MAY, 1946

THE ULSTER MEDICAL JOURNAL

PUBLISHED BY
THE ULSTER MEDICAL SOCIETY.

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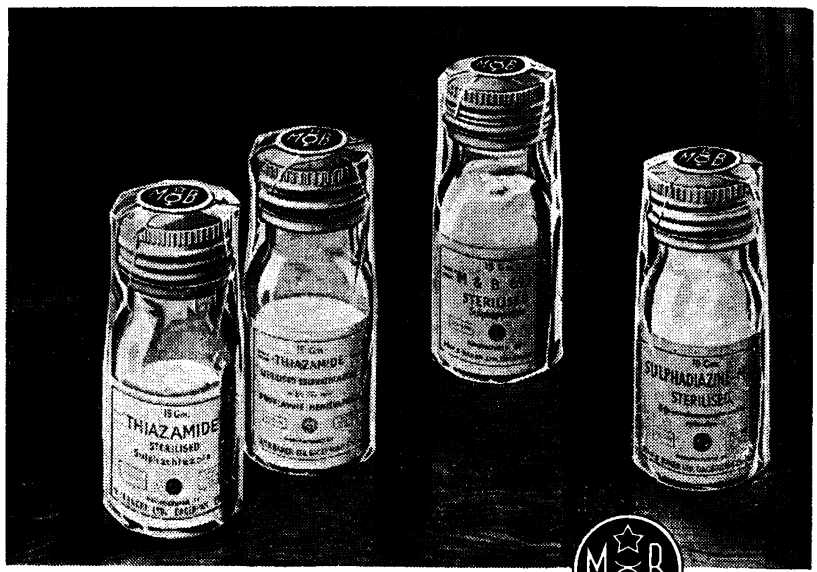

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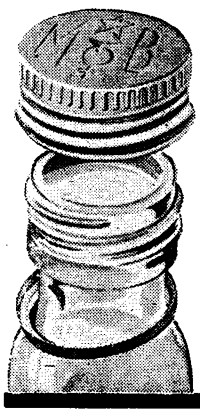

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O-SYL, unlike many other antiseptic substances, **has a lethal action against Staphylococci identical with that for Streptococci.** O-SYL is, therefore, par excellence, the antiseptic to remember where staphylococcal infections are in question.

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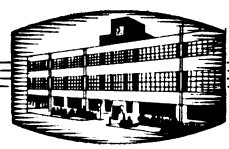

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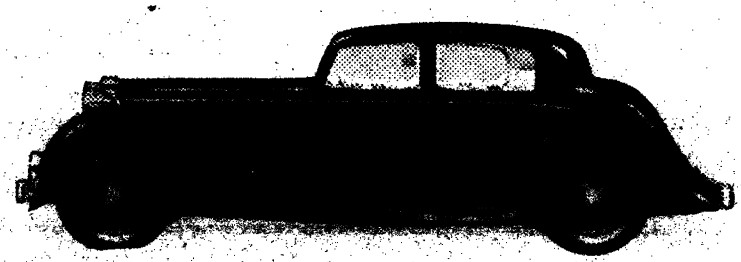

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CONTENTS

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Subscription to non-members, five shillings annually.

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1. Manuscript should be typewritten and fully corrected. Contributors will be responsible for the payment of any sum charged for correction of the printer's proof in excess of ten shillings per sheet (16 pages).
2. Illustrations must be in finished form ready for reproduction. They must be properly labelled in type or by hand, with reference pointers if necessary.
3. Line drawings must be sent whenever possible. Illustrations requiring half-tone blocks are costly, and unless printed on special art paper are often unsatisfactory. Authors will be charged for these half-tone blocks at cost price.
4. The legend describing an illustration must be inserted in the appropriate place in the text, and should not be placed on or appended to the drawing.
5. Orders for reprints must be given when the author returns the printer's proof. The cost of these may be obtained from the printers in advance.
6. Editorial communications should be sent direct to the Acting Editor, Dr. Marshall, 9 College Gardens, Belfast.

ADVERTISEMENTS

First advertising forms go to press thirty days in advance of the date of issue. In forwarding copy, time must be allowed for setting up and submitting proof. All communications for space must be sent direct to the advertisement controllers: MESSRS. GEO. A. STEWART LTD., 38 Donegall Place, Belfast. 'Phone: Belfast 23455.

DATES OF PUBLICATION

Under present difficult circumstances it is hoped to issue two numbers each year: on 1st May and on 1st November.

ROYAL MEDICAL BENEVOLENT FUND SOCIETY OF IRELAND

BELFAST AND COUNTY ANTRIM BRANCH

To The Editor of THE ULSTER MEDICAL JOURNAL.

DEAR MR. EDITOR,—On several occasions you have been good enough to afford the space to appeal for more subscribers to the Royal Medical Benevolent Fund Society of Ireland. I regret to say that the response to these appeals has been consistently very disappointing, but with the natural optimism of our race I would crave your space to try again.

This Society, with its official address at the Royal College of Surgeons, Dublin, was founded in 1842, and is an Irish society for the relief of medical practitioners, their widows, orphans, and dependants in necessitous and deserving cases. The Fund is managed by a central committee in Dublin, with branch committees in the several counties.

During the year ended 30th April,1945 —the latest figures as yet available—one hundred and seven grants were made. The recipients were eighty widows, three doctors, and the orphans of twenty-four practitioners. A sum of £2,482. 10s. was expended on these grants, representing an increase of £356. 10s. from the previous year. This outlay means an average individual grant of just over £23.

Receipts for the year showed a decrease from the previous year, due almost entirely to the loss of subscribers to the Fund through death and failure to replace these by new members. The prosperity, even the existence of a fund such as this is dependent upon the constant recruitment of new subscribers to make good those lost in the course of time.

Many of the smaller and theoretically less important branches have records that are the constant envy of the Committee of the Belfast and County Antrim Branch. Particularly do we note the uniform response in the Counties of Tyrone and Fermanagh, while in County Down the Banbridge and District Medical Practitioners' Club set a pace with a subscription of ten guineas, which finds a glad response throughout the County.

Must Belfast and County Antrim fall behind in this good cause? Is it that we feel we are too thrifty ever to need the help of the Fund? for, if so, it is an ill-founded sense of independence!

Perhaps, Mr. Editor, our appeals have been too indefinite, so that the excuse can be made that no amount was specified. Well, Sir, I want to ask a uniform annual subscription of one guinea from every practitioner within the bounds of Belfast and County Antrim, and nothing less will satisfy me that we of the North-East do justify our own opinions of our charity.

These subscriptions can be paid directly to me by cheque, which entails the additonal work and postage of a formal acknowledgment, or by banker's order, which I shall gladly forward in acknowledging new subscriptions.

Again, Mr. Editor, I am grateful for your space and assistance and, ever hopeful, I await the results of this appeal.

I am, yours faithfully,

F. F. KANE, *Hon. Secretary.*

Belfast and County Antrim Branch,
Purdysburn Fever Hospital, Belfast.

THE ULSTER MEDICAL SOCIETY

THE MEDICAL INSTITUTE,

COLLEGE SQUARE NORTH, BELFAST.

Dear Sir (or Madam),

If you are not a member of the Ulster Medical Society, we would appeal to you to give the question of joining your consideration. The Society has been in existence since 1862, and has always been active in keeping its members interested in the advances in medical science as well as in current professional affairs. The Medical Institute, situated in College Square North, belongs to the Society (through the generosity of Sir William Whitla), and is ideally adapted for meetings, committee meetings, and recreation. There is a library with current medical periodicals, and facilities for reference to medical literature are available in conjunction with the library at the Queen's University. There is also a billiards-room available to members, and lighter periodicals are also provided. Meetings are held at intervals of a fortnight during the winter months, and papers are contributed by members. Distinguished visitors are occasionally asked to contribute papers on subjects upon which they are specially qualified to speak. **The Ulster Medical Journal, the official organ of the Society, is issued to all Fellows and Members free of charge.**

May we, therefore, appeal to you to join the Ulster Medical Society, and so enable us to widen its influence and sphere of usefulness still further? Please make application to the Honorary Secretary, which will ensure your name being put forward for election to membership of the Society.

If you do not wish to become a member of the Society, will you consider entering your name as a subscriber to THE ULSTER MEDICAL JOURNAL? The subscription is five shillings per annum, payable in advance to the Honorary Treasurer.

We remain,

Yours faithfully,

H. P. HALL, *President.*
KENNEDY HUNTER, *Hon. Secretary.*
W. G. FRACKELTON, *Hon. Treasurer.*

FELLOWS.—All persons registered for seven years as medical practitioners under the Medical Acts shall be eligible for election as Fellows. The annual subscription shall be two guineas for those practising or residing within a radius of ten miles from the centre of the city of Belfast, they shall be known as Town Fellows; one guinea for those practising or residing outside this radius, they shall be known as Country Fellows.

LIFE FELLOWS.—Any duly elected Fellow or Member shall, subject to the approval of the Council, be entitled to a life-fellowship on payment of a single subscription of twenty guineas for a Town Fellow, or ten guineas for a Country Fellow. All Fellows or Members of the Society who have paid subscriptions for forty years or more shall be exempted from any further subscription.

MEMBERS.—All persons registered as medical practitioners under the Medical Acts shall be eligible for election as members of the Society on an annual subscription of one guinea. Such membership shall terminate at the end of the seventh year after the date of medical registration. Members shall then become Fellows.

.....19.....

To DR. W. G. FRACKELTON,
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Postal Address .....

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THE
ULSTER MEDICAL JOURNAL

PUBLISHED ON BEHALF OF THE ULSTER MEDICAL SOCIETY

Vol. XV 1st MAY, 1946 No. 1

THE QUEEN'S UNIVERSITY OF BELFAST

CENTENARY ENDOWMENT FUND

At the very beginning of the Belfast Medical School the belief was expressed that "in the course of a few years it might become a school of Physic and Surgery of no trifling importance to the young medical students of this neighbourhood and the Province of Ulster." During the last hundred years the Faculty of Medicine in the University and the clinical teachers in the associated hospitals have done much to bring these hopes to fruition, so that now our graduates can look back upon a long list of doctors who have brought distinction to the school and have gained for it a name not only in Ulster but amongst the great medical schools of Great Britain. Such success has necessitated continual expansion, and there has been a continuous record of the creation of new Chairs—Physiology (1893), Pathology (1901), Public Health (1921), Biochemistry (1924).

In these days of rapid scientific advance and with the increasing interest evinced by the State in matters of health, it is obvious that the University must still further develop its teaching facilities for the Faculty if the position so hardly gained is to be maintained. In the past the staff has been inadequate in number and full facilities for research and teaching have often been lacking. Indeed it has been necessary for the Faculty to concentrate upon the training of undergraduates. The future demands an ever-increasing development of post-graduate teaching, which in turn will require both staff and buildings. To some extent it has been possible to add to the number of teachers, but in order that these may be able to fulfil their functions there are certain developments urgently required. Existing departments of Anatomy, Physiology, and Pathology must be extended. The present departments

in the clinical subjects are completely inadequate, so that it is necessary to build a new clinical block in which the departments of Medicine, Surgery, Midwifery, Ophthalmology, and the newly-created departments of Child Health may be housed. New buildings, additional teachers, increased research, require equipment. With such facilities it is the belief of the Faculty that the School of Physic and Surgery may play a role "of no trifling importance" in the future Health Services not only of this Province but throughout the Commonwealth.

