ultrasonic beam width with depth, and also of sensitivity with depth.
2. A row of wires across the frame at the bottom.
3. A row of wires across the frame close to the transducer which are spaced equally but each successive wire is slightly further away from the transducer. These indicate the depth of the transducer artefact or deadzone

due to the ringing of the transducer after the transmit pulse has been sent.

4. A row of wires moving progressively away from the transducer position which have progressively smaller spaces between them to demonstrate axial resolution.

The AIUM is the American Institute for Ultrasound in Medicine.

Aldasorber n=40 c=1

Anaesthetic gases and vapours released into the atmosphere in operating departments are thought to be harmful to the health or performance of those who work there. Measures to reduce air pollution are being implemented including better air conditioning, scavenging of the exhaled gases during anaesthesia and ducting these away, more frequent use of closed anaesthetic circuits, and the use of absorbers and adsorbers for anaesthetic vapours.

The Aldasorber is one type of these which adsorbs halothane and other vapours. It is disposable, and is changed when the weight has increased by a specified amount.

Ambu 'E' valve c=1 r=2

This is an expiratory valve for use in an anaesthetic breathing circuit which has been designed to prevent the passage of expired gases back into the breathing circuit and reservoir bag. Unintentional rebreathing of expired gases is a problem when using the conventional Magill circuit for controlled or assisted ventilation. The reservoir bag, being empty at the end of inspiration, tends to fill partially with expired gas during the expiratory phase. The Ambu 'E' valve is a two-stage valve fitted in place of the usual expiratory valve which makes sure that expired gases are directed out of the breathing circuit altogether. The Ruben's valve is intended to achieve the same result but with slightly different construction.

Ambu facepiece c=1 r=2

A type of facemask for anaesthesia which has a transparent body allowing early detection of vomit, which is particularly useful during resuscitation. This type also has an inflatable sealing cuff to improve the fit on to the face.

Ambu respirator/resuscitator c=1 r=2

For providing emergency artificial respiration for resuscitation this consists of a bag, valve and facepiece. The bag remains inflated in its resting state and when squeezed closes the expiratory port and inflates the patient's lungs. When the bag is released it automatically re-inflates with fresh air and the patient's expired air passes out to atmosphere via the expiratory valve. Oxygen may be supplied to the bag via a small tube and valve at one end of the bag. The facepiece is usually transparent so that vomit can be seen. A similar type of respirator is the Air Viva.

Ambulatory ECG monitor n=2 c=5 r=3

Abnormalities of the ECG and heart rate may not show when the patient is being monitored in the clinic. At one time it was common to confine the patient to bed and watch the ECG tracing for a few days. Automatic monitors are now available which will recognize abnormalities in the cardiac rhythm.

A special type of automatic arrhythmia detector monitors the patient during his normal working day by means of a special cassette tape recorder which is carried by the patient under investigation. By suitable data compression mechanisms the whole 24 hours (approximately 100 000 heart beats) can be compressed on to one cassette and this is read through on the following day at high speed to identify the frequency and significance of fluctuations in the heart rhythm.

The whole apparatus consists of a number of special portable tape recorders complete with ECG leads and electrodes, and the arrhythmia analyser which is kept at the hospital. The analyser consists of a cassette playback mechanism and a small computer programmed to recognize variations in the heart rate, and possibly abnormalities of the ECG itself. Typically, the output would be a histogram of the heart rate over the 24 hours and the ability to reproduce small sections of the ECG waveform relating to unusual events.

The use of such apparatus is much more cost efficient than long-term monitoring in the coronary intensive care unit, and is also more likely to detect transitory problems because the patient is performing normal tasks.

Anaesthetic Circuit r=2

The part of an anaesthetic machine which contains gases at low (near atmospheric) pressure. This includes all components on the back bar, and the breathing circuit. It does not include the cylinders, pipelines and the various high-pressure control components.

Anaesthetic machine n=40 c=4 r=2

Sometimes referred to as the anaesthetic trolley, this normally refers to a trolley on which are mounted gas cylinders and/or pipelines for various gases used in anaesthesia, together with the various valves, controls and ancillary equipment used by the anaesthetist.

