Conclusions

For the reasons given, we believe the main causes of high mortality and faltering growth in young children in the Gambia to be infection and poor care. Deficiency of specific nutrients may contribute, but in our opinion malnutrition is more often secondary to illness than primary. The possibility that some children are underfed during the process of weaning cannot be excluded, but the nutritional and clinical pattern described as characteristic of kwashiorkor is rare.

These results and conclusions probably apply to large areas of rural Africa, especially West Africa. They may not apply to areas where the staple food is of notably low nutritive value, nor to urban areas where the ecology is entirely different.

Summary

The births and deaths of children in a rural Gambian village were registered as they occurred, and their heights and weights were measured annually.

Of 187 children born during a five-year period, 43% died before reaching 7 years of age. Death rates were high during the first 4 years of life, and relatively low from 4 to 7 years of age. The peak of mortality occurred around the age of 1 year and during the rainy season.

During the first 6 months of life, when breast milk is the main or only source of food for babies, growth was comparable with the British average. Then growth appeared to falter for a few months, around the period of peak mortality; but there was no evidence that children who died, compared with those who survived, had been notably underweight. From about 1½ to 7 years of age, heights and weights were less than those of British children, but the annual increments were similar.

It is considered that infectious disease and inadequate maternal care are probably the major factors contributing to high mortality and impaired growth. Malnutrition, while by no means absent, seems to be more often secondary to disease than primary.

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GUNSHOT WOUNDS OF THE HEART WITH EMBOLISM

REMOVAL OF MISSILES FROM CARDIAC CHAMBERS WITH AID OF EXTRACORPOREAL CIRCULATION

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This is the story of a boy who was shot in the chest with a shotgun. A mass of pellets entered the heart and then dispersed, causing embolism into the greater and lesser circulations. The remaining loose pellets were removed from the cavities of the heart by open operation with the aid of extracorporeal circulation. We have found no published account of any similar course of events even in the masterly and encyclopaedic paper on foreign bodies in the cardiovascular system written by Barrett (1950).

Case Report

A boy aged 12 was shot from a distance of about 35 yards (32 metres) with a 410 shotgun on May 15, 1961. He collapsed and was taken to Black Notley Hospital in Essex, and admitted under the care of Mr. Ronald Reid. There was a single entry wound in front of the chest to the right of the sternum which was closed with two skin stitches. Two litres of blood was transfused and the right side of the chest aspirated, about a litre of blood being removed. Radiographs of the chest showed many pellets scattered over a wide area. The heart was evidently involved. It was noticed that some of his peripheral pulses were absent.

On May 16 the boy was transferred to St. Thomas's Hospital. On admission he was drowsy and a little cyanosed, but his general circulatory state was satisfactory, with a pulse rate of 100 a minute and blood-pressure, measured with a sphygmomanometer on the left arm, 120/60 mm. Hg. The respiratory rate was 30 a minute. There was a round entry wound, which had been sutured, to the right of the sternum over the third interspace. No exit wound could be found. Physical examination revealed signs of a haemothorax on the right but no evidence of cardiac tamponade. Peripheral pulses could not be felt in the right arm below the brachial or in the right lower limb below the femoral. The peripheral pulses on the left side were normal. Radiographs (Figs. 1 and 2) showed a total of 30 pellets widely distributed. Three lay in the region of the right brachial bifurcation, accounting for the absence of pulses at that wrist. Several others were in the right axillary and subclavian areas and presumably lying in branches of these arteries. Two lay in the left carotid bifurcation area and one in the right. These were apparently impacted in the mouths of the internal carotid arteries, as the superficial temporal pulse was easily felt on each side. A number of other pellets lay in line with the heart. No pellets could be seen in films of the lower limb, so presumably the absence of pulses was due to embolism of radio-translucent material to the right popliteal artery.