As the University enters upon the second century of its existence, the Senate decided that the time was opportune for a determined effort to provide the facilities necessary for the proper development of the various Faculties, having regard to present and future requirements. The Centenary Endowment Fund was thus established with the object of raising £250,000, estimated as the amount required. The Government, appreciating the importance of the work of the University in the life of the Province, has promised to contribute towards that Fund to a maximum of £75,000 on a pound for pound basis on moneys contributed from outside sources.

The interest and support of the medical profession is strongly commended. Assistance can be given by donation or by covenanted subscription. All contributions, which should be marked "Queen's University Centenary Endowment Fund," addressed to the Vice-Chancellor at the University, will be gratefully acknowledged, and lists of contributors will be sent from time to time to the Press.

REVIEW

JOURNAL OF THE HISTORY OF MEDICINE AND ALLIED SCIENCES. New York: Henry Schuman. $8.50 quarterly.

This latest American journal appears under the editorship of Dr. George Rosen, with the collaboration of an international board of medical historians. The first issue, of 183 pages, contains articles on a wide range of subjects, including two of particular interest to British readers on "The London Years of Benjamin Waterhouse" by J. C. Trent, and "Medical Education in Seventeenth Century England" by Phyllis Allen. As is to be expected, the Journal is beautifully printed on paper of high quality.

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Malaria in War

By BRIGADIER J. A. SINTON, V.C., O.B.E., F.R.S., M.D., D.SC., D.P.H.
Hon. Consultant in Malaria to the War Office

I CANNOT tell you how much I appreciate the honour that the Committee has done me in its invitation to give the Robert Campbell Memorial Oration. I feel especially proud as I have had the honour, the privilege, and the pleasure not only of being one of his old students, but also of serving under him as a resident pupil and as a house surgeon in the Royal Victoria Hospital.

Before I deal with my subject—"Malaria in War," I must say a few words on a text that Kipling has modified from the Scriptures—"Let us now praise famous men, for their work continueth, greater than their knowing."

We are gathered here to-night to keep alive the memory of a famous man, Mr. Robert Campbell, whose work continueth greater than he in his modesty would ever have anticipated. I see here to-night many of his old colleagues and students who must have felt the stimulus of his example and teaching as I did.

As a teacher I have known few to equal Robert Campbell. He explained his theses with the simplicity, lucidity, and logic that mark the born and inspired teacher. He showed that he had his subject at his fingertips, both mentally and practically. He taught one not to accept what at first sight appeared to be an obvious and simple diagnosis, without first fully weighing the pros and cons of other possibilities. I think it was he who first laid the foundation in my mind for the acceptance of that great principle in research work: "Never take authority when you can get fact, and never guess when you can know." He taught one to be critical, and more especially of one's own work.

His technique as a surgeon was a delight to watch, and I fortunately had many opportunities of observing it at close quarters. He was no mere carpenter, but a surgeon in the very best and widest meaning of that term—a surgeon must be a clinician first. The greatest benefit of his patients was always his aim. As a result his patients had unbounded confidence in him.

He was a faithful friend, a wise counsellor, and an ever-present help in time of need. I wish I was more worthy of paying a suitable tribute to his memory and to that greatness which he never advertised. It is only right that his memory should be kept green by the Belfast Medical School, for which he did so much.

GENERAL INCIDENCE OF MALARIA IN WAR.

The majority of diseases that affect armies are preventable, and a study of past campaigns has shown that many more men are disabled by sickness than by enemy action. Instances have occurred where whole armies have been incapacitated by disease, even before reaching the scene of operations. Expeditions have had to be abandoned owing to the ravages of disease. During the First World War, the ratio of battle casualties to sick admissions was 1 to 1.3 in Flanders, while in Egypt and Palestine it was about 1 to 10, in Mesopotamia 1 to 13, in Macedonia 1 to 27, and in East Africa 1 to 33.

As can be seen from these figures, the ratio rises very rapidly when the tropics or the subtropics are the scenes of operations. This increase is caused partly by the fact that continuous pitched battles occur more commonly in the temperate zones, but mainly because in the tropics—

(i) Disease is more prevalent;

(ii) European troops have had no opportunity of developing any immunity to many unfamiliar diseases, and

(iii) The local conditions are more suitable for the spread of disease, and these are greatly increased by war.

In such theatres, malaria and dysentery are the two commonest causes of morbidity, and of these malaria is the most devastating.

Nowadays, the importance of malaria in war does not lie in the number of deaths caused (usually in the past considerably less than one per cent. of the case-incidence). It is in the widespread debility, both physical and mental, that it produces with resultant enormous loss of fighting strength, of efficiency, and sometimes of morale.

It is evident that all such tropical campaigns are from the first sanitary ones. It is just as necessary to prevent needless casualties from disease as from enemy action. An army is mobilised to go to battle, not to hospital. It has been proved by experience gained in many previous campaigns (vide infra) that not only may the speed of operations be very greatly delayed by the effects of malaria, but in prolonged ones the wastage of manpower produced by this disease alone may be a decisive factor in preventing a successful outcome.

Field Marshal Smuts stated that the East Africa campaign of 1915-18 was "one against nature in which climate, geography and disease fought more effectively against us than the well-trained forces of the enemy." This is equally applicable to the recent campaigns in South-East Asia and the South-West Pacific. Climate and geography were so favourable to the spread of malaria that in those theatres this disease, and *not* the Japanese, was recognised as "Enemy No. 1." In the early days it caused many times as many casualties as the enemy's land, air and sea forces combined.

Records of Malaria in Military History.

There is a large amount of conclusive evidence to show that malaria has had a remarkably adverse effect on military operations from the earliest times, and so has changed the history of the world.

Cardamatis, the Greek malariologist, presumes that the disease which attacked the Greeks before Troy about 1500 B.C. was malaria due to the swampy nature of the ground.

When the "Assyrian came down like a wolf on the fold," they had first to traverse the very malarious Jordan valley before attacking Jerusalem (c. 700 B.C.). Genovese thinks that "the Angel of Death" which smote Sennacherib's host was malaria contracted in that valley.[1]

Although there may be some uncertainty about the validity of the contention

1. This valley lived up to its evil reputation for malaria in both World Wars.

that malaria was introduced into Italy by the Punic invasions about 200 B.C., there is little doubt that both the Carthegenean and the Roman armies had enormous casualties from this disease. During the Civil Wars in Italy the health of Cæsar's army was broken by malaria (Celli, 1933).[2]

Tacitus reported that Gallic and Germanic troops (non-immunes) suffered severely through camping in the unhealthy environs of the Vatican Hill. Repeatedly northern barbarians—Goths, Huns, and Lombards—who attacked and despoiled Rome, were decimated through the agency of malaria (Hoops, 1934).

Jones (1909) has written a book to show how the decadence of the Greeks, in both their military and cultural spheres, was brought about by malaria.

Malaria took a heavy toll of the Crusaders in Palestine. The armies of Salah ed Din and Richard Cœur de Lion are said to have suffered severely from "fever," while facing each other in the Birket Ramadan swamps on the Palestinian coast.[3] Apparently an armistice had to be declared for this reason (Vickers, 1942).

In 1167, the finest army ever commanded by Frederick Barbarossa was decimated in the Roman Campagna by this disease. "Obscure soldiers, nobles and illustrious prelates laid down their lives there. The flower of a nation was exterminated" (Balfour, 1924).

The great military surgeon, Pringle, describes the intense malaria prevailing in the British army in Flanders during Marlborough's campaigns, and in Scotland before and after the Battle of Culloden (Hoops, 1934).[4]

To come to more recent times, when Napoleon set out for Egypt in 1798 with the best army of France, a successful campaign would probably have changed the history of the world. His army, camped near Acre, became riddled with malaria and plague. Our fleet prevented him getting reinforcements of healthy troops, and his grandiose eastern scheme was frustrated.[5]

In our wars with the Dutch in Java about 1800, the personnel of the fleet engaged there were so stricken by this disease that Edam was described as a "regular charnel house."[6]

The ill-fated Walcheren expedition of 1809 to the Lowlands is often quoted as a striking example of the devastating effects of malaria. Some more recent investigations cast grave doubt upon the malarial causation of this catastrophe (Swellengrebel and de Buck, 1938).

In the Rangoon Expedition of 1824-25, only 35 deaths were due to wounds,

2. His troops were largely non-immunes from Gaul and Spain, and had spent the autumn in the highly malarious regions of Apulia and Brindisi. The latter place again became notorious during the First World War (Robertson, 1920).

3. Similarly in 1918, these swamps were responsible for a heavy malarial morbidity among Allenby's troops.

4. The cases during the 1745 campaign were probably cases of chronic relapsing benign tertian malaria. Similar outbreaks have been a prominent feature among troops returning to the United Kingdom from malarious theatres in both the last wars.

5. The area between Haifa and Acre was still one of the most malarious in Palestine in 1942. Large engineering and other anti-malarial work initiated by the Army have now reduced the danger to a low level.

6. Shields, the naval surgeon there, has given a most graphic account of the epidemic.

while 450 out of every 1,000 engaged died of malaria. The Arakan Expedition of 1826 had to be abandoned owing to this fever: "Everyone who was not dead was in hospital"!!

Our troops in the Crimean War also suffered severely from malaria. Macdonald (1923) points out that some of this force occupied practically the same position as the Macedonian Expeditionary Force did in the First World War, and were affected by malaria to the same extent (vide infra).

> "In August 1851, from being in extraordinarily fit condition in the previous months, the armies of the Balkan Peninsula were suddenly prostrated by disease. Apart from the hospital sick, it was universally admitted that no man in the ranks, though not on the sick list, was capable of active field service."

Malaria was the chief cause of sickness in the Chino-Japanese war of 1894-5. In the Ashanti Expedition of 1896, there were in six months 1,491 admissions to hospital for malaria in a force of about 5,000, with a sick rate of 40 per cent. among the officers.

It might possibly be said that most of these examples are relatively old history, occurring before the discovery of the mosquito carriage of malaria, and many before the value of quinine was fully recognised or adequate supplies available. Unfortunately many similar disasters were reported during the first World War.[7]

In that war, malaria had a most important adverse influence on almost all fronts except Flanders. In tropical and sub-tropical theatres, it caused more casualties than any other single factor; the mass debility produced exceeded by far the losses from any other cause. It was responsible for from three to ten times more casualties than enemy action. Indeed, in East Africa the ratio was as high as twenty times.

In fronts such as Macedonia, East Africa, Palestine and Syria, malaria placed a very serious obstacle in the way of successful military operations. The losses of numerical strength and the general deterioration of health, both physical and mental, was enormous among the troops.

On the Macedonian front the average annual admission rate for the years 1916-18 was 404 per 1000. A total of 168,751 hospital admissions were reported, and 25,000 of the more chronic cases had to be evacuated in 1918 (one-fifth of the average strength of the force). One division had 5,000 admissions in one month.

