LOW ARTERIAL PRESSURE.

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Definitions.

Low arterial pressure* (*Hypopiesia*) is a term applied to low arterial pressure in general, whether physiological or pathological, temporary or permanent, congenital or acquired.

Hypopiesia (*primary low arterial pressure*) is a clinical series of primary congenital, constitutional or familial origin, characterised by persistently lowered arterial pressure occurring as a part of a low vitality state either (a) without *apparent* physical abnormality, (b) with symptoms of exhaustion, or (c) in association with conditions of suboxidation dependent upon physical abnormalities, such as elongation and narrowing of thorax, aorta and heart.

Hypotonia (*vascular hypotonus*) is a dynamic and physical state of diminished tone of the smooth muscle in the *walls of arteries, arterioles and veins*, in contradistinction to low arterial pressure, which indicates a diminished lateral pressure exerted by the *blood* upon the vessel wall.

Limits of Low Arterial Pressure.

It is difficult to say where normal levels of arterial pressure pass into low levels. Statistical studies of many thousands of healthy men and women for life assurance purposes over several years yield useful figure-values of average systolic and diastolic arterial pressures. Since these depend, however, on numerous physical, physiological and psychical variables, it is not easy to define them numerically. Under like conditions the "normal" for one person may be abnormal for another, or for the same person under different conditions.

Various observers place the upper limit anywhere between 110 and 100 mm., the consensus of opinion inclining to 110 mm. While certain subjects with pressures below this level have no definite manifestations of ill-health, others in the same group present phenomena which, at any rate in part, appear to arise from the low pressure.

1. **Upper limit.** For practical purposes experience leads me to adopt the figure of 110 mm. Hg. as the upper (systolic) limit of hypopiesia at adult ages for males, and 105 mm. for females. The common pressure-range is from 110 to 90 mm.

2. **Lower limit** The lower (diastolic) limit corresponding to this upper limit of 110 is normally 66 for males and 62 for females. It may range from 80 to 60 mm.

3. **Differential pressure.** As in high arterial pressure the above figures yield a standard differential pressure of 44 mm., though the ordinary excursion may vary between 34 and 54 mm. Differences of 34 to 31 should be regarded as suspect, whereas those of 30 mm. or less are definitely pathological.

* *Note.*—The term "hypotension," favoured by French and American writers, is best avoided because of its ambiguity. Its only defence is convenience in usage, but it is an ugly Greek and Latin hybrid, and "tension" is a property of the arterial "walls" and not of the contained blood.

The lower limit is more difficult to fix than is the upper, since frequently systolic and diastolic pressures do not run on parallel lines, the diastolic in different persons being prone to wide variations. The lowest levels are often associated with disorders of internal secretion, and the highest with chronic glomerulo-nephritis. In feeble subjects the sound usually taken as the sphygmomanometric index of diastolic pressure may be inaudible.

General observations. Low arterial pressures are more irksome but less dangerous than those that are high, and are wont to occur under the influence of, and in association with, a large variety of physiological or pathological conditions.

The sudden, and at times unexpectedly serious, issues of high arterial pressure are so dramatic that they impress both patient and practitioner with a strong sense of their gravity. Thus lay as well as medical attention has been so largely directed to the upper part of the pressure-scale that readings of the lower levels have suffered comparative neglect. A further reason is that, in Great Britain, low pressures in comparison with high are less frequently met with in practice, and when they exist are often overlooked because no estimation of arterial pressure is made.

Notwithstanding that the research problems of arterial pressures that are low are numerous and attractive, little attempt has been made in the direction of exhaustive studies. Hypopiesis, therefore, still remains one of the less definite problems of medicine. This important topic of low arterial pressure had received little mention save in scattered papers and one monograph, until my book on "Low Arterial Pressure" * appeared in 1928.

Even now many practitioners hardly recognise that it exists, and if by chance they come across it, regard it as negligible. During the past decade, certain of its aspects have been studied more closely, but, even in countries where low arterial pressure is far more common, little serious endeavour has been made to undertake intensive inquiries, although the condition is gradually becoming better appreciated.

Incidence. The degree of mass-frequency of hypopiesis between ages 17 and 30 is approximately 3.5 per cent., the majority of subjects manifesting weights below standard sometimes combined with deficient chest expansion.

Sex. Women are affected in slightly greater degree than men.

