James Stevenson Loughridge (1901–1980)

President of the Ulster Medical Society 1965–66

Presidential Opening Address
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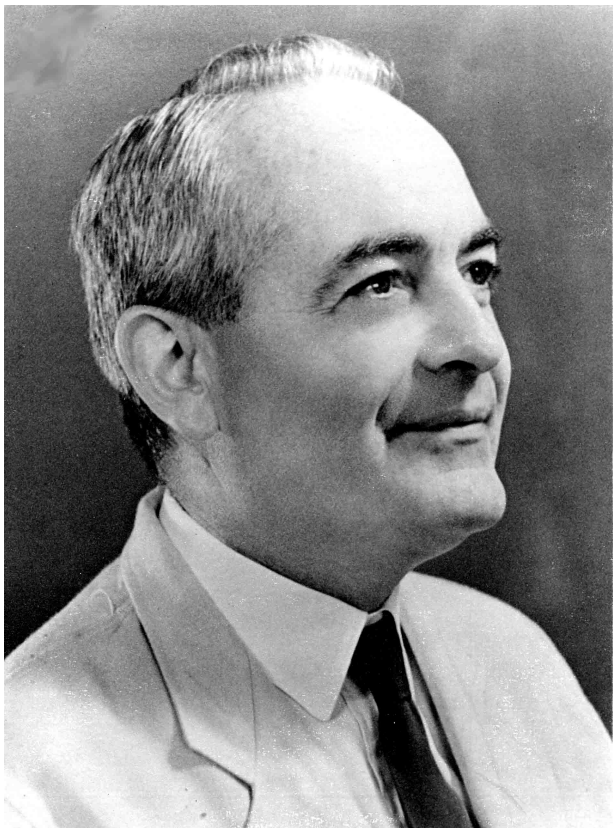
WHAT OF THE FUTURE?

I MUST thank you for the great honour which the Council of the Society has done me in asking me to be your President for the incoming session. I appreciate the honour greatly, though it entails certain responsibilities, not the least being this agony of words, usually called the Presidential address. Even the choice of a subject worthy of the occasion gives cause for thought. I could deal with the present and discuss some aspect of surgery in one or more of its rapidly advancing frontiers. The past has been frequently and brilliantly treated by many of my predecessors in the Presidential chair. The third alternative is to talk of the future and I have been so bold and so foolish as to rush in where my betters have feared to tread.

Other attempts at prophecy are not encouraging. Indeed the only really successful example which occurs to mind is that of Jules Verne, who so clearly foresaw the invention of the submarine, but more daringly and with remarkably accuracy in 1865, exactly one hundred years ago, described a journey from the earth to the moon direct in 97 hours 20 minutes. His prophecy is dramatic in that he placed the projection site in Florida, in that the rocket was fired from a shaft sunk in the ground, and in that he was only 30 hours wrong in his estimation of the duration of the fight. He quoted 97 hours 20 minutes; the actual time of Ranger VII was 67 hours 35 minutes. Further, he conceived the idea of a special observatory—the forerunner of the Jodrell Bank of today.

Now that the impossible has been achieved, and rockets have been placed on the moon and, even much more remarkable, in the vicinity of the planet Mars, it is interesting to note how the incredulity of the common man has given way to indifference to the greatest technological achievement of all time, namely the journey of Mariner IV. Such a prophecy must be unique; and for other would-be prophets and myself, I would humbly keep in mind Sam Gee's dictum on pulmonary tuberculosis – "Never to give a



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forecast, for the only certainty is that you will be wrong." Another discouragement is to think back to my early days in medicine and to note how different the progress has been from what I would then have thought. Thus, up till 1930 the great advances of the previous decades had been largely diagnostic, especially bacteriological, radiological and electrocardiographic. Biochemistry was just beginning to come into its own as a routine clinical procedure, and that was due in no small degree to one of the two notable therapeutic discoveries of the 1920s, namely the introduction of insulin. One generation has seen biochemistry advance from its humble origin to the routine use of radioisotopes and to the greatest scientific achievement of this decade, namely the cracking of the genetic code by Crick and Watson. No one then could have seen that the main advances to come would have been in therapeutics, both medical and surgical. Indeed, one well known surgeon in 1927 was so indiscreet as to say that surgery has reached its zenith, and was incapable of

further advance; whereas in fact the technique of surgery has made more progress in the last 20 years than at any time except the period which immediately followed the advent of Listerian principles in the operating theatres and surgical wards. A main reason for the sudden advance was the isolation and purification of the active principle of the arrow-poison curare. This and other advances in pharmacology and the application of the basic physiology of respiration have revolutionized surgery and the administration of anaesthetics, and have indeed made factual Moynihan's hope that the patient would be made safe for surgery and that surgery would be safe for the patient.