Our French allies there were in no better position. General Sarrail reported that he could only put 20,000 men in the field out of a force nominally six times that number: "My army is immobilised in hospital," he said. The troops of the Central Powers recorded an infection rate of 20 per cent. in Albania in 1916. This rose to 52 per cent. in 1917. Personnel in certain areas had an incidence of 70-90 per cent., and, if relapses be counted, 168-180 per cent.

The enemy, therefore, derived no benefit from the Allies' disability. "Malaria, as usual, was exploiting a favourable situation to the utmost and had joined battle on both sides. We had the spectacle of three fine armies, backed by the most

7. Most of the statistics about this war have been taken from volumes of the *Official History of the War. Medical Services* (1923 et seq.)

powerful nations of Europe and equipped regardless of expense with every modern appointment, virtually paralysed before they were able to strike a blow" (Hackett, 1937).

A remarkable example of the potentialities of malaria in war was seen during the Palestine-Syria campaign of 1918. Allenby's final advance started on 19th September. A severe epidemic of malaria began on 5th October, and 20,000 cases were reported before the end of that year. During the advance 773 men died of malaria. The infection was contracted while passing through the malaria-ridden country behind the enemy's front line, more especially through the notorious Jordan Valley (cf. the Assyrians mentioned previously). Fortunately in the interval before the epidemic burst, the Turkish armies had been decisively defeated—the campaign was won by troops in the incubation period of malaria! If the advance had been held up by the enemy for another two weeks, a great victory might have been replaced by disaster with far-reaching consequences.

The incidence of malaria was even greater in the East Africa campaign (a truly tropical one) than in any other. Here of the *recorded* hospital admissions, fifty-seven per cent. were due to this disease. The annual admission rate rose to 1,423 per 1,000 in 1918, and probably at least a quarter of a million cases occurred during the campaign in a force with an average strength of about 50,000 (Keyworth, 1929).

General Van Deventer in 1917 reported that owing to sickness, especially malaria, the number of men available for duty had no relation to the nominal strength of the force. A Brigade which could muster 1,400 rifles was fortunate.

In 1917-1918, one-third of the Spanish Army in Morocco was immobilised by malaria. One battalion of 890 men had 286 cases and 32 deaths in one year.

When operations on the North-West Frontier of India occur during the malaria season, a large amount of sickness and disability arises from this disease. For example, in the Mohmand Bajaur campaign (August to October, 1933), the hospital admissions for malaria were 418 per 1,000 over the whole period of the campaign.

Apart from the effects of malaria upon armies as a whole, its effects upon famous commanders and noted personalities must have done much to affect the course of history.

Jones (1909) thinks that the "thorn in the flesh" referred to by St. Paul was malaria. Alexander the Great reached Babylon in 323 B.C. on his return journey from India. He died there at the age of thirty-three years from a sickness which some think was malarial, thus preventing him from finding new worlds to conquer. Alaric, the first barbarian prince to conquer Rome, died of malaria (A.D. 400).

When Philip the Bold of France besieged and took Gerona in Spain in September, 1282, his army was almost destroyed by malaria. He himself succumbed to an attack at Perpignan.

Even Irish history has not escaped the influence of malaria. The famous Earls, the hope of the Irish nation, who fled to the Continent from Rathmullen in 1607, succumbed to this disease.

"In July, 1608, the Duke of Tyrconnel and the Barons of O'Neill and

O'Domhail (sic!) with their chaplain and two pages went to Ostia [a notoriously malarious place near Rome], where they remained for two days. After their return they all fell ill with fever. The Duke, the chaplain and one of the pages died. The two surviving noblemen were advised by doctors to change their place of residence; from the Borgo they went to live in a palace near Monte Citorio, which was considered healthy. In September O'Domhail died. The next year Baron O'Neill also died, probably from a recurrence of fever. Thus the last hope of the Irish patriots was in its turn destroyed by the Roman marsh fever. (Medicean Archives, F.3624., 8 Oct., 1609; The Flight of the Earls, Dublin, 1916) (Celli, 1933).

Cromwell, the Great Protector, died of a "quartan," and James I, "the wisest fool in Christendom," of a "tertian."

Such individual events must undoubtedly have affected the fate of nations and the course of history.

It must also be brought to mind that the two greatest basic discoveries in malariology were made by army officers. Laveran, a doctor in the French Army in Algiers, discovered the malaria parasite in 1880. Ross of the Indian Medical Service demonstrated in 1897-8 that this parasite was transmitted by mosquito bites.[8]

The Main Factors in the Spread of Malarial Infections.

Before entering into the details of any scheme for the control of malaria in war, it is necessary to summarise briefly the various factors involved. These include the human host, the malaria parasite, and the anopheline mosquito. They may be visualised as a series of beads joined by links to form a chain with side-chains, which may be endless in nature.

Their relationships are shown graphically in Table I, from which it can be seen that the links connecting the two animal hosts of the parasite, man and mosquito, are the bites of anopheline mosquitoes. This is the only way the disease can be conveyed in nature. It is evident, therefore, that theoretically the prevention of the spread of malaria is simple—the prevention of the bites of infected mosquitoes. But, as Napoleon has said about war: "The principles are simple, the difficulties lie in their execution."

In war the immediate object is to conserve man-power by keeping men fit until the operations are ended; the morbid effects of disease that may develop at a later date are of less urgency. Therefore, any scheme for the control of the malaria menace in war contains two main factors—(a) the prevention or diminution in the transmission of infection, and (b) the control or suppression of any disability likely to be caused by such infections as have not been prevented.

PREVENTION OF THE TRANSMISSION OF MALARIAL INFECTION.

Theoretically such transmission may be stopped (a) by preventing the bites of

8. It is of interest to note that in 1807, Dr. John Crawford, a native of Ireland, who had settled in Baltimore, U.S.A., published an article in the *Baltimore Observer*, entitled "Mosquital Origin of Malaria Disease" (Russell, 1943).

infective mosquitoes, or (b) by attacks on the parasite in either (i) its insect host or (ii) its human one, so preventing the acquisition of infection by man or insects.

TABLE I.
THE SPREAD OF MALARIAL INFECTIONS.

1.	BEAD.	*The Infected Human Host* (Carrier of asexual malarial parasites) becomes *The Infective Human Host* (Carrier of gametocytes or sexual parasites).
2.	LINK.	Who is bitten by *The Susceptible Insect Host* (Anopheline mosquito)
3.	BEAD.	Which becomes *The Infected Insect Host* and then *The Infective Insect Host*
4.	LINK.	This bites *The Susceptible Human Host*
5.	BEAD.	Who becomes *The Infected Human Host.* (vide 1 supra).

A. Prevention of Mosquito Bites.

Such defensive measures fall into two main groups—

(a) Direct protection against the bites, and

(b) Diminution in the chances of acquiring an infective bite by reduction in the number of the mosquito population.

1. DIRECT PROTECTION AGAINST MOSQUITO BITES.

The measures used may be either chemical or mechanical.

(a) *Chemical Protection against Mosquito Bites.*

These consist of the application of creams or lotions, mainly to the exposed portions of the body, to repel the mosquito or otherwise deter it from biting. Many substances had been used in the past. Citronella was the chief ingredient employed in such preparations both in the first World War and in the interval of peace which followed it. Unfortunately, this substance was not one-hundred-per-cent. efficient, especially in the presence of intense anophelism. This fact, combined with the greasy nature of the standard preparations, made it very unpopular, so its use was difficult to enforce among troops.

Early in 1943, a vanishing cream containing pyrethrum was devised in the Middle East Force. This was a great improvement. At the same time teams of expert

workers both in the United Kingdom and America had been engaged in intensive research to find a better repellent. As a result of the trial of many hundreds of compounds, a very effective substance was found—*dimethyl phthalate* (now usually known as DMP). This substance is used alone in the British Army, but the American preparations are reinforced with two other good repellents—indalone and Rutger's 612. DMP was a standard issue to all troops in malarious areas during the last years of the war. It was very effective.

The lasting duration of an application of DMP is, however, only about two to three hours at most. This means that in those circumstances where troops cannot use mosquito nets, they would have to be awakened every few hours to reapply their repellent. This is not a practical proposition. It was found, however, that head veils made of wide-mesh (three-eighth inch) netting, when impregnated with DMP would retain their protective properties during the night hours. Arrangements were being made for a very extensive issue of these when peace was declared. They will presumably be used by our troops garrisoning malarious regions in the tropics in future.

(b) *Mechanical Protection against Mosquito Bites.*

(I) INDIVIDUAL PROTECTION.

Clothing.—The more the body is covered by clothing the less chance has a mosquito to bite. The shorts and short-sleeved shirts which were worn by troops in warm climates during the early stages of the war gave little protection against mosquito bites after dusk, especially when combined with the relatively poor qualities of the Citronella ointment. In theory the troops were supposed to change into tunics and trousers before dusk, but under many active-service conditions this was impossible or not carried out. After a prolonged campaign by the Medical Services, the latter type of uniform was accepted as the standard for active service conditions in most parts of the tropics, and shorts were forbidden except for games.

Unfortunately this was not a complete solution of the problem. Many of the types of fabric available for uniforms were of such a texture that some kinds of mosquito could bite through it, especially when tightly stretched. This could be greatly diminished by applications of DMP. Eventually a fabric of the poplin or gabardine type was evolved which, while light, gave a very high degree of protection. Large supplies of suitable material only began to be available shortly before the war ended.

Mosquito Nets.—As mosquitoes bite mostly at night, to sleep under a proper mosquito net is one of the greatest protections against malarial transmission. It was probably the most effective measure used in the first World War, and formed a very important individual issue to the soldier in the recent struggle. The peace-time type of net was, however, bulky, and often difficult to erect properly in the field, so its use was largely confined to bases and the lines of communication. The invention of a lighter, more portable and easily erected net—the "bush net"—was made in the Middle East in 1941. It extended the possible use of nets almost up to the front line, thus making a great advance in potential protection against mosquitoes.

Anti-mosquito Veils and Gloves.—Veils of mosquito netting and canvas gloves were an original issue to our troops, to protect them from mosquito bites when not covered by a net. The smallness of the mesh needed to ensure protection, made the veils so stuffy, and so diminished visual acuity, that they were seldom properly used. The gloves were also hot and difficult to work with. The provision of DMP-impregnated wide-mesh veils and gloves had none of these objections. In addition they afford much protection for personnel sleeping without nets. Arrangements were being made to supply such veils and gauntlets when the war stopped.

(II) COLLECTIVE PROTECTION.

In fixed camps and bases, the screening of quarters, hospitals, etc., was advocated. This measure was largely employed by the American troops, very many of whom were already "screen-conscious" before entering the army. Unfortunately it was never extensively used by the British forces, partly because of personal objections to being "shut in a meat safe," and partly because of shortage of appropriate materials.

II. REDUCTION IN THE NUMBERS OF MOSQUITOES.

The chances of being bitten by an infected insect can be greatly reduced either—(a) by avoiding, when possible, places where such insects are prevalent (environmental measures), or (b) by reducing the number of mosquitoes in the vicinity of one's enforced habitat (anti-mosquito measures).