These are found in all operating theatres and also in special procedure rooms in the X-ray department, accident and emergency unit, dental clinics and some community clinics. On the trolleys, the gases can be dispensed and mixed. These usually include oxygen, nitrous oxide and carbon dioxide, and sometimes medical air, cyclopropane and anaesthetic vapours such as halothane, ether, etc. The vapours are usually provided in special vaporizers which may be interchangeable according to the particular anaesthetic procedure required.

Simpler machines may also be referred to as anaesthetic machines which only dispense a mixture of nitrous oxide and oxygen. These may be controllable devices such as the Walton 5 or operate from premixed bottled gases (Entonox unit). These latter may be used either on the ward or as a portable unit in ambulances or by district midwives. An anaesthetic machine may also be used in conjunction with, or be incorporated into, a ventilator.

The maintenance of such equipment requires especially formal arrangements and quality control measures, since incorrect operation may cause permanent injury to the patient.

The main components of an anaesthetic machine are high-pressure gas reservoirs and/or pipelines, pressure reducing valves, flowmeters (usually of the rotameter type), pressure gauges, carbon dioxide absorbers, a fresh gas outlet, oxygen flush assembly, and vaporizers. The trolley may also carry monitoring equipment such as ECG and pressure monitors, oxygen meters, oscillotonometer, temperature gauges and pulse monitors, and a Wright's respirometer. Some modern ventilators are also carried on the trolley and become an integral part of the anaesthetic circuit when in use. Other important parts of the system are the suction apparatus and gas scavenging devices.

Analgesia apparatus n=10 c=3 r=2

This is usually an intermittent demand flow machine for delivering a mixture of nitrous oxide and oxygen, possibly with an analgesic vapour during labour, emergency surgery or dentistry. Examples are the Entonox apparatus, Minnitt's apparatus (obsolete), McKesson, Lucy Baldwyn, Walton 5, AE, and Quantiflex RA.

Anechoic chamber n=0 c=6 r=8

This is a special room or chamber with very low ambient noise and reverberation characteristics used for acoustical or audiological testing in research establishments. The term is sometimes wrongly applied to audiometry rooms or acoustic booths used in hospitals. Acoustic booths have less stringent specifications for an installation of the same size.

Anemometer r=2

A device for measuring the velocity of a gas or liquid. The three common types are those which monitor the difference in pressure between two points in a duct (Venturi or Fleisch tube), those which detect the cooling effect of the flow past a heated body (hot wire anemometer), and those in which the flow drives a small windmill. An example of the latter type is the Wright's respirometer.

Aneroid pressure gauges n=50 c=1 r=2

An aneroid pressure gauge or manometer is used to measure relatively low pressure differences from atmospheric pressure. It consists of a metal (usually copper) cylinder with thin corrugated sides often seen in barometers. The cylinder contains air and is completely sealed so that changes in the external pressure cause it to become longer or shorter. One end of the cylinder is fixed, while the other connects to a rack and pinion, with a pointer attached to the pinion. The pointer thus moves over a scale indicating pressure. The system can also be used in reverse so that the pressure to be measured is fed to the inside of the cylinder. There will however be a small error due to changes in atmospheric pressure.

Antistatic chain r=2

Trolleys used in conjunction with anaesthetic apparatus are often seen to have a small metal chain hanging down and dragging on the floor. The object of this is to prevent the build-up of static electricity on the trolley which might otherwise cause sparking when connection is made between the equipment on the trolley and other metalwork. The sparks may in turn ignite anaesthetic gases or vapours.

The chain is not normally necessary because trolley wheels on anaesthetic equipment are usually made of antistatic (conductive) rubber which performs the same function.

Antistatic floor n=15 c=4 r=2

Sparks due to static electricity in operating theatres may cause ignition of spirits, or explosion. Also the small electric shocks received from these sparks may cause minor mishaps. To prevent the build-up of static electricity, the whole operating area is maintained at earth potential by the use of flooring materials which provide a limited leakage path for electricity. Sometimes the whole floor is covered with an antistatic rubber or plastic but satisfactory results can be obtained with tile floors (e.g. quarry, terrazzo) though these may depend on a high relative humidity in the room. Since operating theatres are normally maintained at a relative humidity of 50-65%, this condition is normally met.

