Sphygmomanometer

A **sphygmomanometer** (/ˌsfɪɡmoʊməˈnɒmɨtər/ ***SFIG**-moh-mə-**NOM**-i-tər*), **blood pressure meter**, **blood pressure monitor** or **blood pressure gauge** (also referred to as a **sphygmometer**[1]) is a device used to measure blood pressure, composed of an inflatable cuff to collapse and then release the artery under the cuff in a controlled manner,[2] and a mercury or mechanical manometer to measure the pressure. It is always used in conjunction with a means to determine at what pressure blood flow is just starting, and at what pressure it is unimpeded. Manual sphygmomanometers are used in conjunction with a stethoscope.

The word comes from the Greek σφυγμός (*sphygmos*, pulse), plus the scientific term manometer (pressure meter). The device was invented by Samuel Siegfried Karl Ritter von Basch in 1881.[2] Scipione Riva-Rocci introduced a more easily used version in 1896. In 1901, Harvey Cushing modernized the device and popularized it within the medical community.

A sphygmomanometer consists of an inflatable cuff, a measuring unit (the mercury manometer, or aneroid gauge), and a mechanism for inflation which may be a manually operated bulb and valve or a pump operated electrically.

The usual unit of measurement of blood pressure is millimeters of mercury (mmHg) as measured directly by a manual sphygmomanometer.

1 Types

There are two types of sphygmomanometers:

- **Manual sphygmomanometers** require a stethoscope for auscultation (see below). They are used by trained practitioners. It is possible to obtain a basic reading through palpation alone, but this only yields the systolic pressure.
    - **Mercury sphygmomanometers** are considered to be the gold standard. They measure blood pressure by observing the height of a column of mercury, which do not require recalibration.[3] Due to their accuracy, they are often required in clinical trials of pharmaceuticals and for clinical evaluations of determining blood pressure for high-risk patients including pregnant women.
    - **Aneroid sphygmomanometers** (mechanical types with a dial) are in common use; they may require calibration checks, unlike mercury manometers. Aneroid sphygmomanometers are considered safer than mercury based, although inexpensive ones are less accurate.[4] A major cause of departure from calibration is mechanical jarring. Aneroids mounted on walls or stands are not susceptible to this particular problem.
- **Digital**, using oscillometric measurements and electronic calculations rather than auscultation. They may use manual or automatic inflation. These are electronic, easy to operate without training, and can be used in noisy environments; they are not as accurate as mercury instruments. They measure systolic and diastolic pressures by oscillometric detection, using a piezoelectric pressure sensor and electronic components including a microprocessor.[5] They do not measure systolic and diastolic pressures directly, *per se*, but calculate them from the mean pressure and empirical statistical oscillometric parameters. Calibration is also a concern for these instruments.[6][7][8] Most instruments also display pulse rate. Digital oscillometric monitors are also confronted with several “special conditions” for which they are not designed to be used, such as: arteriosclerosis; arrhythmia; preeclampsia; *pulsus alternans*; and *pulsus paradoxus*. Such people should use analog sphygmomanometers, as they are more accurate when used by a trained person. Digital instruments may use a cuff placed, in order of accuracy[9] and inverse order of portability and convenience, around the upper arm, the wrist, or a finger. The oscillometric method of detection used gives blood pressure readings that differ from those determined by auscultation, and vary subject to many factors, for example pulse pressure, heart rate and arterial stiffness.[10] Some instruments claim also to measure arterial stiffness. However such machines are not recommended for regular users as machines that claim to have 3% accuracy rate, are usually inaccurate to over 7%, and even provided two different readings when checked at the same time. Some of these monitors also detect irregular heart beats.

2 Operation

In humans, the cuff is normally placed smoothly and snugly around an upper arm, at roughly the same vertical height as the heart while the subject is seated with the arm supported. Other sites of placement depend on species, it may include the flipper or tail. It is essential that the correct size of cuff is selected for the patient. Too small a cuff results in too high a pressure, while too large a cuff results in too low a pressure. For clinical measurements it is usual to measure and record both arms in the initial consultation to determine if the pressure is significantly higher in one arm than the other. A difference of 10 mm Hg may be a sign of coarctation of the aorta. If the arms read differently, the higher reading arm would be used for later readings. The cuff is inflated until the artery is completely occluded.