(a) *Environmental Measures against Mosquito Bites.*

These consist in avoiding, where possible, such situations and times in which infected bites are likely to be received.

(i) *Avoidance of Malarious Situations.*—Napoleon said that "the choice of a healthy camp site is one of the first of all military considerations.". This is equally true to-day, and is especially true in regard to malaria.

In the selection of such sites, it is not only necessary to avoid the vicinity of mosquito-breeding places, but also the habitations of malarious persons from whom the mosquitoes can acquire infections.

In actual contact with the enemy, this may not always be possible. Nevertheless the selection of healthy sites, or those which can rapidly be made healthy by anti-mosquito measures, is one of the most important means of protection against malaria.

This method was widely used in the Syrian campaign and the occupation of 1941-43, with most excellent results.[9] As the troops advanced, detailed malarial surveys were rapidly made, and maps prepared showing the best positions for camp sites. These were widely issued within a few days to all commands, and

9. This policy received the active support of the Staff. As a result of this method, combined with a vigorous anti-mosquito campaign (and quinine suppression to a less extent), the malarial incidence was kept at a very low level. In spite of active warfare during the height of the summer malaria season, and the occupation of the country during the even more dangerous autumn months, the incidence was only about five per cent. On the other hand, for the period May to November, 1918, it was forty-three per cent. A similar policy was taken up in Iraq with fine results (vide Graph VII).

the routine orders were also that a medical officer (a malaria expert when possible) should be consulted in the selection of new camp sites, especially those for large camps or installations. This was possible because the distribution of malaria was patchy.

On the other hand in Burma and Assam, the physiography of the terrain and strategic reasons usually made this well nigh impossible. All the country was highly malarious, and more especially the camp sites necessitated by strategic reasons. However, as the result of many months of strenuous labour, many relatively healthy "harbours" were made by monumental works of drainage (hundreds of miles) and anti-mosquito measures.

In the highly malarious South-West Pacific zone, this was easier because the scattered and sparse nature of the local population reduced the number of *infected* insects in spite of the great anopheline prevalence. Unfortunately, when the troops themselves became infected in large numbers, they acted as their own reservoirs of infection until their infectivity was very greatly reduced by suppressive drug treatment (vide infra).

In the campaigns in Italy and Sicily, it was said that the enemy purposely attempted to use malaria as an ally. While occupying the more healthy and defensible hill areas, they attempted to confine our forces to the highly malarious plains and marshy areas. They hoped that, as in Macedonia in 1916-18, our troops would be rendered *hors de combat* by malaria, and so be easily defeated by their healthier troops.

(ii) *Avoidance of Malarious Times and Seasons.*—As the mosquito is mainly nocturnal in its habits, practically all infections are acquired after dusk. For this reason, the minimum number of troops possible should be kept in dangerous areas at night. The vicinity of villages, which usually harbour many infected mosquitoes, should therefore be avoided after dusk. When this is not possible, the very strictest measures of personal protection against bites should be used. The Australian Forces were very insistent on this, with good results.

Climatic conditions often make malarial transmission seasonal in character. Thus, during the colder season in the sub-tropics, there is little transmission, and, although old infections may relapse, few or no fresh ones are acquired. For this reason, few of the troops fighting near the highly malarious Anzio beachhead were at risk in the early months, but would have been if they had not been able to advance before the full malaria season began. Similarly some expeditions into areas of high malarial potentialities were carried out during the off-season in the Burma-Assam theatre with little malaria risk. Later excursions made during the malaria season proved how dangerous such regions could be, unless appropriate anti-malarial measures were strictly used.

(b) *Anti-Mosquito Measures.*

The chances of being bitten by an infective mosquito can also be reduced by causing a diminution in the number of dangerous mosquitoes, by attacks upon them in either the adult or the immature stages of their lives.

(1) ANTI-ADULT MEASURES.

During the 1914-18 War, the chief methods available against adult insects were swatting and fumigation. Neither of these was very effective in practice.

In the interval between the wars, great advances were made in mosquito control by the use of insecticidal spraying solutions. The most effective ingredient of these was pyrethrum. Very fine results were achieved by this method against mosquitoes which harbour in house during the daytime. It was, therefore, considered as one of the chief anti-mosquito measures when the present war started, being much more rapid in action than were anti-larval measures.

The entry of Japan into the war very greatly reduced the available supplies of pyrethrum, although much was grown in Kenya. It, therefore, became a matter of extreme urgency to augment and replace the available supplies. With this object in view, very extensive researches were undertaken in both America and many parts of the British Empire. Eventually it was discovered that a substance—dichloro-diphenyl-trichlorœthane (commonly called DDT)—had unique insecticidal properties. It was lethal in very small doses not only to adult mosquitoes but also to larvæ.

Although slower in its action than pyrethrum preparations, it was more deadly. It also possessed another very important additional property, in that surfaces spread with solutions retained their lethal character for long periods—in some circumstances even for months.

Unfortunately there are a number of dangerous species of anophelines which do not shelter in houses during the daytime, such as *A. minimus,* the most dangerous malaria vector of the South-East Asia region, and *A. punctulatus* of the South-West Pacific zone. Diurnal spraying, therefore, while very effective against species sheltering in houses, tents, etc., during the day (e.g., Mediterranean species), had little chance of destroying these insects which made only transient nocturnal visitations to get a blood meal. It is against this type of insect that the residual effect of DDT is so useful. When the interiors of such habitations have been residually sprayed, the chances are very great that at some visit the insects will acquire a lethal dose by alighting even briefly upon some treated surface.

This residual effect was also taken advantage of on a large scale for outdoor work. On the Burma-Assam front, not only were the outsides of habitations sprayed weekly, but the camp area and a ring of about fifty yards around its periphery was also treated. In this way insects which harboured outside habitations during the day, would pick up a lethal dose on their journeys to and from the camp to obtain blood meals.[10]

In addition, very many large-scale trials were made of spraying of DDT solutions from the air, when large areas had to be protected, which could not be sprayed properly nor quickly from the ground because of physical conditions or enemy

10. Spraying DDT both from the ground and the air is very popular with the troops, as it reduces not only the mosquito population, but also the fly pest, which is usually so very prominent in all tropical campaigns. There is also reason to suppose that it will have a very definite effect in reducing other insect-borne diseases, such as dengue and sandfly fever.

action. It was also a rapid method of reducing mosquito prevalence, although probably not so perfect as ground methods. The deposited spray acts on both adult and larval mosquitoes.

These brilliant results were only obtained after very much laborious and intensive research starting in 1942, and carried out by large numbers of scientific workers in many parts of the British Empire and in the U.S.A., both in the laboratory and in the field. Even yet the potentialities and limitations of this marvellous insecticide have not yet been fully explored. There is no doubt, however, that it has already proved of immense value in malaria control.

To implement the use of this insecticide under field conditions, large numbers of different types of apparatus have been evolved to suit different circumstances.[11] This has involved great intensive work, much of which has been carried out in the field by anti-malarial workers.

(2) ANTI-LARVAL MEASURES.

As the immature stages of mosquitoes can only live and develop in water, the measures against them are all concerned with this element—"No exposed water, no mosquitoes, no malaria."

The various methods used in an anti-larval campaign are summarised in Table II.

TABLE II.

METHODS FOR THE CONTROL OF MOSQUITO BREEDING.

1. Reduction in the amount of exposed water edge.
   (Drainage; filling; flooding, etc.).
2. Making water inaccessible to egg-laying.
   (Screening; sub-soil drainage, etc.)
3. Making water conditions unsuitable for the development of larvæ.
   (Shading; chemical changes, physical changes, nutritional, etc.).
4. Direct destruction of the immature stages of mosquitoes.
   (a) Mechanical (flushing; agitation; etc.).
   (b) Larvicides (oil; paris green; DDT, etc.).
   (c) Natural enemies (fish, insects, etc.).
5. Prevention of the formation of man-made and animal-made breeding places.

All these methods have been used alone or in various combinations in different theatres of war. It is not possible to deal in detail with all those used recently, but only to mention especially those which have played prominent parts in the various anti-malarial campaigns.

11. These include hand sprayers, power sprayers, etc. The use of this insecticide in a smoke cloud is also receiving much attention, and would appear to have distinct potentialities for localised and for widespread mosquito destruction in both war and peace.

(a) *Reduction of Exposed Water Edge.*

Such methods have been widely used, often on a very large scale, to turn unhealthy areas into relatively healthy ones. Very extensive drainage, filling, and canalization works were carried out in the Middle East with great benefit. Similar work was used in North Africa and Italy with good results, as was also the case in the South-West Pacific theatre.

The most extensive works of this nature were those done on the Burma-Assam Frontier. There all sites were very unhealthy, and enormous numbers of troops had to pass through the same bases and camps along hundreds of miles of lines of communication. At the main base at Manipur Road, Assam, about six hundred miles of drains were constructed, and further forward at Palel about two hundred miles, to mention the greatest examples.

Unfortunately much of this work had to be done by manual labour and was necessarily very slow as a result.[12] If mechanical excavators, etc., had been available, much valuable time and sickness would have been saved, but those with the force (and more) were all needed for other urgent military work, such as road-making. The American Army, however, used such mechanical aids with great success in the South-West Pacific area.

Such anti-larval methods are unfortunately slow in showing their effects, and must be supplemented by other more rapid methods of destruction of both adult and larval mosquitoes. They are, however, much more lasting in their effects, and so are more suitable for permanent installations and bases than for transient camps.

(b) *Making Water Inaccessible.*

Subsoil drainage is too complicated a method and too slow in producing effects to have a wide usage in war. In Palestine and Syria, the screening of wells was a beneficial measure.

(c) *Making Water Conditions Unsuitable.*

In some places in the tropics, pools and similar collections of water were filled with rank vegetation, which by rotting made them unsuitable for breeding dangerous species of mosquito. Animal manure was used successfully for this purpose in 1919 in the Afghan and Waziristan campaigns in India, but the introduction of mechanical transport has much reduced the applicability of this means.

(d) *Direct Destruction of the Immature Stages of Mosquitoes.*

(i) MECHANICAL DESTRUCTION.

Good results were obtained in some places by the destructive action of floods of impounded water, released periodically by sluice gates or automatic syphon devices.

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12. On the Burma front especially, the resultant large aggregations of undisciplined tropical labour, mainly non-immune or semi-immune, formed a most suitable nidus for epidemics of malaria. In keeping with past experience, some of these occurred with lamentable results in the early days. Now that large supplies of mepacrine are available, suppressive treatment should remove this menace in future.

These are more applicable in hilly areas. Among other places they were used in Syria, Burma, and the South-West Pacific.

The agitation of the water-edge by water transport along some of the canals in Egypt appeared to have an anti-larval action.

(ii) LARVICIDES.

The anti-mosquito effects of drainage, etc., take some weeks to become evident. This greatly reduces their usefulness for the large number of relatively temporary camps needed in a war of movement. They must be supplemented by some more rapid anti-larval measure, and here larvicides are used mainly. When the recent war began, the two principal larvicides employed were oil and paris green, but later the discovery of DDT was a great advance.