Test criteria exist in some countries such as the requirement that the resistance between two electrodes 60 cm apart on the floor should be between 20 kΩ and 5 MΩ. The reason for the lower limit is that a very low resistance floor would present an enhanced risk of electrocution from faulty equipment or wiring by improving the potential current route to earth.

Antistatic rubber r=2

Rubber or Neoprene can be made into rather poor conductors of electricity by the addition of carbon. The poor conductivity achieved is ideal for use in the operating theatre for the construction of anaesthetic equipment tubing, operating table mats, floors and trolley wheels. Static electricity induced on to the surface of these items will leak away safely, thus reducing the risk of electrical sparks which may cause ignition of volatile anaesthetic agents. Items made of antistatic rubber are normally identified by a yellow flash or label.

Apnoea alarm/monitor n=20 c=2 r=2,3

This device monitors breathing and sounds an alarm if no breathing is detected for more than a preset time limit (e.g. 15-30 s). The two main applications for such devices are monitoring the breathing of premature babies and monitoring the correct action of ventilators in the operating theatre and intensive care unit.

An apnoea alarm for use on babies may operate in one of several ways:

1. Impedance plethysmography in which the electrical impedance of the chest is measured via skin electrodes. The impedance falls as the chest expands and so a signal roughly corresponding to the breathing pattern is obtained. This signal is applied to a circuit to identify when chest movement is insufficient to indicate breathing. In its simplest form this might be a rectifier, integrator and level detector which alarms if the voltage falls below a preset level. The whole device may be incorporated into an ECG monitor using the same electrodes.
2. Chest wall movement detectors may be used which detect the expansion in the chest circumference during breathing. These may be simple strain gauges included in a thread or tape around the chest, or mercury in elastic tubes which varies in electrical resistance as the tube is stretched. The term 'pneumograph' is often used to describe a wider bore air-filled tube

around the chest in which the pressure will vary with the breathing movement.

3. General movement of the infant may be a suitable substitute for actual chest wall movement since the apnoeic episodes experienced by young babies are normally associated with cessation of all movement. This may be detected with a crude form of radar device which directs a 10 GHz electromagnetic wave at the baby and detects changes in the phase of the returning echo and converts this into an activity signal to trigger the apnoea detecting circuit.
4. Movement may also be detected by a variety of sensing systems such as a pressure mattress using thermocouples to detect the flow of air which occurs between segments of an air mattress during movement, or a small air-filled bulb may be taped to the abdomen of the baby and the variations of pressure in the bulb be detected.

Ventilator alarms may monitor the source of power (gas or electricity) to the ventilator and will monitor pressure or flow in the breathing circuit. Typically they are set to alarm if the pressure exceeds a given value and if the cycling of pressure ceases for more than a preset interval. This type, which works in the breathing circuit, is preferable since it will also alarm if there is a disconnection. Examples of ventilator alarms are the Blease, and the East Ventilarm.

Applanation tonometer n=1 c=1.5 r=6.9

The pressure within an elastic-walled sphere or cylinder such as the eye, an artery, or the pregnant uterus can be measured from outside the walls by the use of an applanation tonometer. This may be a mechanical device consisting of a flat ring in which there is a concentric disc maintained flush with the surface of the outer ring but connected to a force transducer. When a section of the wall is flattened by the device the pressure required on the central disc to keep the wall flat is equal to the pressure within the sphere or cylinder. The pressure is calculated as the force applied divided by the area of the inner disc. Large devices of this type are commonly used to measure the intra-uterine pressure during labour. This device is sometimes called a tocodynamometer or guard ring tocograph, and the measuring instrument called a cardiotocograph, which also records heart rate. Smaller devices have been used for measuring pressures within arteries and also within the eye by direct application to the cornea.

A non-contact applanation tonometer exists for measuring intra-ocular pressures. Flattening of a small section of the cornea is achieved by a blast of air with force increasing linearly with time. Applanation is detected optically by shining a collimated light beam on to the test section on the cornea and detecting the reflection. As the cornea becomes flattened the light intensity