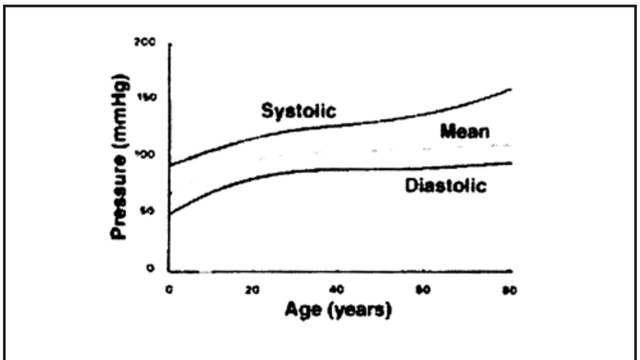
CONTROL OF ARTERIAL BLOOD PRESSURE

Dr S. Sharma, formerly Lecture in Anaesthesia, Tribhuvan University Teaching Hospital, Kathmandu, Nepal; presently Plymouth General Hospital

The blood pressure is the force that causes blood to flow through the arteries, capillaries, and finally veins back to the heart.

It is closely regulated via several physiological mechanisms to ensure an adequate tissue blood flow. Both systolic and diastolic pressures increase with age (figure 1).



The blood pressure is determined by the rate of blood flow produced by the heart (cardiac output), and the resistance of the blood vessels to blood flow. This resistance is produced mainly in the arterioles and is known as the systemic vascular resistance (SVR) or the peripheral vascular resistance (PVR). The interactions between blood flow, pressure and SVR are shown in the equation in figure 2:

Figure 2

Blood pressure = cardiac output x SVR

Using the formula in figure 2 we can see that the blood pressure can be raised either by increasing cardiac output or SVR. Conversely the blood pressure is reduced by a fall in cardiac output or SVR.

Physiological mechanisms to maintain normal blood pressure are listed below:

1. Autonomic nervous system responses
2. Capillary shift mechanism
3. Hormonal responses
4. Kidney and fluid balance mechanisms

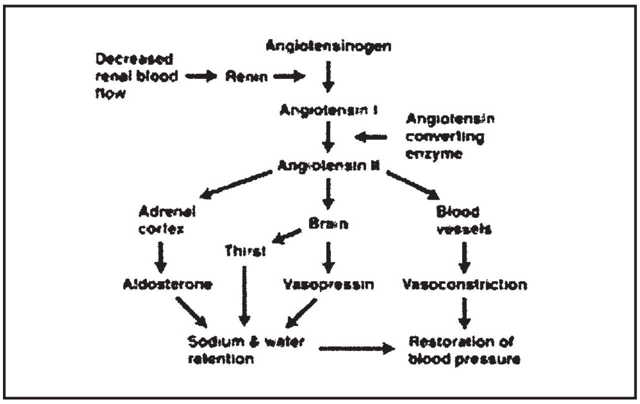
The autonomic nervous system is the most rapidly responding regulator of blood pressure and receives continuous information from the baroreceptors (pressure sensitive nerve endings) situated in the carotid sinus and the aortic arch. This information is relayed to the brainstem to the vasomotor centre (VMC). A decrease in blood pressure causes activation of the sympathetic nervous system resulting in increased contractility of the heart (beta receptors) and vasoconstriction of both the arterial and venous side of the circulation (alpha receptors).

The Capillary fluid shift mechanism refers to the exchange of fluid that occurs across the capillary membrane between the blood and the interstitial fluid. This fluid movement is controlled by the capillary blood pressure, the interstitial fluid pressure and the colloid osmotic pressure of the plasma. Low blood pressure results in fluid moving from the interstitial space into the circulation helping to restore blood volume and blood pressure.

Hormonal mechanisms exist both for lowering and raising blood pressure. They act in various ways including vasoconstriction, vasodilation and alteration of blood volume. The principal hormones raising blood pressure are:

(a) Adrenaline and noradrenaline secreted from the adrenal medulla in response to sympathetic nervous system stimulation. They increase cardiac output and cause vasoconstriction and act very rapidly.

(b) Renin and angiotensin production is increased in the kidney when stimulated by hypotension (figure 3). Angiotensin is converted in the lung to Angiotensin II, which is a potent vasoconstrictor. In addition these hormones stimulate the production of aldosterone from the adrenal cortex which decreases urinary fluid and electrolyte loss from the body.



This system is responsible for the long term maintenance of blood pressure but is also activated very rapidly in the presence of hypotension.

The kidneys help to regulate the blood pressure by increasing or decreasing the blood volume and also by the renin-angiotensin system described above. They are the most important organs for the longterm control of blood pressure.

In conclusion blood pressure is controlled by several physiological mechanisms acting in combination. They ensure that the pressure is maintained within normal limits by adapting their responses both in the short and long term to provide an adequate perfusion to the body tissues.