(1) *Oils.*—Oil was originally the most widely used larvicide and a very good one. It required, however, a considerable staff and relatively large amounts of apparatus to apply it, and was unsuitable for some conditions.[13] As oil has so many other uses in war, and many valuable oil fields in the East were later lost, the question of the conservation of this material became a serious one. Another practical point arose in the Burma campaign, where bulky supplies of oil had to be conveyed over hundreds of miles of road or flown to the front, when all available transport could have been used for other urgent military supplies. This problem was solved, when by the addition of DDT to the oil, the amounts needed became only about one-thirtieth of those previously required.

(2) *Paris Green.*—This is a copper-arsenic compound which is distributed, usually as a dust, on the surface of the water, where the anopheline larvæ ingest it. It is a very useful larvicide used from the ground. It is particularly adapted for spraying from aeroplanes. This method was extensively employed with success in Italy for the treatment of large breeding areas, usually swamps and other inaccessible localities.[14] A very valuable practical method of spraying a suspension of paris green in water was used widely in the Middle East theatre against the larvæ of *A. superpictus,* breeding in shallow pebbly streams.

(3) *DDT.*—Solutions of this insecticide in kerosene oil were found to produce satisfactory results in amounts which would have required thirty times as much unmixed oil. The larvicidal action of the solution was also more rapid. Apart from the saving of transport mentioned previously, this resulted in an enormous saving of labour, and a very great simplification of much of the apparatus needed to supply larvicides.

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13. The oils available came from very many different sources. They were found in practice to vary considerably in their suitability for anti-larval work. Valuable research work on this subject was carried out by many field workers, often with the helpful collaboration of commercial petroleum companies.

14. Large areas with scattered bomb-craters or flooded against tanks, were sometimes heavily mined. This made them too dangerous to treat from the ground, and here air-spraying was very useful.

This larvicide only became available in large amounts about the middle of 1944, but the results of its use were soon acclaimed in many theatres.[15]

(iii) NATURAL ENEMIES.

There are certain fish which are highly larvivorous. The chief one is an American fish—*Gambusia sp.* In a few areas this was used to supplement other methods of larval destruction.

(e) *Prevention of Man-made or Animal-made Breeding Places.*

The activities of an army in a potentially malarious area are always followed by the formation of new collections of water suitable for the breeding of mosquitoes, and so for an increase of malaria.

The making of roads tends to block natural drainage channels, causing swamps and pools. Mechanical transport, apart from breaching irrigation channels, etc., makes ruts in which water collects.[16] Fresh excavations in which water lies are made for various utilitarian purposes (borrow pits, wells, etc.), or are dug for defensive reasons (trenches, dug-outs, etc.), or are produced by enemy action (bomb craters). The results of these human activities often cause great rises in the malaria potential of a locality. The strictest means are needed to stop them, and control their results.

The breaching of canals and the destruction of drainage works, especially in Italy by the Germans, caused a great rise in mosquito production. While much of this was probably intended primarily to hinder the progress of tanks or similar weapons, there is considerable reason to suspect that it was also intended to enlist malaria as an ally.

B. Anti-Malarial Measures Directed Against the Parasite.

Theoretically one should attack the parasite in both the insect and the human host to prevent malaria.

I. ATTACK UPON INFECTIONS IN THE INSECT HOST.

Conditions of temperature will influence adversely the development of the parasite in the mosquito, and low humidity may cut the insect's life span so short that the parasite cannot develop up to the infective stage before its host dies. Apart from these natural factors, no practical means are known to kill the infection in the host apart from its death. These natural events determine the occurrence and duration of the malarial transmission season, and, as has been mentioned above, this has been taken advantage of where possible.

15. While it must be acknowledged that DDT is a most marvellous insecticide, it is still too early to laud it as the panacea for all malarial ills. Much research has still to be done to determine the best, the safest, the most economical, and the most practicable methods of using it. Often untoward results, which would be of comparatively negligible importance in war, would be otherwise in peace-time conditions. DDT kills almost all species of insect with which it comes in contact. How this will eventually affect the balance of nature in localities where it is used, has still to be determined. It is quite probable that its indiscriminate use may have harmful effects upon such useful insects as bees or other pollinators of plants, as well as upon insects useful as destroyers of agricultural and horticultural pests.

16. The latter was a serious problem in the South-West Pacific theatre, as such ruts formed ideal breeding-places for the dangerous local vector, *A. punctulatus.*

II. Attack upon Infections in the Human Host.

(a) *Measures Relating to the Susceptible Human Host.*

It is well known that different races, and even different individuals, vary considerably in the intensities of their reactions to malarial infections. This is apart from the grades of severity conditioned by the effects of different species of *Plasmodium*.

Many aboriginal races, such as Africans, have developed a considerable degree of natural tolerance to malarial infections through long ages of consociation with the parasite. When this has been reinforced, as it usually is, by an increased tolerance acquired as the result of continued multiple infections in early life, the degree of immunity, to local strains of parasite at least, may be very high (Sinton, 1939).

This was one of the reasons for the employment of African troops in the highly malarious tracts of South-East Asia. This decision was amply justified, for the malarial morbidity among such troops was relatively small as compared with that among the non-immune Europeans, or even the semi-immune Indians. The Europeans, who had never had any chance of developing either racial or acquired tolerance, suffered severely.

The employment of such more tolerant troops has an important place in military medicine.

(b) *Direct Attack upon the Parasites in the Human Host.*

The chemo-therapeutic attack upon malarial parasites in the human host falls into two main groups—

(i) Methods to reduce the infectivity of the human host to mosquitoes by destruction or devitalisation of the sexual parasites, and

(ii) Methods of attack upon the parasites capable of causing clinical manifestations (i.e., the asexual parasites).

(i) Reduction in the Infectivity of the Human Host.

To be infective to the mosquito, the human host must carry gametocytes (sexual parasites) in his peripheral blood. There is a drug—pamaquin (plasmoquine)—which will destroy these potentially dangerous forms, even when taken in small doses. As the main human reservoirs of infection in war are usually the uncontrollable local population, the drug could not be widely used for this purpose. Its use was mainly confined to special circumstances, or it was taken as an adjuvant to other anti-plasmodial therapy to reduce the infectivity of patients suffering from severe attacks of the disease.

The routine use of mepacrine suppressive treatment (vide infra), by keeping at a very low level the number of asexual parasites from which the gametocytes are derived, had a most beneficial indirect effect in lowering infectivity. This was especially the case in the South-West Pacific theatre, where the infected native population was scanty locally, and where the main reservoir of infection grew eventually to be the troops themselves at one time. The rigid enforcement of mepacrine suppression had a great effect in reducing the infectivity of these troops.

This is one of the reasons why such therapy should always be a routine in highly malarious regions where anophelines are abundant and uncontrolled.

(ii) Methods of Attack on the Disease-Producing Parasites.

These may be roughly divided into three groups (Sinton, 1945)—

(1) The prevention of the acquisition of infection (True Causal Prophylaxis).

(2) Methods aiming at a rapid clinical cure[17] of malarial attacks and, if possible, at the same time a rapid radical one[17] (Curative Therapy), and

(3) Methods aiming at the prevention or suppression of clinical manifestations in individuals already infected (Suppressive Therapy).

(1) *True Casual Prophylaxis.*

Until quite recently no drug was known that in therapeutic doses was capable of killing the form of parasite injected by the mosquito (sporozoites) before they could initiate infection in the human host. The researches of the Australian team at Cairns have produced strong evidence that the new British drug, Paludrine, may have such an action against certain species of *Plasmodium*. If this be confirmed, it is an epoch-making discovery which should have far-reaching results upon the prevention of malaria, both in peace and war.

(2) *Curative Methods.*

The two main drugs used for this purpose in the recent war were quinine and mepacrine (atebrin; quinacrine).

Quinine has a rapid action in cutting short acute clinical attacks. Given alone, it is probably less certain in producing radical cures in certain infections, and is much more unpleasant to take than mepacrine. Intravenous injections are, however, still the standby in the treatment of pernicious attacks, and have saved large numbers of lives during the war.

In 1939, quinine was the most widely used drug for malaria therapy. It had been the chief therapeutic agent in malaria for over a century. Physicians were familiar with its use, and supplies were available to the Allies. On the other hand, our knowledge of the advantages and limitations of the synthetic drug, mepacrine, was still very incomplete, and the bulk of the supply was held by the enemy.

When, however, the Japanese invaded Java, they captured most of the quinine supplies of the world. As a result, the Allies had to find a substitute. Consequently the manufacture of mepacrine was started on an enormous scale in both Great Britain and the U.S.A. This was a blessing in disguise, for the very great experience of the properties of this drug gained in the laboratory, in hospitals, and in the field during the past five years, has shown that for most military purposes mepacrine is much superior to quinine.

In the original daily dosage used (0.3 grm.), mepacrine was slower in its action on clinical manifestations than was quinine. For this reason the original Army standard treatment recommended quinine as the drug of choice during the first

17. A "clinical cure" is merely the abolition of the clinical manifestations of which the patient complains at the time. Unless, however, the infection is eradicated at the same time ("radical cure"), these symptoms may recur at a later date (Sinton, 1945).

few days and then mepacrine to complete the course.[18] When later the dosage of mepacrine was raised to 0.6 or even 1.0 grm. daily, for the first three days, its action was speeded up, and now many physicians use mepacrine only as a clinically curative agent and often as a radical one.

The standard treatment of malaria has so improved that the Australians in the South-West Pacific theatre report that the case-mortality in uncomplicated cases was only 1 in 3,000 during 1943-44 (Fairley, 1945). This is about one-fifteenth of that recorded in Macedonia during 1916-18.

In the case of radical cures, standard treatments with quinine and mepacrine lasting seven to ten days are effective against the great majority of malignant tertian infections. Mepacrine is also probably more certain in its effects against this infection and is certainly more pleasant to take.

In benign tertian infections, however, while numbers of cases are radically cured by such routine treatment, a large proportion (as high as fifty per cent. is reported) may relapse at a later date.[19] When in the field *so long as* suppressive mepacrine treatment is taken *properly*, these latent infections seldom or never become evident, as they are more easily held in check than are malignant tertian ones.

As occurred after the 1914-18 War, such relapsing benign tertian infections have given rise to a serious problem among troops returning to the United Kingdom, the U.S.A., and Australia, where suppressive therapy cannot be continued as a routine when such large numbers of troops are involved, both infected and non-infected. It loomed up as a post-war problem.[19] The clinical attacks are not dangerous and are easily cured, but radical cure is produced in a relatively small number of cases by any one course of standard treatment. It has been found, however, that the combined quinine-pamaquin treatment elaborated in India many years ago (Sinton *et al.*, 1928-1930), will cure radically a very high percentage of such chronic benign tertian infections. This should be a great help in this post-war problem.

(3) *Suppressive Treatment.*

Suppressive treatment with either quinine or mepacrine does *not* prevent men acquiring malarial infection—it is not a true causal prophylactic, as was once thought. It acts by keeping the number of parasites in the body at such a low level that clinical manifestations are suppressed. In this way men are kept in a condition fit to perform their duties *in spite of being infected.* It is used in war to conserve man-power and efficiency, under conditions in which it would be impracticable to prevent by other means a high malarial morbidity rate.

