Papers and Originals

The Next Ten Years in Medicine: Attempt at an Analysis of Factors Determining Medical and Social Development*

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The task in front of us is to prognosticate for the next ten years in medicine, say, 1965 to 1975. It has twice previously been my privilege to stick my neck out to answer a similar question, so I may as well try it once more. One of the scientific fields I occasionally work in is epidemiology—in the sense J. N. Morris uses the word. The current fashion in epidemiology is to make prospective studies: to take a roll-call and then look into what is likely to happen to the group ten or twenty years hence. If you prognosticate you are sure to be wrong; if you publish your prophecies you may be called a fool, but an analysis of your errors may nevertheless give some information about the laws that govern Nature's wisdom and the insufficiencies of Man in Society.

In 1952 I asked a dozen or so of my Swedish colleagues aged 30–40 years, representing various branches of medicine and considered to be both bright and clever, some questions concerning future developments in medicine. Particular emphasis was given to two items: (1) the impact of medical *science* on medical *care*; and (2) the obstacles presented in society, or by society, to an efficient application of sound medical knowledge.

Scientific Aspects

There was not much science-fiction in the answers provided by my countrymen. Further advance in the fight against infections was a fairly safe bet. Victory has been achieved in the battle against polio, but not in the case of epidemic hepatitis, which actually may be more widespread now because of vastly increased tourist traffic. Invasion by moulds and parasites was feared, but this has not materialized to any extent.

Better understanding of allergic phenomena was predicted, but there was no specific mention of the rapid revelation of the secrets of immunology that has thrown new light on a variety of diseases in internal medicine and paved the way for transplantation surgery. On the other hand, expectations with regard to the understanding of the processes of ageing have scarcely been fulfilled, despite enormous efforts made in the field of atherosclerosis research.

Further progress in cardiovascular and brain surgery with the aid of hypothermia was thought to be a reasonable prospect, but the possibilities of extracorporeal circulation were obviously underestimated, as belonging to the fictional part of the story.

Improvement in psychiatric methods and in the recruitment to psychiatry was hoped for, generally along the lines of psychology and mental hygiene. No reference was made, however, to the revolution we have witnessed in the present era of psychopharmacology.

Finally, with regard to preventive and social medicine, mass health surveys were thought to be premature and of doubtful use in reducing society's load of illness. On the other hand, developments in bio-technology and rehabilitation were regarded as both urgent and hopeful.

Developments in Medical Care

So much for the scientific aspects. With regard to the developments in medical care, obstacles to progress were found not only in the lack of understanding and difference in objectives between doctors and their lay authorities, but also in insufficient communication between doctors outside and inside hospitals, and at times even between hospital specialists themselves.

A more scientific-psychological and less empiric-routine attitude to patients would reduce the efficiency of the physician, judged quantitatively as "patients per hour," but it was hoped that this would be compensated for by a higher quality of medical care. The utilization coefficient of a physician might be raised with least expense by supplying him with a well-qualified secretary or similar aide.

There was a general feeling that the next decade would be one of greatly increased clinical research—research at the same time geared to improved and well-organized postgraduate medical education and training. The process of further subspecialization was thought to be inevitable, but hope was expressed that efforts at integration in medicine would not be lacking.

Now, a dozen years later, it may be asked how successful were these predictions? The medical ones were modest, but even so some extrapolation of observable trends did not materialize during those years. On the other hand, developments of great impact not appreciated at the time have taken place, such as psychopharmacological drugs, extracorporeal circulation and artificial kidneys, the concept of autoimmune diseases, transplantation of organs, and chromosome identification in genetically determined disease. Needless to say, neither the modern equipment for processing electronic data nor the hormonal control of fertility was conceived of in their present immediate applicability.

With respect to developments in medical care and the practice of medicine, what has happened? Most of the problems concerning information, understanding, and co-operation between the profession and the authorities, or within the profession itself, remain unsolved. This does not necessarily mean that animosity or hard feelings exist; these are less likely to be

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experienced on our side—at any rate, at a time when we have the advantage of a seller's market. But it does mean that a complicated and bureaucratic democracy takes an incredibly long time to solve its problems. In the race with scientific and technical development social organization will always lag miles behind.