Emotion. Emotion has only a relatively slight effect by reason of diminished or absent reactive capacity.

Classification.

Hypopiesis cannot readily be classified. There is no universally accepted standard because any such standard should be ætiological and therefore basic. Low blood pressure, like high, is not a disease but a symptom. In both the explanation often lies in more than one causal factor. My own opinion, based on experience of large numbers of cases, is that the subject of hypopiesis in general is never a normal person, and that hypopiesis is the expression of a low vitality state.

Ætiology.

Much current confusion results from the fact that certain of these subjects who exhibit no obvious physical abnormality—the "apparently healthy" class—have been regarded by many writers as normal apart from the co-existence

* "Low Arterial Pressure" 1928; "High Arterial Pressure" 3rd edition 1934: Wm. Heinemann (Medical Books) Ltd., London.

of low levels of arterial pressure. The most reasonable explanations of this fallacy are (1) that observations have been based upon consideration solely of the systolic pressure; (2) that in this group the upper limit of pressure is comparatively stable, being habitually maintained at or near the level of 110 mm. Hg., whereas in symptomatic groups the upper limit is far more labile and readily manifests a considerable fall below this level in response to factors which in the ordinary person would be negligible; (3) that these subjects possess adequate muscular and mental aptitude for all *ordinary* demands, but readily contract infections because of their low powers of resistance.

A careful analysis, however, of the previously inexplicable hypopiesia, including daily sphygmomanometric observations shows that the subjects of this, the purest example of a low pressure state, although they suffer from a condition rather than a disease, are by no means physiological people. Evidence in support of this view is given in the section dealing with hypopiesia (q.v.).

The chief ætiological hypotheses are these:—

1. **Autonomic-endocrine dysfunction.** This induces relaxation of the peripheral circulation, which essentially makes small demands on the arterial system for any rise in pressure. Nutritional changes in body cells and tissues constitute the basis, to which is added a lessening of hormonal control of the posterior portion of the pituitary gland and adrenal medulla, which exert so great an influence on tonicity of blood vessels through mediation of the sympathetic nervous system.

2. **Metabolic influences.** Avitaminosis and other depressant states act adversely upon the katabolic glands—pituitary, adrenal and thyroid—which normally balance the glands of anabolism in controlling the rate of metabolism with which correspond activation or depression of vitality. In this way the power of the heart to produce a rise of pressure in the vessels is greatly diminished.

3. **Biochemical influences.** Disturbance of the acid-base equilibrium of the tissues in the direction of alkalinity takes place, as shown by the urinary ratio of free to combined (ammonia) acidity being greater than the normal 1: 1.75. This is associated with errors of assimilation in youth, and with endocrine deficiency in later life. Metabolic disequilibrium is thus produced with consequent lessening of vitality.

4. **Toxæmia** of gastro-intestinal origin and certain general and focal infections lower arterial pressure, as does the paroxysmal hypopiesis resulting from absorption of histamine-like substances liberated during shock.

5. **Somatic defects.** Poor physique and diminished respiratory capacity sometimes combined with the mechanical defects of hypoplasia, such as small heart, narrowed aortic arch, and elongated and narrowed ascending aorta have been invoked as ætiological, though the influence of body habitus is now largely denied. Such defects frequently accompany chronic pulmonary tuberculosis, as well as other conditions such as hæmorrhage or pernicious anæmia in which there is an insufficient volume of blood for conveyance of oxygen to the tissues.

Life in its biochemical aspects consists in a series of reactions to stimuli, mechanical, electro-physical, chemical and infective, of varying proportions and degrees. Deficiency in response to such stimuli causes symptoms, of which low arterial pressure is one of the most important. The other main cause is toxæmia. Low arterial pressure in recumbency means little, but in fever or under strain has a terrible significance. The estimate of deficiency is the degree of power of

reaction, and the measure of this is the level of the low pressure. Hence hypopiesis should be estimated after exertion to find out how far a patient can react when he gets going, not how slow he is in starting. From this emerges a valuable unifying principle applicable to the whole field of blood pressure, high and low, that response to effort is the most practical test of circulatory efficiency.

Types of Low Arterial Pressure.

Occurring under physiological conditions.