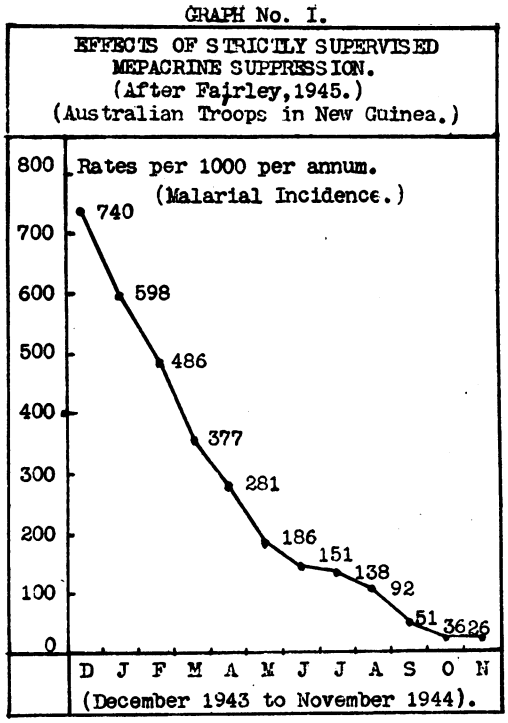
The main beneficial effects of such treatment are—

(a) It diminishes morbidity and so conserves man-power and efficiency, both physical and mental;

18. This method is still considered that of choice by many doctors as compared with mepacrine alone.

19. For almost a decade after the cessation of hostilities in the First World War, many governments continued to pay pensions to ex-soldiers for ailments claimed to be "chronic malaria." It is now known that benign tertian infections rarely, if ever, last more than three years, and malignant tertian ones more than one year. They tend to die out naturally regardless of therapy.

GRAPH No. I.



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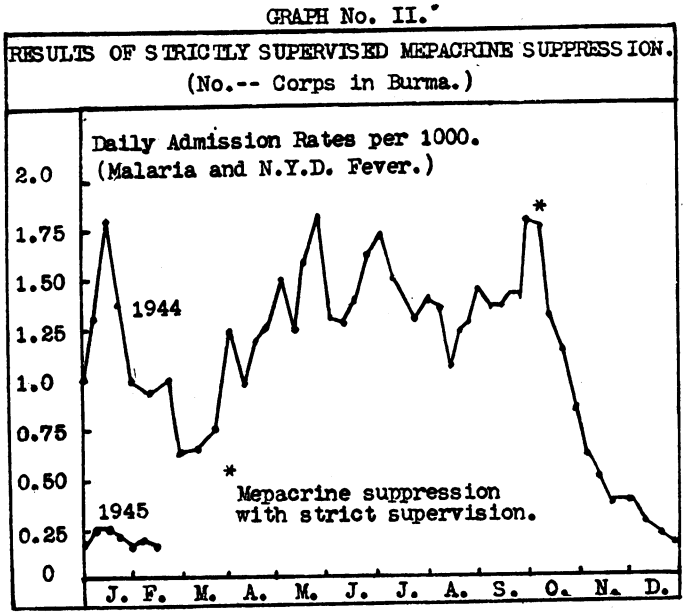

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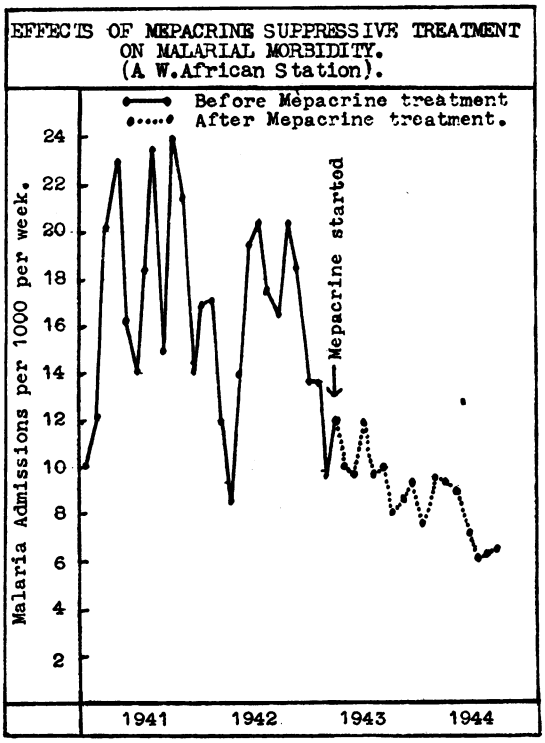

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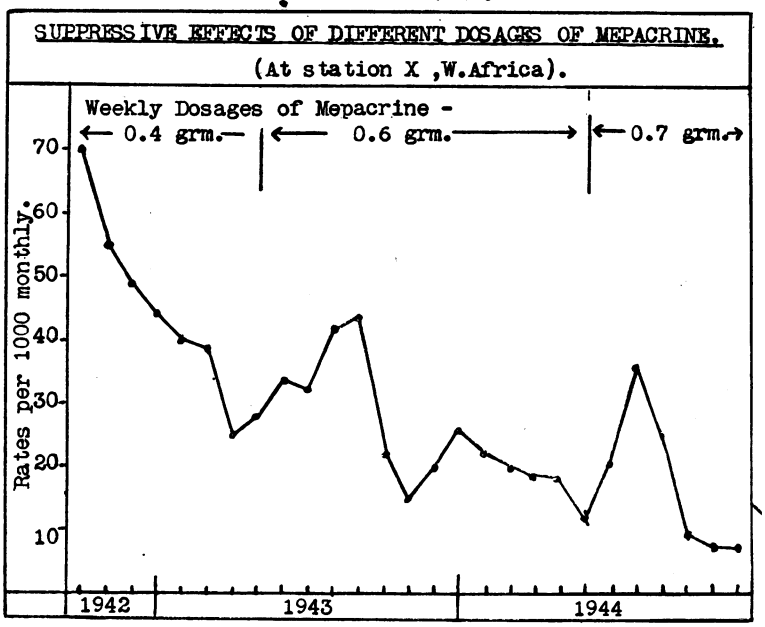


(b) It reduces the severity of clinical attacks, and so the mortality rate;

(c) It diminishes indirectly the number of sexual parasites in the peripheral blood and the prevalence of gametocyte carriers, so reducing the spread of infection;

(d) It diminishes the tendency to blackwater fever;

(e) It assists in the development of tolerance to infection, and

(f) If continued long enough, it will cure radically many infections, more especially malignant tertian ones.

The two drugs used for this purpose were quinine and mepacrine.

Quinine has long been employed as a "prophylactic" in many countries. Its beneficial effects are most evident in immune and semi-immune populations, or in the presence of relatively low malarial transmission, especially of benign tertian malaria. When, however, our non-immune European troops were exposed to severe malarial conditions on field service, it failed to prevent a high morbidity rate when given in a dosage which was practicable for continuous usage. In addition, its bitter taste and other unpleasant effects made it unpopular, so it was avoided by the troops when possible.

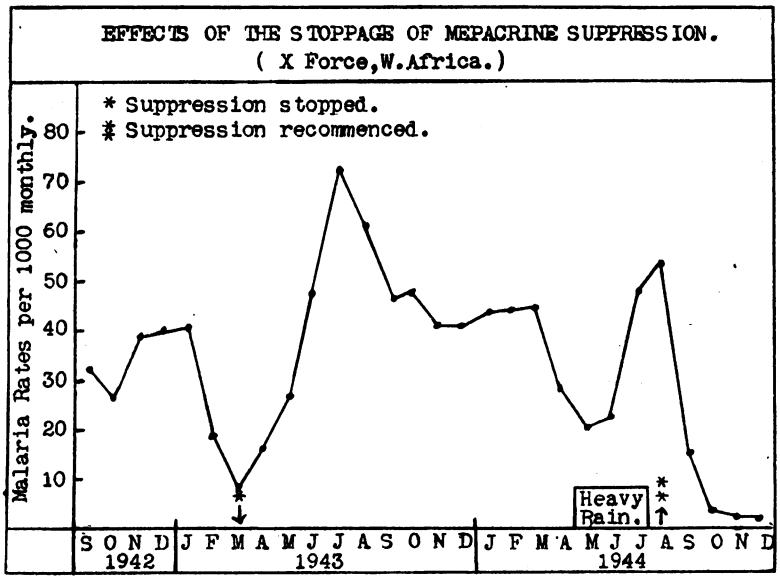
A large series of trials of suppressive mepacrine sponsored by the Malaria Commission of the League of Nations about 1935, showed that a dosage of 0.2 grm. of mepacrine given twice weekly was as good, if not better, than five to six grains of quinine daily, and was more agreeable to take.

The experience gathered in the Second World War has shown that this dosage is insufficient for a non-immune population in the presence of severe infection. The daily dosage was finally increased up to 0.1 grm. daily (a total of 0.7 grm. weekly), with a great improvement in morbidity (Graph IV). This dosage *when strictly enforced* achieved remarkable results.[20] Thus among the Australian Forces in New Guinea, an average malarial incidence of 740 per 1,000 per annum in December, 1943, had fallen to 26 a year later (Fairley, 1945; Covell, 1945) (Graph I). In one Corps in Burma, the average daily rate per 1,000 fell in two months from about 1.75 to 0.2 (Graph II). Similar results were reported from West Africa (Graph III). The rises of malarial morbidity which follow upon the stoppage of suppression are shown in Graphs V and VI.

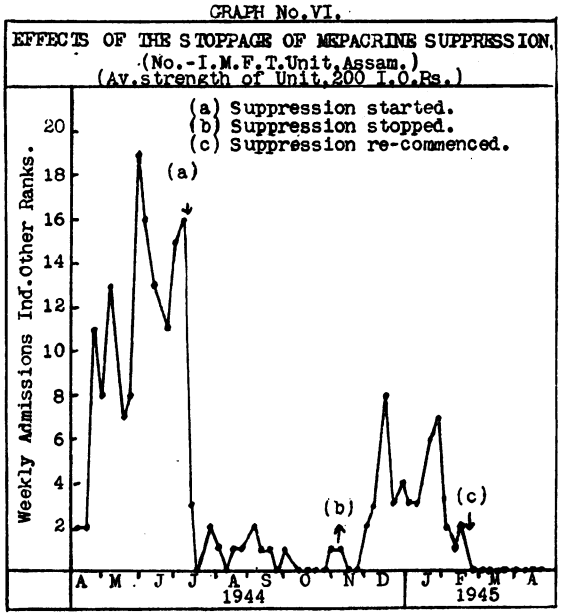
Mepacrine has also another great advantage in that when such suppression is continued for about one month after leaving a malarious area, it produces a radical cure of practically all malignant tertian infections. It is extremely rare for a relapse to occur. It is, however, otherwise with benign tertian malaria, relapses from

20. While malariologists were convinced of the invaluable effects of such suppression, it was very difficult to convince the combatant officer and some medical officers that the reported failures were due to failure to take the drug in the dosage ordered. It was suggested that such apparent failures were due to a variety of factors only encountered in the field—fatigue, cold, mental strain, low diet, etc. It was the brilliantly planned and executed investigations carried out by the Australian L.H.Q. Medical Research Unit, directed by Brigadier N. Hamilton Fairley, A.A.M.C., at Cairns, which were conducted on human volunteers, that dealt with all these points practically, and proved conclusively that 0.1 grm. mepacrine taken daily without fail would absolutely suppress the clinical manifestations of malarial infection. (Full details are given by Fairley, 1945.)

