was 6 lb. (2,720 g.), and from non-infected placentae 6 lb. 6 oz. (2,890 g.), a difference of 6 oz. (170 g.).

The present investigation confirmed these findings and showed that 130 African babies whose placenta was infected with malaria parasites had a lower mean birth weight than 262 whose placenta was not infected. The difference in birth weight between the two groups was 11 oz. (312 g.). The proportion of newborn with very low birth weights was greater in those whose placenta was infected.

It appeared that there is a negative correlation between frequency of infection of the placenta and the parity of the mother. The increasing resistance to the infection might be due simply to the increasing average age of the women at each successive parity and correspondingly higher degree of immunity. It is of interest, however, that the percentage of babies weighing less than 5½ lb. (2,500 g.) is increased in the malarious group at each parity. The comparison between the average birth weights and percentage of prematurity of South African babies of various races (Salber and Bradshaw, 1953) with Nigerian babies born in Ilesha is of interest. It will be seen from Table IV that the average birth weight of Nigerian infants is lower, and the percentage weighing less than 5½ lb. (2,500 g.) at birth higher than any of the four races, including the Bantu, which are of negro stock.

TABLE IV.—*Birth Weights of South African Babies Compared with Nigerian Babies*

Race	Average Birth Weight	Percentage Less Than 5½ lb. (2,500 g.)
European S.A.	7 lb. 8 oz. (3,400 g.)	4.2
Coloured S.A.	6 lb. 14 oz. (3,120 g.)	9.6
Bantu S.A.	6 lb. 12 oz. (3,060 g.)	11.5
Indian S.A.	6 lb. 7 oz. (2,920 g.)	18.3
Nigerian (Ilesha)	6 lb. 3 oz. (2,805 g.)	20.4

An investigation of the presence of congenital malaria in a sample of 117 newborn babies showed that, although 25.6% of them had infected placentae, no malaria parasites could be found within 24 hours after birth in any newborn infant. This confirms the results obtained by Bruce-Chwatt (1952) and indicates that congenital malaria is very rare in the indigenous population of Nigeria, in spite of the frequent infection of the placenta.

Summary

Out of 362 newborn African babies 30% had a placenta infected with malaria parasites.

The mean birth weight in the 130 newborn that had an infected placenta was 11 oz. (312 g.) less than the birth weight of 262 whose placenta was not infected.

There were 33% of premature babies in deliveries where the placenta was found infected with malaria parasites; in deliveries with non-infected placenta the respective figure was 12%.

There was no case of congenital malaria among 117 newborn, 25.6% of whom had an infected placenta. There appears to be a negative correlation between frequency of infection of the placenta and the parity of the African mother.

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MECHANISM OF ACUTE HYPOTENSION FROM FEAR OR NAUSEA

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It is common knowledge that emotion, particularly fear, may cause syncope. There are great difficulties, however, in obtaining records of the circulatory events which precede the attack, and many situations, such as high-flying jet aircraft or the altar steps, are impossible to investigate.

There is a small amount of evidence that the final mechanism of syncope induced by fear of needles is the same as syncope induced by haemorrhage, for Brigden *et al.* (1950) and Greenfield (1951) each demonstrated vasodilatation of forearm vessels in a single subject during the phase of low blood pressure.

Further evidence has now become available. An investigation into the cause of cerebral damage following nitrous oxide anaesthesia for extraction of teeth was suggested by the clinical material collected by Bourne (1957). It was at first thought that reduction in arterial oxygen saturation might be the main factor, but it is shown in this paper that severe hypotension is not uncommon, and that a precipitating cause is the well-known fear of the dental chair.

Emotion is often associated with nausea, and either or both may cause syncope. The effects of spontaneous nausea have from time to time been recorded in this laboratory during the course of circulatory observations, and the treatment of alcoholic patients with apomorphine allowed an opportunity of obtaining control records before nausea was induced.

Material and Methods

The subjects were volunteers; the dental patients being young healthy males (21 to 39 years) in need of urgent extraction of one or, at the most, two teeth. The alcoholic patients were older males (40 to 60 years).

Intravascular and intrathoracic pressures were measured with capacitance manometers and changes in arterial oxygen saturation with a continuously recording photoelectric device on the ear. Forearm flow was measured by venous occlusion plethysmography and recorded on the same photographic paper as the measurements of vascular pressure. Plethysmography was unsuitable in the dental cases owing to the inevitable final phase of violent muscular movements. In some subjects, however, the vascular resistance of a limb was measured by an arterial "run-off" method (Hayter and Sharpey-Schafer, 1958). In this method the artery is suddenly occluded by a high-pressure cuff. The rate of fall of arterial pressure distal to the cuff varies with the vascular resistance in the limb. This resistance, calculated by an empirical method, shows a good correlation with the resistance calculated from simultaneous pressure and flow measurements. The method is rapid, as only 2 seconds' occlusion is necessary for calculation, and is relatively free from artifact when violent muscular movements are to be expected.