Social Developments

This, of course, does not mean that society is stable. It is not. Technical and economic progress has been very rapid. In 1952 we still lived under the dread of a cyclic economy, with booms and periods of unemployment alternating. War experiences had not been forgotten; difficult times might well wait around the corner. To-day, all of this seems to be historical. We live in an affluent society, where the gains in national economy are consumed even before they are achieved. Automation means cheaper mass-production with less effort and reduced manpower; time and facilities for entertainment, travel, and intoxication expand. Thus, leisure makes consumers of us all, and previous industry and resolution give place to idleness and artificial fun. It should, however, be added that the demand for higher education has increased like a powerful tidal wave, smashing the traditional educational systems into pieces, and applying new, though possibly immature, psychological concepts in the fostering of a new generation. Instead of unemployment we are often facing a shortage of personnel, particularly in certain of the most exacting sections of medical care.

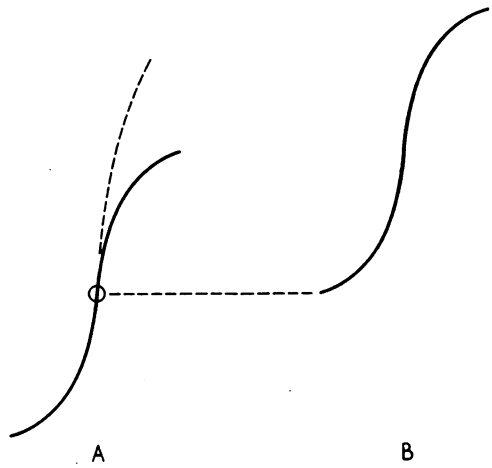
In short, I believe that we underestimated the rate at which technical developments take place outside and inside medicine, and we perhaps overestimated the capacity for administrative change within society. Because individual purchasing power is growing fast and seeking targets even beyond the satisfaction of immediate needs, and because knowledge is being widely disseminated and the zest for more knowledge is constantly being aroused, the demand for service rather than goods has risen beyond expectations; and one of the most desired services is medical care. The crisis in medicine to-day is one of an increase in demand, at least temporarily, vastly in excess of the concomitant increase in supply.

Change in Pattern of Disease

I have dealt at some length with my personal experiences of, and mistakes in, prognosticating the future of medicine. I have done so, however, because I am not fully convinced that the challenges to medicine do mainly originate in a "changing pattern of disease." It is true, of course, that a big change has occurred in the patterns of disease over, say, the last fifty years. But the process is a fairly slow one, and is intimately related to major changes in society—technical, economic, and "social." The pattern of disease and the vital statistics—birth rate, death rate, and longevity—are interdependent. Much depends on the kind of recognition an ailment is given. "Disease" is a word with many different connotations, and the same is true of "health."

One of the lessons I believe I have learnt from the follow-up of our prospective prophecy is this: be careful in extrapolation of trends. Having spent some of my earlier years in the study of haematin compounds, I am sensitized to the dissociation curve of haemoglobin.

This curve has a steep central portion and two less steep ends. The upper part describes what is happening when one approaches saturation. I believe such a curve is also valid with regard to many biological processes, including those of vital statistics and of changes in patterns of disease. It is also valid in various areas of medical care, although different areas may occupy different parts of the curve at one and the same time. It is clear that areas in which developments move along the steep part of the curve are those that attract the greatest interest, because the observer believes that the tendency will last for ever and, if so, its impact will be tremendous. I give here two examples in which such a tendency seems to be broken: recent studies in my country indicate that we no longer have any noteworthy increase in mortality from myocardial infarction; and, looking into medical care in hospitals, the rapid decline in average length of hospital stay in medical wards that was observed in the 1950s has slowed down and there may actually be a slight upward trend again. But, as is illustrated below, the overall tendency may be true, but it will manifest itself not wher one would expect, but elsewhere.



In A, extrapolation might give an impression of a continuous steep rise, while the curve actually becomes less steep. At the same time, in B, another *unexpected* development starts which is responsible for a steep rise in its turn.

Some Comments on Swedish Medicine

Up to this point I have tried to interpret some experiences from the last decade in order to prepare myself for a glimpse into the future. But I have also had occasion to halt at a midway station, and I will try to examine some of the lessons learnt there. In 1959 the Swedish Government summoned seven persons to make an estimate of future needs for medical personnel, particularly doctors, in our country. The report was ready late in 1960. Before dealing with its recommendations I think it is necessary to point out some of the main features in the structure of medical care in Sweden, particularly those that are at variance with conditions in your country.