GRAPH No. V.



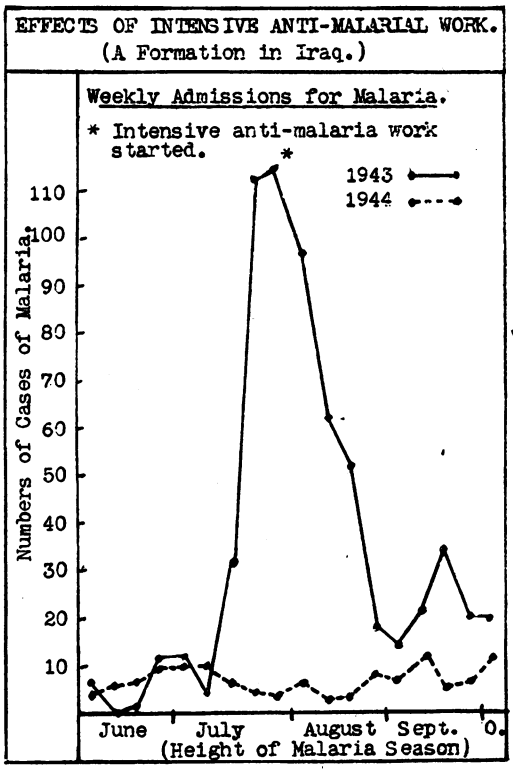
GRAPH No.VI.



which may have serious repercussions on man-power at a later date after suppression has ceased (vide supra).

These brilliant results can only be produced by very rigid discipline in the enforcement of suppressive treatment to *all* men on *all* days.[20] Slackness in the daily

GRAPH No. VII.



indigestion of the proper dosage of the drug is followed by a rise in malarial morbidity.

Some of the main advantages of mepacrine suppression over quinine for troops are :—

(a) It does not interfere with their mental and physical activities;

(b) Its protection lasts longer because of its slower excretion;

(c) Relatively larger therapeutic doses are easily tolerated;

(d) Prolonged ingestion (years) has caused relatively few undesirable effects. (The man-power lost to the army through such idiosyncrasies was infinitesmal as compared with the man-power conserved), and

(e) If continued for a month after leaving a malarious area, practically all malignant (and probably many benign) tertian infections are radically cured.

It has, however, the disadvantage that it *dyes* the skin yellow, but this is neither a toxic effect nor a jaundice.[21]

With the proper enforcement of suppressive mepacrine a force can maintain itself for many months in the field with a relatively low malarial incidence. This is possible under conditions where, without it, the disease would put the force out of action within a few weeks.

The use of suppression must *never* be considered to justify any relaxation in the enforcement of measures of personal protection against mosquito bites and so against malarial infection. Any negligence of these measures will be shown at a later date by benign tertian relapses, which may have serious repercussions on man-power.

For all schemes for malaria control in war, one must adopt the axiom of Cromwell—"Neglect no means."

ANTI-MALARIAL ORGANISATION AND RESEACH.

The fine results which were achieved in many theatres were gained by no primrose path, but, as always in malaria control, by "blood and toil, sweat and tears."

The Army formed a special Malaria Branch of its Hygiene Department in 1939. Too much credit cannot be given to the field units of the British Forces who conceived and carried out the various control schemes in different regions.

The Malaria Field Laboratories were staffed by experts from all parts of the Empire. They were a new type of unit, solely concerned with the prevention of malaria and *not* with clinical treatment. They surveyed, evaluated, and advised upon the special malaria problems of their areas. In addition, they carried out very much most valuable research and teaching work. The schemes drawn up by these experts were executed by energetic Anti-Malarial Units—another new kind of unit, under the supervision of the officers of the Malaria Field Laboratories and officers of the Hygiene Department.

Both these types of anti-malarial units did not confine their activities merely to the bases and lines of communication. Many sections were found working immediately behind the front lines within range of shell-fire and doing duties of inestimable value.

In addition to the field workers, from the early stages of war, numerous expert teams of "back-room boys," mainly civilian, were engaged in researches directed to find new methods for defeating the mosquito and the malaria parasite. These were not only medical men, but enthusiastic scientists of all kinds—entomologists, chemists, physicists, physiologists, engineers, etc. Never in history has so much talent been concentrated upon the control of a single disease. The thanks of the Army and the Empire is due to these too-often forgotten workers.

Those discoveries which appeared promising in the laboratory were immediately tried out in the field by units of the Malaria Organisation or by special teams of

21. The two new anti-malarial drugs (Paludrine, the British one, and SN 7618, the American one) have not this disadvantage. Preliminary reports suggest that these drugs may be even more effective than mepacrine. This, however, requires further confirmation in the field and over a much longer period of time and experience.

experts. In this way their importance and practicability under field-service conditions were evaluated. The field units, by reporting the practical difficulties or shortcomings of the methods under test, were able to guide the experimental workers in remedying the defects.

BENEFITS ARISING FROM MALARIA IN WAR.

That great physician Osler has said that "If a census were taken among the world's workers on disease, the judgment to be based on the damage to health and direct mortality, the votes would be given to malaria as the greatest single destroyer of the human race." Apart from the destruction of life and health, the national, social, and economic losses caused by this disease are unbelievable (Sinton, 1935, 1936).

While the recent war has caused lamentable effects in many countries, there is no doubt that the brilliant advances in malaria control resulting from war conditions, will do much to benefit millions of people and enormous tracts of the globe in the future.[22]

The recent war has resulted in such a drive into methods for controlling this disease as has never been seen before. The basic researches carried out in the United Kingdom, in the U.S.A., in Australia, in India and other parts of the British Empire, have resulted in what will probably prove to be epoch-making discoveries. From the humanitarian standpoint, these should have far-reaching effects in diminishing the morbidity and mortality from malaria. From the economic aspect, they may make possible to an undreamed-of extent the exploitation of the great natural resources of the tropics for the benefit of all mankind.

Some of the outstanding benefits are:—

(a) A tremendous stimulus to all aspects of malaria prevention and control;

(b) The discovery of new anti-malarial drugs of great promise;

(c) A great expansion of our knowledge of the basic principles of the mode of action of anti-malarial drugs, both new and old, and their limitations;

(d) The discovery of marvellous new insecticides;

(e) Better methods for the practical application of both new and old methods of malaria control.

From this it can be seen that out of the evils of war many good things may spring.

22. In many places the anti-malarial measures carried out by the troops had an immediate effect in improving the health of the local population.

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REVIEW

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Penicillin in Subacute Bacterial Endocarditis

By B. T. SMYTH, M.B., AND R. J. L. WILSON, M.B.
Penicillin Officers to the Royal Victoria Hospital

Foreword by Penicillin Trials Committee (Belfast Centre)

IN the autumn of 1944 a small committee was formed in Belfast to investigate the clinical applications of penicillin, and for various research projects special supplies of penicillin were received from the Medical Research Council of Great Britain. In February, 1945, the committee agreed to accept responsibility in Northern Ireland for a thorough clinical trial of penicillin in subacute bacterial endocarditis. This trial was organised by the Medical Research Council on a nation-wide basis, and University centres in England, Scotland, and Wales also took part. In each of several groups of such centres a different daily dosage was allotted and, in the case of Belfast, this dose was fixed at 250,000 units. Relatively large quantities of penicillin were therefore required and used, and it was necessary to insist on adequate bacteriological confirmation of diagnosis, and on a careful and prolonged clinical and laboratory control of the progress of the disease during and after treatment. The preliminary results from all centres were recently reviewed by Christie (1946).

The Belfast Committee is greatly indebted to successive Penicillin Officers attached to the Royal Victoria Hospital, Drs. L. Leitch, R. J. L. Wilson and B. T. Smyth, for their interest in the special investigation and treatment of these cases in that hospital. The report below has been prepared for the Committee by Dr. Wilson and Dr. Smyth, and is of such general interest that its publication is most desirable.

It has long been recognised that subacute bacterial endocarditis is probably almost invariably fatal, usually within one year of onset. With the advent of sulphonamides hopes were raised that a cure might have been found, but clinical investigations over an extended period have shown that such hopes were unfounded and the progress of the condition could not be arrested. When penicillin became available, hopes were again raised, but early reports were most conflicting, and the need for adequate dosage was not at first appreciated. With more adequate supplies of penicillin, especially those granted to the M.R.C. for the purpose, it has become possible to study its efficiency in some detail.

Fifteen patients suffering from subacute bacterial endocarditis have been treated in the Royal Victoria Hospital, Belfast, during the past fourteen months. Before treatment was begun, in each case the clinical findings were confirmed by recovery of the organism from the blood stream. Treatment was given to every patient from whom a penicillin-sensitive organism was isolated irrespective of the degree of decompensation and mechanical inefficiency.

Clinical Manifestations.

The occurrence of typical signs and symptoms of the disease was as follows:

Pyrexia (100°F. or over)	15	Clubbing of fingers	6
Rheumatic History (rheumatic fever, joint pains, scarlet fever, or chorea)	10	Loss of weight	5
		Heart failure	5
		(Œdema of ankles, 4 cases; enlarged liver, 1 case; basal lung crepitations, none).	
Malaise	9		
Anæmia	9		
Dyspnœa (breathless when walking on the level)	8	Microscopic red cells in urine ...	4
		Major emboli (lung, brain, spleen, etc.)	7
Petechiæ or Osler's nodes ...	7		
Sweating	6	Splenic enlargement	7

The probable duration of the infective condition before treatment, as far as could be ascertained from the history of the case, varied from two to twenty-six weeks.

No. of Cases.	Duration of Infection in Weeks.
4	5
5	6—10
3	11—15
3	16 or over

Special Investigations.

In each of the fifteen cases the initiation of treatment depended on the isolation on at least two occasions of penicillin-sensitive organisms having similar morphological and cultural characteristics.

Blood Culture.—When this investigation was suggested by the clinician, a sample of the patient's peripheral venous blood was withdrawn with aseptic precautions by means of an all-glass syringe sterilised in a hot-air oven. Two bottles, containing 50 cc. Douglas and Hartley broth respectively, were each inoculated with 2 cc. of the patient's blood and incubated at 37°C. Subcultures were made on blood agar at intervals over a period of two weeks, and no culture was regarded as sterile until this period had elapsed. Routine blood cultures taken during and after treatment were examined in a similar way.

In the series under review no difficulty was experienced in obtaining positive cultures from any patient. The majority of these cultures gave a growth in forty-eight hours, while incubation for ninety-six hours was sufficient for the remainder. However, this is probably not a universal finding. In a case recently diagnosed, but not included in this series, blood was taken for culture on six occasions before a positive result was obtained. In another case, also not included, only two out of six cultures were positive, and these yielded a growth of hæmophilus influenzæ. This organism was not sensitive to penicillin. No treatment was given, and the same organism was later isolated from the valvular lesions at post-mortem.