Within the memory of our elder colleagues a would-be surgeon had to serve a long apprenticeship as an anatomist, and our seniors worked for as many as seven years in the dissecting room as a pre-requisite to an appointment on the surgical staff. Later the emphasis changed to pathology, but now the essential basic science is physiology. Most of the recent advances in surgery have been physiological, and physiological principles and techniques are now applied in many fields. Thus the artificial kidney is an ingenious machine: it has solved the technical difficulty of making a semi-permeable membrane, allowing the passage of metabolites and drugs and retaining the protein and cellular constituents of the blood: it does so at body temperature, keeps the extra-corporeal blood sterile, and returns it to the circulation free of foam and free of clots. With this machine many patients have been safely carried through critical illnesses, and even chronic disease has been held in check by its repeated use.

The anaesthetists now practise true physiology, applying the laws of gaseous exchange and the knowledge of the mechanics of respiration and circulation to the needs of each individual patient. They have improved the heart-lung machine to the point where it is used daily to maintain an extra-corporeal circulation adequate to the needs of the patient during operations on the heart itself. They have also gone beyond the limits of the physiological norm in the induction of the state of hypothermia, and in so doing have made the patient safe for surgery which would otherwise be impossible. All these techniques are really in their infancy and no one can tell how they will develop in the next generation.

Nor must we forget how the ophthalmic surgeon is learning to use laser beams in the treatment of local conditions in the retina, or how the aural surgeon is using a microscope to operate on the auditory ossicles and the semi-circular canals, so that 80 per cent. of patients with certain kinds of deafness can now be made to hear; or how the neuro-surgeon is using a beam of protons to cause localised necrosis in the brain, and is using ultra-sonics as an aid in diagnosis.

The increasing magnitude and duration of operations, particularly of heart operations, require constant critical and skilled supervision of the patient in the post operative period. This need has given rise to the system of intensive care in which a special ward is used to nurse the patient on his return from the operating theatre. Here a special team of nurses watches the patient and keeps a constant check on his colour, blood pressure, pulse and so on. The Italians have recently introduced an intensive, care monitoring system, patriotically named after Galileo. A recording instrument is situated by each bed in the recovery unit, and all the recorders are connected to a central console at the nurse's station. This console "hunts" each bed in turn, and for 15 seconds it displays the blood pressure, pulse, E.C.G. and temperature of each patient automatically and continuously, but the doctor by pressing a button can concentrate on the records of any one patient. An alarm is included in each monitor, and if the safe maximum or minimum of each single phenomenon is exceeded, a warning light goes up at the patient's bedside and a bell rings. A defibrillator and a pace maker can be included to give automatic control of arrhythmia.

The long list of galenicals which constituted the bulk of the pharmacopoeia down the ages and as recently as twenty years ago has been largely swept away, to be replaced by a wealth of new therapeutic agents, liver extract (already replaced in turn by the isolation of cyanocobalamin), the sulphonamides, antibiotics, tranquillizers and the cyto-toxic drugs. The discovery of penicillin was one of the highlights of the mid-twentieth century; its abuse is one of the tragedies, as its indiscriminate use has led to the evolution of drug resistant mutants. Infectious agents maintain a more or less constant siege of the body and invasion is prevented only by a continuing but fluctuating immunity. Recently the antibiotics have given a temporary advantage to the body, but at a heavy cost. The battlefront is now in a sort of truce which may end at any time in the near future with a resumption of hostilities by more aggressive organisms attacking persons whose immunity has been reduced by disuse atrophy. The best example is the hospital staphylococcus to which patients are exposed in surgical wards or during prolonged

operative procedures. It may be that antibiotics will soon prove to be no longer of value, and that we shall have to return to a modern version of Lister's carbolic spray – currently depicted on our postage stamps. A main danger of upsetting the truce between man and his pathogenic bacteria is the use of anti-bacterial drugs either in inadequate dosage or on wrong principles. The anti-bacterial drugs have given a temporary control of the communicable diseases but have been disappointing in the attempt at eradication. The past decade has seen a spectacular decrease in the incidence of tuberculosis but the emergence of drug resistant bacilli render the future bleak unless other means of control are introduced. Malaria has been nearly eliminated, but already it has been shown that monkey malaria can be transmitted to man and it may be that attempts at the eradication of one parasite will make possible its replacement by another more difficult to treat. It is noteworthy that the disease-causing viruses are rarely affected by drugs, except possibly by interferon, but it is fortunate that two of them – smallpox and poliomyelitis are preventable, not by eradication, but by raising the active immunity by vaccination with attenuated virus.