After initial improvement the patient's general condition deteriorated slightly and further radiography showed the positions of the pellets in the cardiac area to have changed, suggesting that they lay free inside the cavities of the heart. Surgical intervention held the risk of starting further dangerous bleeding from the heart or the wounded vessels, but it was considered that this risk was outweighed by the dangers of leaving the haemothorax and cardiovascular wounds uncorrected and the risk of further embolism of shot from the heart. Further embolism of shot particularly into the cranial circulation might have had grave or fatal consequences.

Operation.—On May 17 general anaesthesia, administered by Dr. P. G. Luprian, was induced with cyclopropane and suxamethonium and maintained with nitrous oxide, oxygen, and curare. The left femoral artery was prepared for cannulation for perfusion as a first step in case cardiac embarrassment made the use of extracorporeal circulation necessary at an early stage. The chest was opened with a transverse incision through the right fourth and third left interspace. The right chest contained a mass of blood clot. The shot had traversed the right lung, leaving a large contusion around its track. Thence it had apparently entered the right side of the heart, to which the lung and blood clot adhered. It was planned to start left heart perfusion and cooling as a first step in order to avoid disturbing the damaged right side. The pericardium, which contained blood-stained fluid, was incised in the midline.

FIGS. 1 and 2.—Radiographs showing wide distribution of pellets.

The heart was retracted gently in order to insert an 8-mm. cannula into the left atrium, but it promptly fibrillated, so the cannula was rapidly placed in the right atrium instead, while the ventricles were manually compressed to maintain a circulation for 30 seconds until a beat returned and until extracorporeal circulation was started. Perfusion was maintained with a DeBakey type roller pump and a disk oxygenator (Osborn, Bramson, and Gerbode, 1960). The circuit was primed with a mixture of fresh heparinized blood and routine "ACD" banked blood which had been recalcified and heparinized.

During insertion of the cannula into the right atrium one free shot was extracted from the right auricular appendage. The patient was cooled on perfusion and a left atrial decompression catheter inserted at 30° C. Cooling was continued to 10° C., measured in the nasopharynx. Perfusion was then stopped so that the heart could be examined under dry conditions. On looking down through the left atrium and mitral valve into the left ventricle four loose shot were seen lying like eggs in a nest in the apex of the ventricle. They were readily removed with a gall-bladder scoop (Fig. 3). Two other pellets were removed from among the chordae tendineae by elevation and manipulation of the heart. Three further pellets lying in the left atrium near the orifices of the pulmonary veins were next removed. One pellet which had gone through the back of the left atrium was also removed. The remaining pellets could be felt in vessels of the lung, presumably having embolized into branches of the pulmonary artery from the right atrium. These were left undisturbed. This made a total of 11 free pellets removed from the cavities of the heart and one from behind it.

The course of events appeared to have been that some 30 pellets had entered the chest in a loosely adherent mass and traversed the right lung and pericardium. They next entered the right atrium, whence a number embolized into the pulmonary circulation. The rest passed through the interatrial septum to enter the left atrium, whence some continued into the left ventricle and others went on into the systemic arteries. The small wounds in the back of the left atrium, interatrial septum, and front of the right atrium were repaired. The perfusion was restarted, air expelled from the heart, and the patient re-warmed. Heart action resumed spontaneously. Perfusion was discontinued. The pericardium was loosely closed in part. The chest and mediastinal area were drained and the incision closed. A tracheotomy was performed.

Post-operative Progress.—Respiration was artificially assisted with a Smith-Clark respirator through the tracheotomy for four days. At first the patient was semicomatose. This was thought to be due to the short period of inadequate

FIG. 3.—Removal of four loose pellets from the apex of the ventricle by means of a gall-bladder scoop.

circulation which had occurred when the heart fibrillated and just before the perfusion was started rather than to the presence of the emboli in the internal carotids. He was moved from the recovery room to the ward on the fourth day after operation. Convalescence was uneventful apart from transient pain and hyperaesthesia in the right foot caused by the popliteal embolism. This was managed conservatively and the popliteal pulse returned and the symptoms subsided. The ankle pulses were still absent but the circulation in the foot was normal when he was discharged to his home on June 30.