With a manual instrument, listening with a stethoscope to the brachial artery at the elbow, the examiner slowly releases the pressure in the cuff. As the pressure in the cuffs falls, a “whooshing” or pounding sound is heard (see Korotkoff sounds) when blood flow first starts again in the artery. The pressure at which this sound began is noted and recorded as the systolic blood pressure. The cuff pressure is further released until the sound can no longer be heard. This is recorded as the diastolic blood pressure. In noisy environments where auscultation is impossible (such as the scenes often encountered in emergency medicine), systolic blood pressure alone may be read by releasing the pressure until a radial pulse is palpated (felt). In veterinary medicine, auscultation is rarely of use, and palpation or visualization of pulse distal to the sphygmomanometer is used to detect systolic pressure.

Digital instruments use a cuff which may be placed, according to the instrument, around the upper arm, wrist, or a finger, in all cases elevated to the same height as the heart. They inflate the cuff and gradually reduce the pressure in the same way as a manual meter, and measure blood pressures by the oscillometric[5] method.

3 Significance

Main article: Blood pressure

By observing the mercury in the column while releasing the air pressure with a control valve, one can read the values of the blood pressure in mm Hg. The peak pressure in the arteries during the cardiac cycle is the systolic pressure, and the lowest pressure (at the resting phase of the cardiac cycle) is the diastolic pressure. A stethoscope is used in the auscultatory method. Systolic pressure (first phase) is identified with the first of the continuous Korotkoff sounds. Diastolic pressure is identified at the moment the Korotkoff sounds disappear (fifth phase).

Measurement of the blood pressure is carried out in the diagnosis and treatment of hypertension (high blood pressure), and in many other healthcare scenarios.

4 Pressure sensors in digital devices

There are two types of pressure sensor that may be used in digital devices: capacitative and electrostatic.

5 References

[1] As the etymology indicates, this should have the somewhat different connotation of 'a gauge to measure pulse', whereas the main function is actually to measure pressure.

[2] Booth, J (1977). “A short history of blood pressure measurement”. *Proceedings of the Royal Society of Medicine* **70** (11): 793–9. PMC 1543468. PMID 341169. Retrieved 2009-10-06.

[3] “Comparing Mercury and Aneroid Sphygmomanometers”. *Sustainable Hospitals / Lowell Center for Sustainable Production*. Sustainable Hospitals / Lowell Center for Sustainable Production. 2003. Retrieved 23 February 2015.

[4] Misrin, J. “Aneroid Sphygmomanometer: A Battle for Safer Blood Pressure Apparatus”. Retrieved 27 February 2012.

[5] Oscillometry, Explanation of oscillometric detection in Medical Electronics, N Townsend, p48-51

[6] Can we trust automatic sphygmomanometer validations? Turner MJ. Journal of Hypertension. **28**(12), December 2010, pp. 2353–2356 doi: 10.1097/HJH.0b013e32833e1011.

[7] Automated Sphygmomanometers Should Not Replace Manual Ones, Based on Current Evidence Martin J. Turner and Johan M. van Schalkwyk American Journal of Hypertension. **21**(8), p. 845.

[8] Sphygmomanometer calibration--why, how and how often? Turner MJ1, Speechly C, Bignell N. Australian Family Physician. October 2007; **36**(10):834-838.

[9] Inaccuracy of wrist-cuff oscillometric blood pressure devices: an arm position artefact? Adnan Mourad, Alastair Gillies, Shane Carney, Clinical methods and pathophysiology

[10] Oscillometric blood pressure measurement: progress and problems. van Montfrans, Blood Press Monit. 2001 Dec;6(6):287-90