Special mention is to be made of the chlorinated hydrocarbons. Synthetized in the 1880s, the toxic effect of D.D.T. on insects was recognized only in the 1940s, and almost immediately it was used with effect against ticks in Malaya, against mosquitoes in India, flies in N. Africa and lice and scabies everywhere. At the battle of El Alamein it is recorded that 50 per cent. of the Africa Korps was glued to the commode by dysentery. If D.D.T. had been used by the Germans and not by the 8th Army, the result of the battle could easily have been very different.

But the most recently introduced tool is likely to be the most revolutionary of all. I refer to the computer. Up to 1957 general purpose high speed digital computers had been used in physics and applied mathematics, and were almost unknown in medical research. In 1962 Kendrew & Perutz were awarded the Nobel Prize in Medicine for their studies in the structure of haemoglobin and myoglobin – a problem successfully solved by the use of computers. Already in U.S.A. the computer is being used more in bio-medical research than in pure physics or mathematics. Medical research is particularly amenable to the use of computers and their continued spread is almost certain. The computer is being used in epidemiology, vital statistics, in the analysis of laboratory data and in the processing of continuous physiological data. I see the physician of the future filling in a questionary and feeding the items together with a long list of biochemical and other data into a computer and reading off the diagnosis on a cathode ray scheme, or on a punched card. In the storage and retrieval of clinical and laboratory records the Mayo clinic is working out a scheme where the clinical history, physical findings and laboratory data are all recorded on a work sheet, which after a day or a week is sent for key punching. After the cards are verified, edited and checked for errors, all the clinical information is filed in blocks, one block for each patient. Each block represents about 200 items of information and actually occupies about 10 inches of tape. One reel of tape holds information on about 2,900 patients. A printed report can be made when required. The computer has also been used in the storage and analysis of pathology and post mortem examinations. A computer based programme is even developed for automated personality assessment. It is said to be used enthusiastically by physicians of Mayo Clinic, who claim that it is welcomed by patients.

In California, people avail themselves of the Permanente scheme, similar to our British United Provident Association, but at the fee of an extra $20, the members may have a yearly check. A series of 24 cubicles are arranged in a large circular building. The member, as he enters, is given a computer punched card stamped with his name and particulars. In the first cubicle his retinal fields are photographed and the result is lodged in an analogue computer. In the second cubicle the Achilles tendon reflex is measured as a test of thyroid function. In a third cubicle, the E.C.G., the blood pressure and the pulse rate are all noted electronically and in a fourth the E.E.G. is recorded. In a fifth room the serum lipoids are measured. In a sixth room the member meets his first technician, who takes a sample of blood by pricking the finger. The blood is transferred to an automatic analyser and eight biochemical parameters are measured, blood sugar, urea, sodium, potassium, chloride, bicarbonate, protein and transaminase. This machine can deal with 60 persons per hour. In the next room the individual under test has a second pin prick for haematological parameters. The results from all these tests are fed into the computer. The only non-automatic test is of the urine, a specimen of which is passed through a hatch and planted out for organisms in a quick growth medium. A positive or negative result is obtainable in 30 minutes and a technician passes the result to the computer. Another cubicle is given over to the determination of height, weight and other anthropometric data. The person

under test emerges from this series of cubicles at the end of 40 minutes, when the computer issues a sheet of paper containing all the data appertaining to that individual. He then enters a consulting room where his doctor advises him according to the findings.

The brothers Jungnar are now engaged on a similar project in Varmland for the Swedish Government. They are attempting to measure the biochemical and haematological parameters of 100,000 persons, together with their retinal photograph, urinalysis, blood pressure and a completed questionary. The findings are stored on magnetic tape. The scheme is now about to be applied to the whole population of Sweden. The Jungnar equipment handles all the required tests of 400 persons per hour. The British Ministry of Health has taken preliminary steps to carry out a pilot study of population screening in an English town on the Swedish pattern. The scheme will entail the recruitment of staff, the specialized automative machinery and data-processing equipment, for a series of large buildings throughout the country. Every individual will have his own card which will contain a yearly record of these routine tests.