1. *Psychical Hypopiesis.*

This form is induced by sudden and intense emotion of depressing nature, or more commonly by prolonged gloomy and debilitating influences. Bradycardia is frequent. Organic cardiac insufficiency is usually attended by tachycardia and cyanosis, and is thus readily distinguishable.

2. *Physical Hypopiesis.*

(a) Hypotonia. Often an accompaniment of (b).

(b) Hypopiesia (primary, essential, congenital or constitutional hypopiesis).

Hypopiesia appears usually in combination with an inherent diminution of peripheral arteriolar and capillary tonus and the response of the heart thereto. The task of the heart is to compensate for the inadequate filling of the vessels with blood, thereby inducing a clinical picture of insufficient pressure which differs from that of hypotonia in that it is not the arterial system alone that is involved. Cardiac attempts at compensation lead to arterial pressure approaching standard levels, a fact which should be borne in mind if these cases are not to be overlooked.

The subjects of hypopiesia react well to demands for physical or nervous effort with corresponding improvement in circulatory tone, provided always that such effort falls within their limit of reserve. Similar hereditary and familial forms also occur, lessened cardio-vascular tone involving several members of the same family, often with slow pulse rates, and spreading over two or more generations.

Some students of blood pressure are inclined to doubt whether constitutional low arterial pressure has any real existence. This attitude of mind is erroneous, but explicable on the view that certain writers have included under a single heading not only the true "physiological" state of essential low pressure, but also various pathological groups such as hypoadrenia or other endocrine defect which come under Martinet's umbrella syndrome of "hyposphyxia."

(c) *Hypopiesis Temporarily Induced as a result of Change of Posture* (postural or orthostatic low arterial pressure).

This postural form arises from local disturbance in the peripheral sympathetic nervous supply to the vessels and sweat glands, so that the normal vasomotor reflex no longer induces vasoconstriction when the subject changes from recumbency to a sitting or standing posture. Multiple causes probably exist, but many postural low pressures are associated with disease of the central nervous system. "The centre lies not in the cord but in the brain, and the site of the lesion is either in a sympathetic centre, or in an afferent path controlling the entire response, or generalised through afferent paths or nerve endings."⁽¹⁾

Signs. On standing there ensue (i) loss of reflex vasoconstriction, (ii) reflex acceleration of heart rate, evidenced by inability to sustain a level of arterial pressure commensurate with physiological activity, and followed by a notable drop in systolic and a lesser drop in diastolic pressures.

Symptoms. The most frequent are (i) considerable weakness or syncopal attacks dependent on the sudden fall in pressures often in conjunction with deficient sweating when the subject stands.

Other symptoms are (ii) pallor, blurred vision, headache, vertigo and malaise, (iii) slow and constant pulse rate, (iv) notable variations in arterial pressure, (v) increased distress in hot weather, (vi) slight lowering of the basal metabolic rate, (vii) rise in blood urea towards the upper limit of normality, (viii) loss of libido, (ix) slight changes in the central nervous system, (x) youthful appearance in comparison with the true age.⁽²⁾ The chief utility of postural observation lies in the detection of lack of vasomotor control and functional circulatory efficiency. It is not improbable that this postural form in reality constitutes a part of hypopiesia.

Conditions of association. Low arterial pressure occurs symptomatically in association with numerous conditions of striking diversity.

(a) *Physiologically* it is induced temporarily as a result of recumbent rest, quiet sleep, undue fatigue, moist heat, the menstrual cycle, pregnancy and labour. It tends to become permanent in athletes, in those of gentle and placid temperament; with muscular exercise, age, routine and warm climates; often with unexciting routine.

(b) *Pathologically* it results from acute conditions of shock and collapse; from nearly all the acute specific infections, notably cholera, typhus and enteric fevers; diphtheria, influenza, pneumonia and cerebro-spinal fever; in chronic states attended by wasting, especially pulmonary tuberculosis in its late stages; in Addison's disease, which constitutes the fullest expression of adrenal insufficiency; in constitutional affections such as status lymphaticus, myasthenia gravis, etc.; in primary and secondary anæmias; in chronic infections, intoxications and circulatory disorders; in chronic arthritis and fibrositis, and finally as a terminal event. In transient form it may also occur in coronary thrombosis.

Clinical aspects.

I. Hypopiesis.

The following are the leading characteristics of a well-defined case. Lesser degrees naturally do not manifest the same extreme picture.