Medical care in Sweden for a long time had its basis in services provided by general practitioners, many of whom were appointed by the King as "provincial physicians," each serving his particular "district" of the country both as a doctor and as a medical officer of health. We have witnessed a tremendous expansion of our general hospitals owned and run by county councils or the cities—an expansion which has rapidly shifted the emphasis of medical care from the fields to those medical fortresses. The hospitals to-day are the core of the medical structure, equally attractive to patients and to physicians, and the pride of the local authorities, who spend two-thirds of their tax money in this business. Of 6,500 physicians in 1958, roughly 4,000 were working in hospitals, 2,000 were practising outside of hospitals, and 500 were engaged in research.

Patients believe in the machinery of the hospital; doctors enjoy its security, the easy access to its modern facilities, and the stimulating possibilities in the exchange of ideas with colleagues. Since the second world war this hospital expansion has absorbed all new physicians coming into the market and has returned very few into practice. The practitioners were almost thought of as gradually becoming extinct until quite recently, when there have been signs of a reversed trend in so far as a number of fairly large group-practices, with several or even a great many different specialists, have established themselves in

modern medical buildings, with equally modern equipment, mainly in the cities or the larger towns. In this time of rapid transport the single rural practitioner appears to have become obsolete. This group-practice movement obviously has been considered acceptable to the profession because it continues the atmosphere of a medical fraternity prevailing in the hospital and safeguards acceptable standards of performance. An interesting feature of this development is that the Swedish Medical Association has very actively assisted in planning and financing such group-practices, even to the point of assuming financial responsibility through a special foundation, in relation to which some of the practitioners may be regarded as employees of a co-operative organization.

The return to the stage of the practitioner, albeit by means of a panel of specialists, has been to some degree facilitated by the Swedish variant of compulsory health insurance. In contrast to your National Health Service, our system is mainly an outgrowth of a social-security philosophy in which conservation of a reasonable standard of living in cases of unemployment, retirement, or illness is the main theme ; thus, apart from free hospitalization and heavy drug-subvention, the emphasis is mainly on cash benefits for wage-earners on an insurance basis. In addition, three-quarters of doctors' bills are reimbursed according to a special fee-schedule which is obligatory for doctors in salaried positions but not for private practitioners. There is a completely free choice of doctor—and of patients—in our country, and this is thought to be in the interest of both parties. It may perhaps be regarded as a luxury from the point of view of the State, but so far it has not been questioned.

Future Demands for Doctors

I would now like to revert to the work of the Royal committee that in 1959 had to look into the future demand for doctors. This committee evaded the problem of medical *needs*, and based its calculations on estimates of *consumer demand*. Among the most important factors in their analyses were the change in age-composition of the population, with a relative increase of age groups making particularly heavy demands on medical care ; the continuous rise in the national gross product ; and the redistribution of income to pensioners—all of which will increase purchasing power and consumer demand considerably. On the other hand, the supply of medical services would be likely to be limited by several factors: such as general reduction in working hours, increased percentage of female doctors with a smaller volume of work, and a reduction in the patient-load carried by individual physicians. This combination of factors that increase demand and diminish supply would obviously call for an increase in medical manpower. This was also the recommendation of the committee, which advocated a doubling of the admissions to medical schools.

With one physician for about 1,100 of the population in Sweden, as against one per 900 in England at that time, we had a rather low physician-density in comparison with countries such as the U.S.A. with one per 800, Western Germany with one per 700, and the Soviet Union with one per 600. On the other hand, international statistics show that there is an inverse relation between numbers of physicians and numbers of hospital beds—that emphasis on the hospital is a device which saves medical manpower. However, in Sweden we are already facing a situation where the utilization of *existing* hospital facilities is seriously hampered, not so much by a shortage of physicians as by a shortage of other medical personnel, and of nurses in particular. A recent prognosis concerning the nursing profession shows that we are unlikely to reach a balance between demand and supply of nurses. The reason is that, although there are enough applicants to our nursing schools, the losses consequent on marriage and childbirth are increasing so fast among the younger generation of nurses that—despite increase in admission rates—no big surplus reaches the labour market. With strained personnel resources in medical services, other than physicians, there are three possible remedies: increased automation of all technical services such as laboratory work, preparation of food, etc. ; up-grading of lower groups by improved instruction ; and employment of more male personnel.

Time-lag in Training

In the training of medical personnel there is a considerable time-lag before the products reach the market in any substantial numbers. It will still be several years before the increased output of young physicians is sufficient to meet the demand. But once the increase has gained momentum it is likely to produce an overshoot before it can be tuned down.