Of the many problems still awaiting solution, mention may be made of a few. From the earliest times man has aspired to graft limbs or organs, but only recently has success been achieved and that in a limited field. The earliest successes were in replacement of the cornea. This is a very delicate operation which is greatly helped by the fact that the cornea has no blood supply. About 80 per cent. of corneal grafts are now successful, though special immunological problems remain to be solved.

The technique of transplanting a kidney is already standardized and is not unduly difficult. The renal artery and vein of the donor kidney are sutured to the iliac artery and vein in the iliac fossa, the ureter being connected to the bladder. The operation has been performed successfully in many patients, in all of whom the donor was an identical twin. In cases other than identical twins the donated kidney works for a limited time. If the problem of the immune reaction can be solved a major breakthrough in transplantation will have been achieved. Living bone or artery, or even heart, will then be used to replace parts damaged beyond repair. In the case of heart transplants it will be technically easier to replace the lungs as well as the heart, as this will entail suturing only of the aorta and both venal cavae; as the pulmonary artery and veins will remain intact. The future of surgery will largely be that of repairing traumatic lesions, transplantation of organs and the repair of congenital defects. The surgeon, like any other good craftsman, likes to do constructive work – a description which applies to most operations, except for those used in the treatment of malignant disease. This group is mutilating by its very nature. Every surgeon will welcome the day when a non-mutilating cure for neoplasia will have been found.

The profession of medicine has been called into being for two great needs, the relief of pain, and the cure of disease. The attention of the profession is therefore focussed primarily on the individual patient. The care and attention which the medical man has given to his patient down the ages is manifest in the high regard for, and the universal trust, of the sick person in his doctor. The good doctor has one paramount interest, the welfare of his patient, and he has had no cause to consider other factors. But now the very success of medicine is raising problems of fundamental importance to mankind as a whole. These problems refer to the individual, to the genetical influence on future generations, and to the world population.

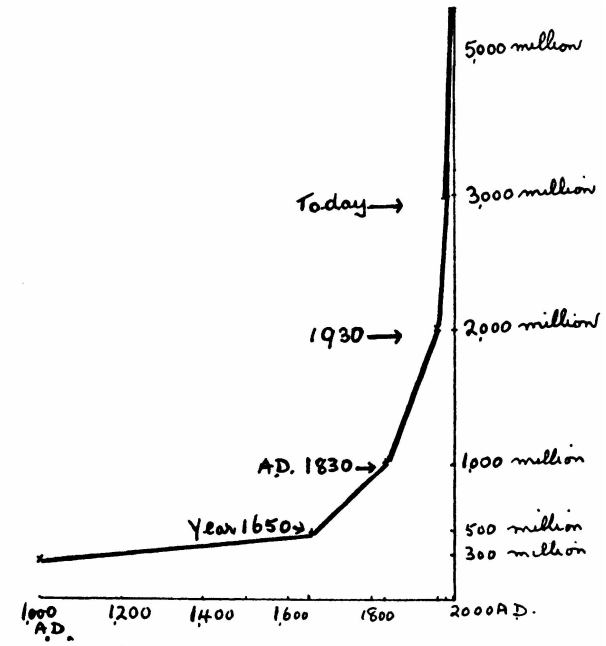
The advantage to the individual cannot be gainsaid. With an adequate diet, improved hygienic living conditions and medical care from birth and the elimination of many of the serious infections, the expectation of life has increased enormously and the majority born may now expect to live healthily for the accepted normal life span. Unfortunately we have discovered no elixir of youth, and our hospital wards will increasingly become geriatric units. We have an increasing number of people living the length of the allotted span, but we still have

" Last scene of all
That ends this strange eventful history
Is second childishness and mere oblivion
Sans teeth, sans eyes, sans taste, sans everything."

I was first made acutely aware of the genetical significance of our work on the day when the late Foster Moore had the tragic obligation to remove both eyes of a baby for glioma of the retina; and on the same day to read in the British Medical Journal of this malignant disease occurring in three members of one family, whose father had survived the removal of a retinoblastoma in his own babyhood. Congenital pyloric stenosis had a high mortality until 1940. Since then surgical treatment results in a recovery rate of nearly 100 per cent. The medical treatment of diabetes not only saves the lives of young people suffering from the disease, but it has allowed them to have children, a state of affairs unknown before the rise of insulin. Pediatric medicine and surgery save the lives and preserve the health of many potentially

valuable members of the race, but they undoubtedly contribute to the perpetuation of the genetically unfit.