Results

Effects of Dental Gas

Twenty-one subjects were investigated, five developing hypotension and the remainder showing evidence of the effects of emotional stress on the circulation. Circulatory

Data From Continuous Records Just Before Administration of N_2O

Case No.	Heart Rate	Pulse Pressure (mm. Hg)	Arterial Pressure (mm. Hg)
1	108	80	152/72
2	105	96	191/95
3	143	68	145/77
4	111	100	201/101
5	135	85	175/90
6	92	50	134/84
7	98	68	151/83
8	102	84	174/90
9	109	108	201/93
10	96	75	161/86
11	112	67	135/68
12	96	95	195/100
13	115	72	158/86
14	90	43	115/72
15	94	66	126/60
16	112	60	126/66

data obtained from continuous arterial records just before administration of N_2O are shown in the Table. In many subjects both heart rate and pulse pressure were considerably increased.

On giving gas the mean arterial pressure and pulse pressure increased still further and the arterial oxygen saturation fell to about 60% (Fig. 1). With tooth extraction or severe asphyxia large changes in intrathoracic pressure were superimposed on the arterial pressure trace, while in some subjects violent pronation of the forearm interfered with recording in the brachial artery. During induction of anaesthesia the arterial "run-off" method showed constriction in the forearm.

FIG. 1.—Upper trace: arterial O_2 saturation. Lower trace: arterial pressure. N_2O was given at the black signal on the time marker. Calibrations in mm. Hg, % saturation, and time marker in seconds in this and subsequent figures.

FIG. 2.—Upper trace: arterial O_2 saturation. Lower trace: arterial pressure. N_2O was given at the first arrow and the subject tipped into the supine posture at the second arrow. Arterial pressure was low before the anaesthetic was given. There is a gap of 15 seconds between the upper and the lower record.

Administration of N_2O was not the main factor in causing hypotension, since in four out of five subjects arterial pressure was low before the mask had been placed on the face (Fig. 2). Indeed, in two subjects the giving of gas raised the previously low blood pressure. One subject had hypotension and syncope when tipped into the erect sitting posture preparatory to proceeding with the dental gas, recovered when tipped into the supine position, again had syncope when erect, and was finally successfully anaesthetized and a tooth extracted while supine.

The final, or efferent, mechanism of the fall in arterial pressure is shown in Fig. 3. The vasodilatation in forearm vessels was similar to that found in syncope induced by haemorrhage (Barcroft *et al.*, 1944) or by fear of needles (Brigden *et al.*, 1950). Bradycardia was also present and pallor of the skin persisted afterwards for many minutes, suggesting discharge of posterior pituitary hormone.

There remains the problem of how this vasovagal fainting reflex is initiated. The evidence presented above suggests that emotion or fear is the main factor. Reduction in arterial oxygen saturation, which can also result in vasovagal fainting (Anderson *et al.*, 1946), would seem to be only a possible additional cause.

FIG. 3.—Data calculated from a continuous arterial record. Forearm resistance was measured by an arterial run-off method (Hayter and Sharpey-Schafer, 1958). With the fall in arterial pressure there is vasodilatation in the forearm. Arterial pressure in mm. Hg and forearm resistance in arbitrary units.

Effects of Apomorphine

Five alcoholic patients were investigated in the supine position. Effective right auricular pressure (right auricular pressure minus intrathoracic pressure) was measured by the differential manometer system described by Lee *et al.* (1954).

Arterial pressure and forearm flow were recorded on the same photographic paper. After a control period a suitable alcoholic drink was made available and 4 mg. of apomorphine was given intramuscularly. Some minutes later, when nausea and yawning appeared, effective right auricular pressure fell (3 to 7 mm. Hg), the heart rate increased, but the mean arterial pressure was maintained. Still later, in three subjects, the mean arterial pressure fell below 50 mm. Hg and there was bradycardia and vasodilatation of forearm vessels (Fig. 4).

FIG. 4.—Syncope after apomorphine. Upper trace: arterial pressure. Lower trace: forearm volume. The rate of rise of volume on applying a collecting pressure is proportional to the flow. Upper record: before apomorphine. Lower record: after apomorphine, showing hypotension, bradycardia, and dilatation of forearm vessels.

About 30 other cases of spontaneous nausea have been observed, in which right auricular pressure fell with the onset of nausea. Differential manometer systems were not used in these cases, so that possible changes in intrathoracic pressure were not taken into account. The evidence suggests that dilatation of the peripheral venous system precedes hypotension in syncope induced by nausea.