At present the overall ratio of physicians to nurses is 1:3. It is easy to predict that it will be moving towards 1:2 in the next ten years, and perhaps later on even towards 1:1. One of the major problems in the future will be, not to get applicants for a sophisticated education, but to get people who are prepared to do the routine jobs. We can already discern a tendency for young nurses to avoid the general wards and the care of the aged and the suffering, in favour of highly technical units and administrative posts.

The idea that one should learn from the mistakes of earlier predictions and should try to make up for any specific inadequacies might of course be challenged. A second prognosis might perhaps be biased and distorted, and result in an overshoot to the other side. This is particularly true, as already stated, with regard to investments in education of certain professional groups. There is a great hazard in creating too narrow a specialization at too early a stage.

If I stick to the lessons of our earlier attempt to look into the future this would mean greater confidence in advances along science-fiction lines in research as applied to medical care, greater emphasis on the potentialities of consumer-demand for medical care in an affluent society, and a still slow and inconsistent performance on the part of executive bureaucracy.

The open question in Britain for a visitor from abroad is the inertia of the National Health Service. In all countries people are striving for improvement in their welfare, either by raising the standards of existing organizations or by circumventing official obstacles through private endeavour. In Sweden it has become quite clear that the central Government and Parliament have been major stumbling-blocks to progress in care of the sick, in complete contrast to the achievements of local authorities. For this reason the State is now transferring almost all of its responsibility for medical care to local authorities, who know where the shoes really pinch. In Britain and Sweden opposite philosophies seem to govern medical care and education. Britain has centralized the former, but fortunately permits considerable freedom in educational programmes. Sweden has centralized education, even at university levels, but there is a fair amount of freedom in the organization of medical care. Personally, I regard freedom as an essential prerequisite for rapid progress, both in education and in care of the sick.

Hopes for the Future

Looking at the science-fiction aspect of medicine, extrapolation of already discernible trends points to a vast increase in techniques and devices for survival. The artificial limb has been followed by the artificial lung and the artificial kidney ; pace-makers are already whipping the tired heart to new efforts, and transistorized artificial hearts in a pocket-size version may well wait around the corner. While recognizing that Nature as yet is superior as a constructor, surgeons have accepted the challenge of the electronic industry and—with the support of immunology—got going with a wave of organ transplantation. It remains to be seen whether this will come to mean that never before have so many done so little to so few, or whether it does in fact signify a breath-taking step towards the realization of eternal life.

To-day one is also prepared to make a reasonable bet that the relationship between virus and malignant growth may be disclosed in the next ten years, and one can only nourish the hope that the roads to the cure of a number of dreadful conditions may be opened. Thus there is much to indicate that immunology may become the most important of the half-basic, half-applied sciences in medicine. It may, in addition, help in identifying man-made diseases in a society that is creating an increasingly artificial human environment.

Another feature that has an immediate bearing upon mankind is the control of fertilization now available at costs far below those of cigarettes. The combination of a safe sexual performance between satisfactory partners, and the availability of artificial insemination with a particularly successful brand from the central sperm bank, does in fact create entirely new possibilities for the modern woman; they are sure to have a considerable social impact.

The New Technology

Among objectives already on their way is the extensive use of electronic data-processing. Without doubt this will represent a revolution in diagnostic work and in medical record-keeping. Preventive medicine to-day is no longer a question chiefly of environmental hygiene. It is focused upon each individual, from embryonic life until death. Not without resistance on my own part have I, in recent years, been forced to accept the superiority of well-programmed questionaries and their subsequent handling by computers when dealing with health screenings and routine history-taking. I can no longer doubt that we must avail ourselves, at least in hospitals, of this new technology, which has still to be adapted to specific medical needs. It will certainly prove useful also in diagnostic screening and as an educational tool. The possibilities in monitoring and regulating biological processes in the unconscious state are already commonly exploited in operating-rooms and intensive-care units.

These are some of the near-by extrapolations. But what of the unexpected that we should be looking for? Let me make just one bet, but a big one: that research will find a biochemical key to schizophrenia and a rational treatment of that disease, not in mental institutes, but in the metabolic ward.

An extrapolation of the forces within our society that we can identify to-day indicates a continuous increase in the national gross product of the order of 50% in ten years, and a simultaneous increase of 30% in the proportion of it devoted to medical care, resulting in almost a doubling of the money spent on medicine. In a way this can be said to express the health consciousness and the fear of suffering and death in our civilization.