It is mainly of the increasing world population and the consequences that I should like to speak a little more fully. The near elimination, during the past few decades, of the Captains of the Men of Death, principally tuberculosis, syphilis, gastro-intestinal infections and malaria, has contributed to a notable increase in the expectancy of life. At the same time the scientific production of food and its rapid transport to the large centres of population have caused an unparalleled increase in the world population. Indeed the increase has been called a population explosion, and justifiably so when we look at the figures. Thus radioactive methods of dating indicate that man has lived on this earth for 200,000 years and more. Yet it took 199,000 years, i.e., up till the year 1000 A.D. for the numbers of the human race to touch the 300 million mark, an average increase of 1,500 persons per annum. The birth rate was high, but it was almost neutralized by the high death rate, aided by periodic sharp reduction caused by epidemics. The world population was 500 million in the seventeenth century; it was 1,000 million in 1830 and 2,000 million in 1930. And in the past 30 years over 1,000 million have been added to make a grand total today of 3,000 million. It has been said that one-seventh of all mankind who have ever lived, are alive at this moment. About 17 million more people will be living in Britain in the year 2000, i.e., it will require a new city the size of Belfast each year and every year to accommodate them.



WORLD POPULATION 1,000 A.D. — 2,000 A.D.

Every biologist knows what a population growth curve of this kind means, whether the curve refers to men or lemmings, to locusts or to bacteria – it means that something is going to happen, and in Nature that something is a crash.

Nature has ensured that in man, as in all other species, the mechanism of reproduction is frighteningly effective. The recent enormous increase in the human population is due, not to an increased fertility, but to the advances in the medical sciences which have caused a sudden and dramatic fall in the death rate, while the birth rate remains high. This fall became acute a decade ago when malaria – the natural controller of the population in the tropics – was largely eradicated. The immediate consequence is a tremendous excess of young people. In some parts of the world half the population is less than 14 years of age and in many other parts half is less than 18 years of age. The reproductive potential of the next 30 years arising from an age distribution of this kind needs no emphasis. Further, the increase is very different in different parts of the world, so we in the United Kingdom constitute a progressively smaller percentage of the human race. The present rate of increase of world population is 2 per cent per year. This does not sound very much but if continued annually for 200 years, the population will be 150,000 million or 50 people to every one now alive. All these will have to be fed, housed, exercised, transported and given amenities, including a health service. It is very evident that in the long term, either birth rate must come down or the death rate will once more go back up. The ability to be fruitful and multiply and to inherit the earth is not, of course, peculiar to man. The prime duty of all species of plants and animals is to survive, and to this end the reproductive capacity is such that any living creature, able to multiply without hindrance, would soon swamp the world. The fact that this does not happen was first noted by the Rev. T. R. Malthus in his Essay on Population. He recognized that the populations of all species are held in check by limiting factors. The main factors are lack of food, disease, and war. In Nature, relaxation of one limiting factor allows a population to increase until it bumps up against the same factor on another level, or against one of the other factors.

In passing it may be noted that Malthus said in 1826 that the indiscriminate doles and bounties upon large families were utterly to be condemned as tending to aggravate the very evils which they were

supposed to remedy; also that Darwin on reading his Essay was impressed by Malthus's phrase "Struggle for existence" and from it Darwin got the idea of how such a struggle would play a part in the formation of new species.

The population explosion is a direct cause of aggressive imperialistic expansion as in the struggle for lebensraum of pre-war Germany and Japan and now of post-war China. It affects also the living conditions in the world's conurbations. The great wen that is London is now pathologically large with traffic paralysis, and frustration and loss of long hours in commuting.

It is shortly going to affect us in these islands in a way never dreamed of by our forbears. I refer to the colour problem. Smethwick is a borough, famous in the past for James Watt, of the steam engine, and William Murdock, the pioneer in gas lighting. Today it has a population of 60,000 of whom 10 per cent are coloured. These coloured people have migrated from Jamaica and the remote villages of the Punjab. Why? Because at home they are at starvation level and they come here because the post-war boom in the car industry has meant a shortage of labour in the unattractive and unskilled occupations. Thus England is doing what U.S.A. did in the eighteenth and nineteenth centuries and South Africa did in the nineteenth and twentieth centuries. We now criticise S. Africa for apartheid, but I believe we shall see a similar reaction in Birmingham, in Bradford and in Notting Hill within a generation. I see an increase of unhappiness for both white and coloured.