6 External links

- US patent 2560237, R. H. Miller, “Sphygmomanometer”, issued 1951-07-10

- US patent 6752764, Man S. Oh, “Pocket sphygmomanometer”, issued 2004-06-22

7 Text and image sources, contributors, and licenses

7.1 Text

- **Sphygmomanometer** *Source:* https://en.wikipedia.org/wiki/Sphygmomanometer?oldid=676787638 *Contributors:* Bryan Derksen, Alex.tan, Fubar Obfusco, Rsabbatini, Stevertigo, GTBacchus, Tregoweth, Ahoerstemeier, Julesd, N-true, Steinsky, Robbot, Matt Gies, Ævar Arnfjörð Bjarmason, Bensaccount, Jfdwolff, Jason Quinn, Wstclair, Doops, Icairns, Eliazar, Discospinster, Rama, Mjpieters, Mani1, Kwamikagami, Mwanner, Rajah, Hooperbloob, Espoo, Alansohn, Free Bear, Axl, Mac Davis, TaintedMustard, RainbowOfLight, Pol098, Tabletop, Wikiklrsc, Spidermonkey, Julo, Macaddct1984, BD2412, Mendaliv, Dlimeb, Rjwilmsi, Linuxbeak, Crazynas, FlaBot, Sky Harbor, GreyCat, Mfranck, WriterHound, AbinoamJr, Okedem, Draeco, Djillene, Blitterbug, Frençs2000, Allens, Bibliomaniac15, SmackBot, KVDP, DocKrin, Thumperward, Ebertek, A. B., OrphanBot, DMacks, ML5, Mgiganteus1, Tawkerbot, Nehrams2020, Audiosmurf, Tawkerbot2, Fvasconcellos, NorthernThunder, Lindsay658, Thijs!bot, Epbr123, Robsinden, N5iln, AntiVandalBot, Kaini, Deflective, Barek, Mamcleod, Karlhahn, Michael V Hayes, Scanlan, LookingGlass, R'n'B, Nynicks00, BrokenSphere, Katharineamy, Mikael Häggström, Wiher, Cmichael, Vanished user 39948282, JMSchneid, VolkovBot, Thisisborin9, Tomer T, Plenumchamber~enwiki, Finngall, Spinningspark, AlleborgoBot, Rknasc, SieBot, YonaBot, A. Carty, Masgatotkaca, Manway, Fuzzy Chicken, BrokeTheInterweb, Motyka, Tatterfly, Cellorelio, Animeronin, ClueBot, Gits (Neo), Ntdgr3nade, Jmk, Rubin joseph 10, NuclearWarfare, Versus22, Rickremember, Dthomsen8, DrGregHouseMD, Addbot, Yousou, Freakmighty, Mvhayes, Globalinflatables, MrOllie, LaaknorBot, Glane23, Bob K31416, 5 albert square, Castillo4, Lightbot, Dr.queso, Luckas-bot, Yobot, Fraggle81, Gobbleswoggler, AnomieBOT, Sz-iwbot, Materialscientist, Obersachsebot, Xqbot, Srich32977, BristolQueen, Quod erat demonstrandum 3.14159, Fortneca, Hexafluoride, Citation bot 1, Tinton5, Haaninjo, Arfgab, Vrenator, Defender of torch, Specs112, Yeng-Wang-Yeh, RjwilmsiBot, RobertDeto, EmausBot, Coasterlover1994, Turjan, FlopEJoe, Rishigupta02445, NTox, ClueBot NG, Netsurfer123, Twillisjr, Weeksgo, Oddbodz, Calabe1992, BG19bot, Vagobot, Sharu wikki, YVSREDDY, Terrytibbs1983, ChrisGualtieri, Cheese22211, Punit43, Tentinator, The Herald, Teamarsenal, Momomoos, Leopardtail, Monkbot, Jelly Bean MD, Santos33, Mikeobama123, Bruceafriedman and Anonymous: 150

7.2 Images

- **File:BloodPressure.jpg** *Source:* https://upload.wikimedia.org/wikipedia/commons/3/3b/BloodPressure.jpg *License:* Public domain *Contributors:* ? *Original artist:* ?
- **File:Clinical_Mercury_Manometer.jpg** *Source:* https://upload.wikimedia.org/wikipedia/commons/1/16/Clinical_Mercury_Manometer.jpg *License:* Public domain *Contributors:* Transferred from en.wikipedia to Commons by Liftarn using CommonsHelper. *Original artist:* Mvhayes at English Wikipedia
- **File:Commons-logo.svg** *Source:* https://upload.wikimedia.org/wikipedia/en/4/4a/Commons-logo.svg *License:* ? *Contributors:* ? *Original artist:* ?
- **File:Portal-puzzle.svg** *Source:* https://upload.wikimedia.org/wikipedia/en/f/fd/Portal-puzzle.svg *License:* Public domain *Contributors:* ? *Original artist:* ?
- **File:Sphygmomanometer&Cuff.JPG** *Source:* https://upload.wikimedia.org/wikipedia/commons/a/ae/Sphygmomanometer%26Cuff.JPG *License:* Public domain *Contributors:* Transferred from en.wikipedia; transferred to Commons by User:Common Good using CommonsHelper. *Original artist:* Original uploader was ML5 at en.wikipedia
- **File:Sphygmomanometer.JPG** *Source:* https://upload.wikimedia.org/wikipedia/commons/6/6e/Sphygmomanometer.JPG *License:* Public domain *Contributors:* Transferred from en.wikipedia; transferred to Commons by User:Common Good using CommonsHelper. *Original artist:* Original uploader was ML5 at en.wikipedia

7.3 Content license

- Creative Commons Attribution-Share Alike 3.0