The social and economic climate in which this development may be expected to occur strongly favours emphasis on technical developments in preference to time-honoured personal care of the sick and suffering. We are likely to get two privileged groups, and one neglected group, among our patients. The healthy wage-earner will become the privileged, for whom a battery of health-screening procedures will be available without cost. Privileged also will become anyone suffering from a sufficiently interesting disease to warrant special investigation and the assemblage of technical experts for diagnosis or treatment. The underprivileged will be the aged, the worn out, the deteriorated, and, perhaps still more, the psychologically maladapted—in short, the useless, the uninteresting, and the nuisance.

Emphasis on technology leads to increased institutionalism. The larger the unit the more will specialized know-how be available in one place. The type of specialization required to-day is increasingly that of a new system in the division of labour within hospitals: instead of clinical departments and wards, the patients would be carried along an industrial assembly line, euphemistically labelled as "progressive care." It is astonishing to witness how often large sums are considered justified for investment in technical equipment in hospitals, in contrast to the extreme caution with which expenses for human resources are approached.

There is no doubt that some equipment is very highly labour-saving. This is true of administrative data-processing and of some routine laboratory services. It is apparently also true with regard to the preparation of food in huge industrial kitchens. In other areas, automation may chiefly be used to provide a higher quality of service: the intensive-care unit may be taken as an example. But the very efficiency of the new technology has also brought medicine face to face with an ethical dilemma that has never before been so disturbing as to-day. The new power of maintaining artificial life in the absence of a functioning brain repeatedly poses questions about the border-lines of life and those of the physician's responsibility. This is a very troublesome dilemma, not least for the many young doctors and modern nurses who have found their way to technology in an attempt to escape the burdens of human understanding in the old-fashioned clinical environment.

Crisis in Staffing

Labour-saving equipment is one answer to the approaching or already existing crisis in staffing. The number of aged citizens is growing, and even if the breaking-point, the ultimate phase of debility, can to some extent be postponed, I see no reason to believe that it can be abolished. Care of the chronically ill or the debilitated cannot easily be mechanized. It will require a modest amount of medical attention and high-quality nursing, and this has to be provided over twenty-four hours for seven days a week. This is precisely the kind of job that is unattractive and unrewarding in the present glamorous world, with its emphasis on that precious tax-free thing leisure. And appeals to somewhat older women whose children have already left the home have, at least in our country, met with a rather indifferent response. Therefore the expensive "acute" hospitals are filled with chronically ill patients whom the relatives refuse to take back and who have nowhere else to go. At present I fail to see any way out of this humiliating situation short of some kind of compulsory social-care service. In a more distant future, when automatic processes have reduced the overall need for human labour, and some kind of occupational therapy will be a privilege among the idle masses with inadequate I.Q.s as predicted by Sir George Thomson, a solution may perhaps be found.

Doctors of the Future

One facet of the next decade in medicine concerns the education of doctors who will receive their training in the next few years. What kind of a world—medical and otherwise—will we be preparing them for?

It appears to me that we are getting two levels in medical education. One is an expanding area of medical science comprising such items as cellular and molecular biology, protein synthesis, genetic codes, chromosome aberrations, cybernetics, etc., but no night calls; the other is a rather limited area of medical care, such as is presented to the general practitioner—common colds, healthy children, inoculations, and degenerative cardiovascular diseases—and night calls. There is a discernible tendency among medical students who have been exposed to and inoculated by the basic sciences to regard the doctor's job as dull and unrewarding, dealing with the symptomatic but not with the heart of the matter—the causes. It seems as if one could visualize two kinds of medicine—one a non-curative biology of man, the other a curative brand of charity. How are we going to deal with such a disruption within the medical profession? I can see no simple solution.

The medical world into which our colleagues of the future will enter will, furthermore, be one of large units: large industrial corporations, large administrative bodies, large schools and universities, and large hospitals. I have recently reviewed the

plans for a hospital with 2,500 beds, in which every conceivable specialty and subspecialty was to be represented. By its mere dimensions the control of such a hospital will pass out of the hands of the doctors, who will be reduced to technical specialists, each in his own narrow field. The individual at all levels is thus reduced in importance ; and this is equally true of patient and physician. The attitudes become group-centred, rather than individual-centred. To work with reasonable efficiency in such a place a new type of doctor may be required, one who is satisfied with an anonymous group-ego within the medical unit. Again I can see no easy way to mould the bright, curious, and enterprising medical student into such a shape, although I must admit that in our school system there are obvious tendencies to promote this development.