It is evident that if the population is allowed to increase unabated, a check will inevitably be met, in one or more of three ways – war, famine or pestilence. War has always been a means of keeping population down, and its killing power reached a climax only in the past 50 years. Thus in the Great War of 1914-18 this country, France and Germany lost 5 million men; a tragedy all the greater because the deaths were not, as Nature would ordain, of the old and the feeble, but by contrast they were of the young and the fit. I think there can be no doubt but that many of the errors of commission and omission which led directly to the Second World War were due to the fact that many of the best brains of a whole generation were lost in the First World War. The races of mankind were further weakened by lack of food and the pandemics of influenza and of encephalitis lethargica. The number of millions who died in the Second World War will never be known, but the world has been spared any great pandemic such as followed the First World War.

The threat of war is still with us and in even more frightening forms whose power of destruction has completely overwhelmed the means of defence. As we sit here in this hall at this moment we could be all extinguished in a flash, for Kruschev has said that with three nuclear bombs he could destroy Britain. Nor are nuclear weapons the only means by which mass destruction could be carried out. The recent death of a bacteriologist in a laboratory in Wiltshire indicated that our own government is working at secret methods of bacteriological warfare. The chemists, too, are active in their search for poison gases. Indeed biological warfare may easily be a powerful factor in the future. Its facts have high priority on the secret list; either for direct killing or indirectly by destroying crops or promoting epidemics. It has been said "Before long it will be the medical establishments which will be surrounded by barbed wire and it will be the biologists rather than the physicists who will be subjected to the most intense loyalty checks."

If we have enough wisdom not to go to war, can we avoid famine? Food supplies can be increased by irrigation, by improved methods of agriculture and by the elimination of plant diseases and pests, but there is a geographical limit to one and drawbacks to the others; though not the least difficulty is the education of the backward, e.g., in the primitive agriculture of India. The large increase in the population of the West consequent on the Industrial Revolution coincided with the conversion of the prairies of U.S.A. and Canada into wheat fields. These fields still produce a surplus which goes but a little way to meet the starvation always present and even extending in the East. No further large areas in the world are available for extension and already large fertile tracts in U.S.A. and China have degenerated into dust bowls through ill-advised husbandry.

A sudden and welcome increase in food productivity followed the introduction of the chlorinated hydrocarbons and other pesticides. Although they were introduced only a few years ago, the enthusiastic advertisements of the great oil companies have already faded from the pages of the scientific journals, for their use has upset the balance of Nature to an alarming extent by their diffusion the world over. Recent investigations in France show that the fatty tissue of 6 out of 10 people tested after death contain an average of 5 p.p.m. of D.D.T.; Americans have also 5, but some people in Sweden are showing levels of 12 p.p.m. Many of the beautiful and useful insects like butterflies and honeybees have been killed as well as the pests. The voices of the

insectivorous birds like the cuckoo and the corncrake are seldom heard in the land. Millions of fish have been killed in the Mississippi River because aldrin was used on the neighbouring farms. The infertility of the Speyside ospreys which feed on sea fish and the finding of D.D.T. in the livers of the Antarctic penguins have proved the widespread diffusion of these poisons throughout the oceans of the world.

I see no prospect of the pressure of population being eased by migration to the moon or one of the planets. Apart from the sheer physical impossibility of transporting a sufficient number of people to have any affect on the congestion here, the few explorers who reach the moon and return will have to tell a dismal tale of lack of water and of air, of intolerable heat and radiation torturing them continuously for 14 days at a stretch, to be followed by an equally long period with the temperature at or near absolute zero. The photographs radioed back to earth by the satellite Mariner IV prove that water is also absent on the planet Mars.

These explorers will be glad to return to Mother Earth, where other problems will still be waiting for solution. One of these is the problem of pollution of the atmosphere, the rivers and the sea. The pollution of the atmosphere came with the Industrial Revolution. It has taken a constant heavy toll of health and life, with two maxima – one in London in the winter of 1952 and the other in Belgium in 1930. Legislation has recently done much to clear the air, but more could still be done. Our rivers, rising in the hills as gurgling brooks of limpid water, become black and poisonous before they reach their estuaries. It surprises us to read that the Thames was a salmon river in the eighteenth century when its water was taken as low as Greenwich for making beer. Erie, one of the five great lakes of N. America, is dying; its once gleaming sands are now covered with smelly slime and its waters have been poisoned with chemicals and sewage. Even the oceans with their immense reservoirs are being affected. Oil and sewage are the most obvious pollutants, along with radio-active materials, but others are equally serious. For example, two hundred thousand tons of lead are used every year in anti-knock petrol and most of it finds its way into the air and eventually to the sea where the concentration of lead has increased tenfold in the past 50 years.