Effects of Emotion in Heart Failure

The vasovagal fainting reflex has not been recorded in patients with heart failure. Such cases have been bled up to 2,000 ml. without firing this reflex (Howarth *et al.*, 1946), while venesections of 1,000 ml. cause fainting in over 50% of normal subjects (Wallace and Sharpey-Schafer, 1941). Circulatory measurements of all kinds have been made by one of us in about 700 patients with heart failure. None fainted from emotion, nausea, or other cause. Any explanation, therefore, of the afferent mechanism of the faint reflex in normal subjects must take into consideration that it does not operate in heart failure.

Discussion

Emotional fainting might be mediated in a simple fashion from the central nervous system via the efferent vasomotor nerves, causing vasodilatation in muscle vessels. If this were so, there is no reason why subjects with heart failure should not faint; indeed, many of those with a low cardiac output might well develop hypotension more easily than normal subjects. So simple a mechanism, therefore, does not cover all the facts. The most attractive explanation at the present time is that there is an afferent pathway for this reflex fired from the heart itself and that diminution of the amount of blood and virtually complete emptying of a ventricular chamber during systole is the stimulus. (With a failing circulation ordinary procedures are unlikely to empty the heart completely and the faint reflex, therefore, is not brought into play.)

The results presented in this paper suggest that there are two ways in which emotion may tend to empty the heart in normal subjects. The first is by nervous stimulation of the contraction of the heart, initially increasing the stroke output; the second is reduction of filling pressure, possibly due to venodilatation in the splanchnic area. Stimulation of the contraction of the heart simultaneously with decreased filling pressure has been studied by Henry and Gauer (1950) in dogs. Following reduction in cardiac filling pressure by bleeding, they gave adrenaline and were able to show that large pressure transients developed during systole in the cavity of the left ventricle when that chamber was virtually emptied of blood. Such large transients might well stimulate receptors which are known to exist in cardiac muscle. It is suggested, therefore, that the effect of emotion is indirect, first causing a diminution of the amount of blood in the heart. Then impulses pass from the heart to the central nervous system. Thence the reflex is mediated via the efferent vasomotor nerves, causing vasodilatation of muscle vessels.

There are other events which support this theory. Recovery occurs in a very few seconds when the filling pressure of the heart is raised by tipping into the supine position (Fig. 2). Continuous records, too, may show conspicuous fluctuations of arterial pressure with respiration during the initial phases of fainting which suggest that reflex vasodilatation is occurring intermittently with small changes in filling pressure. Finally, there seems to be some truth in the popular belief that fainting may be prevented by "taking a grip of oneself," since muscular tensing, or movement, can cause the low arterial pressure to rise (Brigden *et al.*, 1950), presumably by increasing the amount of blood in the heart above the critical level. This last mechanism may explain the recovery that took place in some dental patients when nitrous oxide was given.

Effects of Forced Maintenance of an Upright Posture

Normally a person who faints falls to the ground and arterial pressure is restored in a few seconds. In the dental chair or the ejection seat of a jet aircraft the upright sitting posture is forcibly maintained, and arterial pressure can remain for many minutes below 40 mm. Hg at heart level. Of these two similar situations, the latter is clearly more dangerous. There is some evidence from pilots who have recovered and landed safely that a number of mechanisms may cause syncope. Fear and nausea, hyperventilation, coughing, and the Valsalva manoeuvre have been described, while heat at over Mach 1 and the immobile sitting posture are additional factors. Of these mechanisms, fear and nausea might produce the longest period of hypotension, for, provided no mechanical disaster occurred to the aircraft, baroreceptor constriction should restore consciousness in about 10 seconds in the others. A pressure suit is a complete answer to all these mechanisms, the difficulty being to blow it up when it is needed.

The dental chair is a simpler problem. Unfortunately our observations showed that the dental surgeon and anaesthetist did not recognize that severe hypotension was present and were apt to call this state "a nice quiet gas." They were clearly prepared to go on extracting teeth under relatively good conditions. Dental surgeons seem to be unwilling to extract teeth in the supine posture. They claim that their instruments are unsuitable, but it is more probable that they fear legal action should teeth or the effects of aspirated blood clot appear on an x-ray film of the chest. It is unlikely that the complete answer—extraction in the prone position—will be popular. At second best, patients might be pulled out of the chair on to their faces, on the floor, when palpation of the pulse suggests that severe hypotension is present.

Summary

Continuous circulatory measurements were made before and during N₂O anaesthesia for tooth extraction and the administration of apomorphine for chronic alcoholism. Five out of 21 dental patients developed acute hypotension with vasodilatation of forearm vessels, four of these before the anaesthetic was given. Fear appeared to be the main cause, with a fall in arterial oxygen saturation as a possible minor factor. Apomorphine-induced nausea caused a fall in the effective filling pressure of the heart which preceded hypotension and syncope.

It is suggested that emotional stimulation of the heart beat and a fall in cardiac filling pressure cause virtual emptying of a ventricular chamber during systole which fires the afferent mechanism of the faint reflex. There is strong evidence that subjects with heart failure, whose ventricles are not easily emptied, do not faint.

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