What else is going to happen in the community ? It seems as if people will continue to agglomerate in cities and large towns—whenever necessary spreading out again into adjacent suburbs. There is little hope that in the next ten years we shall see an end to the shortage of good urban housing or to the ensuing traffic congestion. There may be an increased tendency, with a greater amount of leisure time, for more people to indulge in double housing. In contrast to road-bound traffic, wireless communication seems to be without limits.

All this will probably result in an infinitely more complicated and interlocked society, depending more and more on internal regulations to diminish friction. Teachers and doctors together will be given the task of conditioning citizens to this regulation of human nature. The task of manipulating their fellow-men, by means of drugs, neurophysiological conditioning, and social casework, will ultimately become a major one for the future general practitioner and his para-medical collaborators. The pharmaceutical industry will certainly help to pave the way for the brave new world.

Conclusion

I have already said that I believe there is more than fiction to medical science fiction. The Brave New World and the Oceania of 1984 are representations of the anxiety and horror experienced by British liberals before the advancing social technology. I am afraid there is more to this kind of fiction. It may well represent what we all are up against, not necessarily from political evil, but from the inherent course of technology as such. For a long time Britain has stood as a safeguard of individualism, of freedom, and of independence—so much so that you have given these values priority to short-sighted material gains. But the question is, for how long will you be able to avoid a more definite break-through of tendencies prevailing in many other parts of the world, including mine ? From a speech by the Chief Medical Officer to the Ministry of Health, Sir George Godber, I conclude that more hospitals, more group-practices, and less individual medicine will be the Ministry's keynotes, and they sound very familiar to me. Apparently we are all bound for a new era, that of "greater medicine." Let us hope that this will be not only a quantitative goal. If it has to come, we must try to make it truly great.

Effectiveness of Pertussis Vaccines

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As the result of a preliminary study (Preston, 1963) it was suggested tentatively that pertussis vaccines may be providing children with incomplete immunity against some strains of *Bordetella pertussis*. The need was stressed for a fuller investigation of freshly isolated strains, and comparison of their antigenic composition with that of pertussis vaccines. With the ready co-operation of many general practitioners, paediatricians, and bacteriologists throughout the country, a widespread collection of material has now provided sufficient evidence to confirm this tentative suggestion beyond reasonable doubt.

Materials and Methods

Strains.—Strains of *Bord. pertussis* were obtained from the Public Health Laboratories in Bournemouth, Brighton, Bristol, Cardiff, Coventry, Ipswich, Leeds, London (Colindale), Manchester, Southend, and Swansea ; Ruchill Hospital, Glasgow ; Fazackerley and Alder Hey Hospitals, Liverpool ; Lambeth Hospital, London ; Ancoats, Booth Hall, Duchess of York, Monsall, and Withington Hospitals, Manchester ; Royal Manchester Children's Hospital ; Hope Hospital, Salford ; Western Bank Children's Hospital and the University, Sheffield ; and from home cases in Manchester, Salford, and Wigan.

Typing Sera.—The three major heat-labile agglutinogens (1, 2, and 3) of *Bord. pertussis* were originally described by Andersen (1953), antigen 1 being species-specific—that is, common to all strains of *Bord. pertussis*—and antigens 2 and 3 being type-specific—that is, present either alone or together on different strains of the species. Monospecific absorbed antisera for these three antigens have been prepared and standardized as previously described (Preston and Te Punga, 1959 ; Preston 1963).

Serological Typing by Slide-agglutination.—A suspension of each strain of *Bord. pertussis,* grown on charcoal-blood-agar, and each vaccine (standardized to contain approximately 50,000 million organisms per ml.) was mixed with a standard loopful of each of the three monospecific sera on a glass slide and rocked gently for five minutes. If there was then no apparent agglutination by antibody 1, observation was continued for a further five minutes. Degrees of agglutination were recorded as follows:

+ + +, Rapid agglutination, complete within 3 minutes.
+ +, Agglutination within 3 minutes ; complete within 5 minutes.
+, Slow agglutination, incomplete within 5 minutes.
±, Very slow agglutination, inapparent within 5 minutes, incomplete within 10 minutes.
0, No agglutination (by antibody 2 or 3) visible to naked eye within 5 minutes.

Typing of Strains

From January 1963 to December 1964 155 freshly isolated strains of *Bord. pertussis* were collected from cases of whooping-cough occurring in widely separated areas of Great Britain: 132 (85%) were agglutinated only by antibodies 1 and 3 (serotype 1,3), 2 (1%) by antibodies 1 and 2 (serotype 1,2), and 21 (14%) by all three antibodies (serotype 1,2,3). The predomi-

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