It is a sobering thought that as the population increases, so will most of these pollutions increase and so will the relative amount of food decrease, also our capital of certain special materials. First amongst these is fresh water. One fifth of the world's land surface is desert, and that area is increasing. By increased personal use but mainly by the demands of industry, the supply of fresh water even in this country is no longer able to meet the demand. Already in New York, the situation is serious and whiskey drinkers have been advised to use imported soda water. Our fossil fuels, coal and oil, are burned wastefully to the extent of many millions of tons annually, and will be exhausted in a century or two. Several hundred tons of the rare metal, tin, go with used food cans into refuse dumps daily. Lead is becoming scarce and silver ever more precious. Recently the U.S. Government has been forced to debase its silver coinage. It is only a matter of time until X-ray films will cease to be made. What will the radiologists do then, poor things? The image intensified has just arrived in time! About one-half of all our mineral resources have been extracted in the past 50 years.

The choice before us for the future is either to restrict the population of the earth to 1,000 million and to allow them to live on steak and pheasant and to have a cottage in the country, or to let the population expand to 100,000 million when it will of necessity become confined to skyscraper tenements with personal freedom reduced to a cruel minimum, and to live on soya beans and seaweed.

If the world's leaders have the wit to avoid all-out war and if we do not have to contend with a serious pandemic, how are we to survive as an intelligent species and how are we to have the space in which to live and move and have our being with sufficient of this world's goods to enjoy life and to satisfy our bodily and mental needs? I see only one answer and that is birth control. But birth control is no easy solution. It suffers from several severe handicaps. None of the methods is completely reliable, and all have one or more disadvantages. There are psychological difficulties and religious prohibitions. Most important of all, it is likely to be practised by those whom we regard as the cream of mankind to their own eventual extinction, while the indolent, the thriftless and the irresponsible will continue to increase. The need for control illustrates the lack of cerebral inhibition in those who fail to practise, and ignorance and prejudice in those who preach against it.

Within a generation we have seen an unbelievable breakthrough in science and in medicine. Show a diesel engine, a steam turbine or a helicopter to Leonardo or Galileo or Archimedes and they would have no trouble in understanding the principles by which they work; but show them an electronic

computer, a nuclear reactor or a television set and they would be entirely at a loss. Röntgen's discovery of X-rays in 1895 was a factor in the break between classical physics and the present day conceptions of radioactivity, the structure of the atom, and quantum mechanics. In only one important subject has progress been tardy, and that is in our knowledge and understanding of our own minds. This is probably to be expected, particularly when we reflect that the chief function of the human brain down the ages has been to seek food and only secondarily to seek truth. Indeed the intellectual qualities have been very unequally divided among the great number of people who have ever lived. 'Take 300 men out of history," wrote Sir Arthur Keith, "and we should be still living in the Stone Age." It may be that Keith exaggerated and the number may have been 3,000 or 30,000, but even so it is still true that without an exceedingly small number of uncommon men, the vast mass of humanity would have remained inert.

I have only time to mention the steady and exponential rate of growth of scientific knowledge since 1900. It is said that of all the scientists who have ever lived, three-quarters are alive and working today. Of all the scientific knowledge in the world, two-thirds has been discovered since the Second World War. In the 1920s, the analysis for blood urea took place as single tests in the clinical room beside the ward; now an average of 300 tests are done daily in the biochemical laboratories of the Royal Victoria Hospital alone. Indeed, these laboratories are among the most fully automated in the United Kingdom.

The growth of knowledge has altered profoundly the theory and practice of medicine. At first empirical, it has been influenced in turn by pathology, bacteriology and biochemistry. Now medical physics is playing an increasingly important role in modem medicine, which is recapitulating to some extent what Helmholtz did in his lifetime. You may remember that he started his medical career as a surgeon in the Prussian Army, became interested in the anatomy of the eye and ear, and then in their physiology. Another step took him to the physics of light and sound, and to applied and then to pure mathematics.