The one constant symptom of which all patients with absolutely low arterial pressures complain is lassitude together with readily induced physical and mental fatigue.

Physically such subjects are disinclined to rise in the morning; their frequent complaint is of broken sleep; during the day they would rather sit or lie than stand; on slight effort they become fatigued, being breathless on going upstairs or on quick movement; more strenuous or prolonged exertion so depresses their already low pressures and low vitality that for several hours or even days they remain exhausted; gastro-intestinal disturbances may be troublesome.

Mentally they are conscious of vague feelings of anxiety or apprehension; they are depressed and unable to concentrate their thoughts; only by a determined effort of will can they fix their attention upon work, which often brings on occipital pressure-headache; mental functioning is slow and memory impaired with frequent lapses; giddiness may supervene, and faintness even up to convulsions and syncope.

The signs most frequently observed are pallor of skin and conjunctivæ; a small and soft pulse, which may be dicrotic; cold and cyanosed extremities with tendencies to chilblains and varices; delayed capillary flow; muscular weakness and flabbiness; and diminished urinary ratio of titratable free to combined acidity.

It is necessary here to remark that many of these patients through exercise of strong will-power are capable of strenuous effort for a considerable time. Nevertheless, sooner or later the limits of individual reserve are overstepped, direct warnings appear in the shape of single or multiple symptoms, and the subject flops. In severer forms these unfortunates may collapse suddenly and undergo complete breakdown, or they may succumb to an acute infection or an anxiety state, finally becoming neurasthenic or even mentally defective.

II. *Hypopiesia.*

Hypopiesia, apart from the low levels of arterial pressure, may be symptomless, or may exhibit the above manifestations along with other peculiarities. The actual low levels determine which of these two varieties will predominate.

A notable feature of hypopiesia is that on the sphygmomanometer scale the boundary line between the zone of no symptoms and of symptoms is often very sharply defined. As soon as arterial pressure falls below this line, which differs with the individual, symptoms ensue, and with a still further drop they increase in intensity. A downward difference of even as little as two to three millimetres makes all the difference between comfort and discomfort.

As children such subjects are frequently of stocky build, lethargic and with flabby muscles; in adolescence they can do stationary exercises and lift heavy weights, but fail in rapid or vigorous movements, so that in later life they tend to put on excessive weight. Prolonged exertion induces first discomfort, then lassitude and fatigue, and finally malaise with headache, prostration and nausea, even up to vomiting and diarrhoea. During the day they may be able to rouse themselves to necessary activity, but at night are glad to seek their beds. Mentally they are usually alert, and may be brilliant so long as their pressures, especially the diastolic, maintain individual standard levels. If the pressures sink to below the level of ease, these patients become dull and apathetic, and in the presence of persistent headache cannot even think. Hence they favour the lightest of literature, while heavy or abstruse treatises are shunned.

Prognosis.

Prognosis on the whole is favourable, but there is a special liability to cardiac insufficiency on the one hand, and to fatal shock on the other.

The Biological Law of low arterial pressure. From the foregoing clinical and biochemical observations I was led to formulate the law that "low arterial pressure, whether congenital or acquired, temporary or permanent, is always to be regarded as an expression of low vitality." In other words, the hypopietic subject exists in an inferior constitutional state in which he suffers from low and inadequate reactive capacity to normal and abnormal stimuli. Up to a point stimulation is beneficial, but if carried just beyond the narrowed limits of reserve, depression of vital energy rapidly ensues.

Control of low arterial pressure. In cases presenting no symptoms treatment is unnecessary, and may even be harmful. This applies particularly to athletes

and to people over 50 years of age. In other cases treatment is of no avail, e.g., status lymphaticus, where the heart and great vessels are reduced in size and the arterial pressure correspondingly low.

1. *General Measures of Control.* There are many in whom appropriate treatment is beneficial. In general, daily life should be so ordered as to conserve energy and to enhance vitality. Diet should be nourishing, balanced and easily assimilable, a sufficiency of vitamins being ensured. In addition to other drinks, a pint of water for each 5 stones of body-weight should be taken daily. As a rule alcohol is best avoided, but in neurasthenia with gastric symptoms, or in anorexia due to exhaustion, a little stimulant, preferably stout, whisky and soda or port, with meals tends to restore the vital balance. In severe forms, such as Addison's disease, myasthenia gravis and adiposis dolorosa, prolonged rest in bed may be necessary in combination with appropriate hormone therapy. Exercise is indicated, but should always be within the patient's limited power of reserve. For many subjects, dancing and horse-riding act as beneficial stimuli. Graduated walking exercise, at first on the level, and later on prescribed gradients, favour oxidation and counteract respiratory deficiency. All games should be played in moderation, nine holes at golf rather than eighteen, and one set of tennis followed by a rest before continuing, since excessive exertion, sudden or prolonged, depletes still further the low vitality and drops the pressures down to levels of malaise.