Discussion

One of the strange features of this story was the way in which the pellets had remained in a single mass during their course of 35 yards from gun to patient. This discharge of spread shot "en bal" is, however, recognized and sometimes follows some modification of the cartridge or gun-barrel before firing, with the object of diminishing spread and increasing the range. The pellets which were removed from the heart showed evidence of some process such as this, for they were faceted and, indeed, some were still lightly adherent to each other on removal (Fig. 4). According to the account we received they had not ricocheted during their course, nor had they struck any bone in their transit in the body to account for their deformities. Another feature was the size of the shot. They were number fives. The diameter of the pellets was a little

Fig. 4.—Removed pellets (diameter about 3 mm.) showing facets and light adherence.

over 3 mm., so that they were large enough to be arrested and firmly impacted at the bifurcations of the carotid and brachial arteries in a child of this age. Smaller shot might have progressed further into the cranial vessels.

Barrett (1950) quotes two cases, one fatal and one followed by hemiplegia, due to small pellets entering the carotids from gunshot wounds in the neck. He also quotes cases in which foreign bodies left in the heart have caused complications and death due to thrombosis and embolism. This might have been a complication quite apart from the possibility of further embolism of the shot themselves had they not been removed from the heart. Barrett (1950), D. E. Harken (quoted by Barrett), and other writers in recent years all agree that foreign bodies in the heart should be removed. It was not always possible to do this in the past. The use of extracorporeal circulation should greatly facilitate it in the future, as the operation described here, which would have been impossible without it, shows.

The happy result in this case was made possible by many helpers. We are particularly indebted to the other members of the perfusion team at St. Thomas's Hospital; to the nursing staff in the theatre, recovery room, and City of London Ward; to the staff of the Jenner Laboratory; and to the blood donors. The skilful treatment by Mr. Reid's service made the patient's survival possible in the early hours after wounding.

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ALCOHOL AND ROAD TRAFFIC ACCIDENTS

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The effect of small doses of alcohol on a skill resembling driving has been studied by Drew, Colquhoun, and Long (1958), who showed that performance began to deteriorate at blood-alcohol levels of 20 to 30 mg./100 ml. They disproved any threshold level, but showed rather that impairment of performance was progressive and linearly related to blood-alcohol concentration. At a blood-alcohol level of 80 mg./100 ml. the mean error of performance during their test had increased by about 16%.

Similar reports of the effect of these surprisingly small doses of alcohol on driving ability, judgment, reaction time, and behaviour, with associated blood-alcohol concentrations in the regions of 4 to 65 mg./100 ml., have been reported by Lauer (1939), Bjerver and Goldberg (1951), Loomis and West (1958), and Cohen, Dearnaley, and Hansel (1958).

A special committee of the British Medical Association (1960), reporting on the relationship of alcohol to road accidents, concluded that a concentration of 50 mg. of alcohol per 100 ml. of blood in the driver of a motor vehicle was the highest that could be accepted as consistent with the safety of other road-users.

The purpose of the present investigation was to establish to what extent alcohol was a factor in persons involved in road traffic accidents who arrived at a hospital casualty department. The road traffic accident (R.T.A.) casualties comprised any persons involved in injury with a propelled vehicle—a comprehensive group inclusive of injuries sustained from mishaps to drivers to those occurring from the jolting of passengers on buses.

An attempt was made to obtain blood samples from all such R.T.A. casualties. Uninjured patients were simply asked to give a blood sample, no specific purpose being indicated. Where injury had occurred an additional few millilitres of blood was taken at the time of other blood investigations. The specimens were taken immediately after arrival so that they might reflect, as accurately as possible, the blood-alcohol level at the time of the accident. Blood alcohol was estimated by the method of Conway (1957).

During the 12-months of the investigation 574 R.T.A. casualties were recorded in the admissions register; of these, 398 (69%) had blood-alcohol estimation carried out. The discrepancy between these figures is explained by refusals, omissions, and emergencies which precluded delay. We do not believe that any significant selection resulted.

Results

Accident Rate and Time of Day

The 574 casualties which occurred during the 12 months were subdivided into 24 groups to indicate their hourly incidence during the day (Fig. 1 A). The