The automation in the laboratories is extending into industry. The National Coal Board has now opened the world's first fully automatic coal mine at Bevercotes in Nottinghamshire. The whole operation from winning coal at the face to the final stage of loading it into railway waggons is controlled automatically. The automatic machine in the factory or in the office is the precise economic equivalent of slave labour. It is quite clear that mass unemployment is bound to follow, or a working week of a few hours only. We shall then have the great problem of leisure and a population completely untrained to use spare time interestingly or beneficially. Many will revert to the open air life, some will indulge in passive recreation like the theatre and television. Only a few, even of university graduates, will read anything more than the yellow press. It is probable that the majority will be bored and lapse into alcoholism and gambling, with the more adventurous taking up a life of crime. Education for leisure is one of the great problems of the future. Recent years have seen an increase in the number of crimes of violence, said to be fifteenfold in the past 20 years. This increase has come as a great shock to those liberals who equated crime with poverty and bad housing; the new violence seems actually to be a product of prosperity and of overcrowding.

It is many years since Pavlov did more to unravel the workings of the human mind than all the introspective writers down the ages. His work on conditioned reflexes has been followed up by himself and his successors in a way unknown to western physiologists and psychologists until the phenomenon of brain washing emerged in recent years.

When students, we all learned something of his work on conditioned reflexes, but neither physiologists or psychiatrists appreciated that Pavlov was a careful clinician, and when he wished to extend his experimental findings to morbid psychology in man, the Soviet Government placed a nearby psychiatric clinic at his disposal. In the United Kingdom and the United States of America prejudice against Pavlov caused many psychologists to neglect his work even though his methods were irreproachably scientific. Pavlov always insisted that experimental facts, however limited in their range, which could be repeatedly tested and checked took precedence over the vaguer psychological speculations. It was only following World War II when great advances in psychotherapy were made by the use of drugs that Pavlov came into his own and his experimental methods were applied to the mechanics behind the historical techniques of human indoctrination, of religious conversion, and of brain washing.

The intense study of neurophysiological problems by the Russians since the Revolution has helped them to perfect the methods now known as brain-washing with astonishing results on their own nationals and in their great state trials, and also on those of other nationalities who had become their prisoners of war,

astonishing by reason of the surrender of strongly held beliefs and the adoption of new beliefs often directly opposite to the former. This is not the time and place to consider these recent advances in detail with all their potentiality for good or for evil in the years to come, but it behoves us to consider our own beliefs dispassionately and to remember that many of them have been handed down and accepted uncritically by generation after generation. We must ask "What are the facts? What do they prove?"

The future task of the doctor is to learn how to train the human brain to withstand stresses and strains, how to make it better, able to think and how to learn from experience; and how to redirect it, when disorientated, back into religious and ethical balance. For we are men gifted with religious and social apprehension and with the power of reason. All these faculties are physiological functions of the brain. The brain should not therefore be abused by having forced upon it any religious or political mystic, which stunts the reason, or any crude rationalism which stunts the religious sense.

Can we anticipate a continuation of the idea of progress? The question is not unreasonable when we compare the poetry and prose of today with the fine cadences of the language of the Old and New Testaments, or of "sweetest *Shakes- pear*, fancies childe" when he "Warble his native Wood-notes wilde", or when we compare what now passes for art when compared with the works of the old masters, and even more in the present day bedlam of pop and jazz in contrast with the music of Bach and Beethoven. In his monumental study of the genesis and decay of civilizations, Toynbee has shown that the continual challenge of the environment and man's response afford some explanation of the mechanics of human progress. In the 19th century the triumphs of applied science had caused the idea of progress to be so well established that it was no longer contested by anyone. The twentieth century is realizing that if progress has occurred it is neither simple nor continuous, and that advances in one direction are frequently accompanied by retrogression in another. Recently the belief in progress has been further weakened by the growing recognition that advances in technical knowledge are by no means sufficient to ensure social and moral progress, and also by the fear that the use of scientific knowledge for destructive purposes may out-pace and arrest the growth of its power for good – a situation all the more serious when to the power over nature is added power over the minds of men. We must remember that if science and technology can be used as instruments of oppression and destruction, they can also be used to promote freedom and well being; and also that if they facilitate the concentration of power, they can also show us how to prevent its abuse. Science leaves the path open to progress or to regression. The choice is ours. It remains that knowledge is not sufficient, but it is a necessary condition of progress. It can do something to help man to shape his own destiny before the end is reached.