Craving for sunshine is often greater than that for food, so that holidays in sunny places are to be encouraged for those hypopietics who are obliged to reside in cold, damp and changeable climates. Most hypopietics are sensitive to barometric variations and have a good idea of what the weather is like before they get out of bed. On sunny days they are bright and cheerful; on dull, cold or wet days they are miserable and depressed.

2. *Special Measures.* The two main indications for treatment are vasomotor paresis, which may amount to peripheral failure, and myocardial weakness, which may progress to cardiac failure. When these appear in conjunction the effect can be deadly. The three chief causes of peripheral failure are dehydration through hæmorrhage, prolonged diuresis, and persistent diarrhoea. These are respectively seen in profuse loss of blood, diabetic coma, and in cholera. In diphtheria myocardial or peripheral failure may occur, or the two may be combined. Additional causes of vasodilatation are toxæmia, as in pneumonia, or shock of traumatic nature affecting the central nervous system.

For vasomotor paresis, after arrest of hæmorrhage or first aid treatment for shock dehydration must be combated by gradual intravenous injection of 1,000 c.c. of a 10 per cent. solution of glucose in normal saline with 15 units of insulin hypodermically five minutes after the glucose injection has been begun.

Vasoconstrictors should be employed. Adrenaline is effective, but its action is brief. It is given in doses of 5-7 minims of a 1 in 1,000 solution hypodermically every hour or so. Its effect may be prolonged by alternation with pituitrin 0.5 to 1 c.c. hypodermically, or with ephedrine. Strychnine gr. 1/20 cautiously by mouth every two to three hours, or coramine intravenously 1.7 c.c. repeated if required, are of great utility as stimulants.

Apart from emergencies, for hypopiesis in general pituitary insufficiency yields to whole gland pituitary substance by mouth, 2 grains twice daily, and this may be continued over long periods, noting the effect at weekly intervals. Suprifen

is also valuable, either orally, subcutaneously or intramuscularly. It has a chemical formula between that of adrenaline and ephedrine, avoiding the intense vasoconstriction of the former, while exerting a more lasting and less toxic effect than the latter. Suprifen has thus a wide range of dosage, and is well tolerated in doses much larger than those usually given, namely, 15 drops by mouth, or up to 2 c.c. twice daily by intramuscular injection. The main contra-indication is lack of reserve power of the heart, but in peripheral dilatation is useful in promoting the return flow of blood to the heart by its constrictor effect on arterioles and veins.

Other special measures are breathing exercises, Schott exercises, massage and passive movements, alternate hot and cold douches, various forms of electricity, and oxygen foam baths. Where sunshine is lacking systemic irradiation with a cored carbon-arc lamp adds the requisite ultra-violet rays.

In associated diseases, treatment should primarily be directed to manifestations of the original malady. In Addison's disease treatment is not so certain, but whole gland suprarenal gr. v. by mouth, aided by regular and cautious hypodermic administration of adrenaline in 5 minim doses, at times ameliorate the feeling of exhaustion. For this symptom alone glycocoll in 15 grain doses continued for a month thrice daily has a good effect.

Conclusion.

This contribution is a summary of the results of investigation of low arterial pressure states over many years. An unusually large number of cases (for this country) has been observed, and the deductions based on personal experience. They are not intended to be in any way dogmatic, but rather as attempts to clarify the confusion that still exists as a result of imperfect classification and incomplete knowledge of the true causal factors.

REFERENCES.

1. ELLIS, L. B. and HAYNES, F. W. (1936), *Arch. Int. Med.*, **58**, 773.; and *Am. J. Med. Sci.*, 1928, 147.
2. CHEW, E. M., ALLEN, E. V. and BARKER, N. W. (1936), *North West Med.*, **35**, 297.

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