Infecting Organism.—This was a streptococcus of the viridans group with one exception in which a diptheroid of the C. hofmanni type was repeatedly isolated.

The sensitivity of the recovered organism to penicillin was measured by the method of serial dilutions using the Oxford staphylococcus as a standard. The organisms isolated had a range of resistance from one quarter to twice that of the standard staphylococcus.

Erythrocyte Sedimentation Rate.—This was determined in Westergren tubes and the values were not corrected for anæmia. When the patient came under treatment it was invariably raised, showing a range of 25 mm. to 145 mm. in the first hour, but during and subsequent to treatment there was a progressive return towards normal limits (8-10 mm. in one hour). In three cases the E.S.R. was normal within forty days of initiation of treatment. In five cases it became normal between the fortieth and eightieth day, in two cases between the eightieth and one-hundredth day, and in four cases between the hundredth and one hundred and seventeenth day.

Hæmoglobin and Red Cell Counts.—Nine of the fifteen cases showed marked anæmia. The lowest value encountered was 30 per cent. Hb. (Sahli); the highest value being 62 per cent. (Sahli). The hæmoglobin values averaged 50 per cent., and the red cell corpuscles averaged 3½ millions per cubic mm. These figures showed a progressive improvement in the absence of any treatment other than the control of infection.

System of Dosage.

The first three cases in the series received twenty days treatment at the rate of 250,000 units penicillin daily, giving a total of five million units. These courses were given by intramuscular drip. Following a recommendation from the M.R.C., the duration of treatment was increased to twenty-eight days, and two patients were subsequently treated by means of intramuscular drips for this period. Two subsequent patients had initial treatment by this method, but at their own request this was changed to intermittent intramuscular injections. Injections of 31,250 units in 2 cc. sterile saline were given at three-hourly intervals. The remainder of the patients received the entire course of treatment by three-hourly injections. Sterile abscesses at the needle site developed in two patients treated by the intramuscular drip method. No allergic reactions to penicillin were encountered. Heparin was not used as an adjuvant to penicillin in the series under review.

Hudson *et al.* (1946) have shown that serum penicillin levels are maintained at a constantly higher level by injections, compared with the levels obtained by means of continuous intramuscular drip when a similar daily dosage is employed. They suggest that peak concentrations following injections may be of value in assisting penetration of penicillin into less vascular tissues.

Clinical Response during Therapy.

Subjectively the patients usually reported an improvement in general well-being and increased appetite in the first week and often within the first few days. In all patients, bacteriological examination showed that the blood stream became sterile within a few days of commencement of treatment. In seven cases sterility was attained within forty-eight hours, in three within three days, whilst in three others the blood cultures were not taken until the sixth, eighth, and ninth days,

and were then found to be sterile. In no case did organisms appear in the blood stream during the period of hospitalisation.

Once the blood stream had been rendered sterile the temperature generally fell to within normal limits, with the exception of a few cases in which the temperature did not fall to a consistent basal level until therapy had been discontinued. In seven cases urinary infection with penicillin-resistant organisms (B. Coli and enterococci) was associated with low-grade pyrexia during some period of treatment. Specific therapy was intentionally withheld until penicillin treatment had been completed. Eradication of the urinary infection resulted in the temperature falling to normal.

In five other cases, in spite of obvious clinical improvement, the temperature did not reach a basal level until penicillin therapy had been discontinued. A similar persistence of pyrexia followed by a rapid fall to normal after cessation of penicillin therapy has been described by Hudson *et al.* (1946). This may have been due to the presence of pyrogens in the penicillin solution.

The incidence of embolic phenomena during and after treatment was low. Skin petechiæ or Osler's nodes occurred in four patients. The presence of red blood cells in the urine in five cases suggested some development of embolic lesions in the kidney. These signs occurred either during treatment or within two weeks of its conclusion. They were considered to be of little prognostic significance at this stage, and probably did not indicate persisting infection. One patient developed signs of cerebral embolism on the third day of treatment, and another who had auricular fibrillation developed a pulmonary embolus on the thirtieth day.

Another case in which an aneurysm of the abdominal aorta developed was of special interest and is described below.

Case 11.

A girl aged 19 years was admitted on 29th November, 1945, as a case of pyrexia of unknown origin. She complained of severe pain of seven days duration in the left upper abdomen. The pain radiated through to her back and she had intermittent vomiting. She had had acute rheumatic fever (her first attack) six weeks prior to admission. Other previous illnesses included scarlet fever and diphtheria in childhood. The patient was a poorly nourished girl with marked pallor of the skin and conjunctivæ. No petechiæ or Osler's nodes were present. There was marked tenderness in the left hypochondrium, but the spleen was not palpable. The liver and kidneys were not enlarged. Pulse 112. Temperature 102°F. B.P. 70/40. No cardiac enlargement was detected. There was a mitral presystolic murmur and also a mitral systolic murmur conducted into the axilla. No thrill was present. There was no evidence of heart failure and no dyspnœa on exertion. X-ray of chest showed no abnormality. Erythrocyte sedimentation rate was 25 mm. in one hour. White corpuscle count was 6,400 per cubic mm. Blood cultures gave a growth of streptococcus viridans on three occasions.

Penicillin therapy was commenced on 10th December, 1945. Dosage was 250,000 units per day given by three-hourly intramuscular injections for twenty-eight days (total seven million units). Six days after treatment was instituted petechial

hæmorrhages were noted for the first time in the skin of face, chest, and abdomen. Intermittent attacks of abdominal pain and vomiting continued to be frequent, and often necessitated the administration of morphine.

On the eleventh day of treatment abdominal examination revealed the presence of a rounded swelling in the left umbilical region. This swelling pulsated and was definitely expansile. Several days later this tumour had increased in size, and was diagnosed as an aneurysm arising from the abdominal aorta just above its bifurcation. It was thought that this aneurysm had resulted from the lodgment of a portion of infected vegetation in one of the vasa vasorum. During the following fourteen days the aneurysm continued to increase in size, attaining a diameter of about 7 cm. Subsequently the aneurysm showed no further development, and attacks of abdominal pain became less frequent.

The patient's general condition steadily improved, and just before her discharge from hospital in March, 1946, the aneurysm had become half its former size. Once treatment had been begun her temperature became normal by the third day, and continued so throughout her stay in hospital. As it was recognised that the presence of the aneurysm constituted a nidus in which organisms might persist in laminated blood clot, a subsequent course of penicillin (200,000 units daily for twenty-one days) was started twenty-three days after the completion of the regular course, with the intention of sterilizing such a focus. This additional course made the total dosage 11.2 million units. No relapse has occurred within twenty weeks since therapy was initiated.

Assessment of Results.

In this series of fifteen patients, four died. Their survival periods from the end of treatment were eleven, twelve, thirteen and twenty-four weeks. Summaries of their case histories are given later.

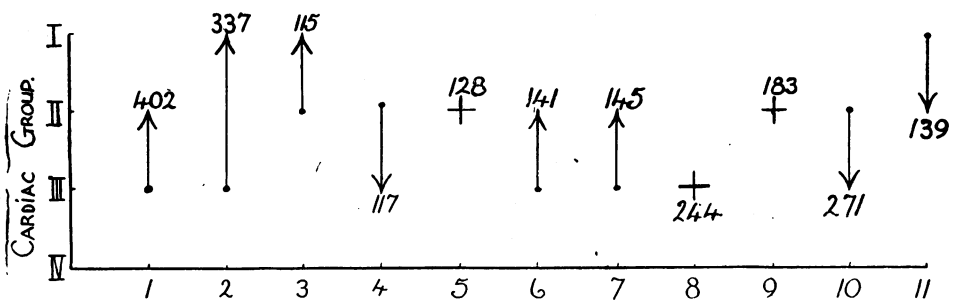
In order to assess progress the remaining cases have been graded into four groups before and after treatment. The grading was based, as suggested by Lewis (1944), on an estimate of cardiac reserve. These groups are as follows :

Group 1. Breathlessness on walking quickly or uphill.

Group 2. Breathlessness on walking on level ground.

Group 3. Breathlessness on walking slowly for a short distance.

Group 4. Breathlessness at rest.



Arrows indicate the new grading of the patients when reviewed.
Cases marked (+) showed no change in cardiac condition.
The period in days from commencement of treatment to review is indicated in each case.

Five patients at the time of review showed an improvement in cardiac reserve. Three cases showed no change. Three cases showed a slight decrease in cardiac reserve. In cases 9 and 10 little further improvement can be expected, in view of the long interval since the beginning of treatment.

Below are case summaries of those patients who died.

CASE 12.

A female aged 21 years was admitted on 16/1/45. She gave a history of rheumatic fever as a child. The probable duration of infection was fourteen weeks. When admitted she had paralysis of right arm and leg and inability to speak. Clinical examination revealed pyrexia, mitral stenosis, and evidence of a left cerebral embolus. There was no heart failure, auricular fibrillation, or enlargement of the spleen. There were no petechiæ, Osler's nodes, or red cells in the urine. Dental caries was marked. Blood culture gave a growth of str. viridans on six occasions before treatment was begun.

Pulse 100 per min. Temperature 100°F. B.P. 98/56. Hæmoglobin 40 per cent. Erythrocyte sedimentation rate 110 mm. in one hour. Red corpuscles 2,600,000 per c.mm. White corpuscles 15,000 per c.mm.

Penicillin treatment was begun on 26/2/45, at the rate of 250,000 units per day for twenty days, given by intramuscular drip (total five million units). Next day the temperature had fallen to 98.4°F, the pulse was 92 per minute, and blood culture was sterile. The immediate clinical response was good. Blood cultures remained sterile until the patient was discharged from hospital on 4/6/45.

On 30/7/45, when patient attended for a routine observation, she was found to have a petechial rash, painful areas in the pulps of her fingers, and some pyrexia. Blood cultures gave a growth of str. viridans similar to that of the primary infection. On 4/8/45 (nineteen weeks after the conclusion of her penicillin course) patient was re-admitted to hospital with pyrexia and rigors.

8/8/45.—Intramuscular penicillin drip was begun at the rate of 200,000 units per day.

17/8/45.—Patient complained of considerable pain in both thighs where the drip needle had been inserted. Three-hourly injections of 31,250 units penicillin were substituted for the intramuscular drip. Red cells in the urine suggested renal emboli. The urine was grossly infected with coliform bacilli, and her general condition was little altered since admission.

19/8/45.—Patient insisted on going home, contrary to advice. Penicillin given in second course of eleven days was 2.75 million units. Total penicillin given was 7.75 million units.

Patient died in her own home thirteen weeks later (thirty-four weeks after the conclusion of the first course of penicillin, or eleven weeks after conclusion of the second course), with signs of active cardiac infection. No post-mortem examination was obtained.

It is quite possible that the infection might have been controlled had this patient remained in hospital to finish her second course of penicillin. The organism showed no significant change in co-efficient of resistance when isolated after re-admission,

and it had a similar morphology. This was probably a case of relapse of infection following inadequate therapy.

CASE 13.

A poorly nourished male patient aged 36 years was admitted on 13/9/45, complaining of breathlessness on exertion, swelling of the ankles, weakness, and excessive sweating. He had noticed small tender areas in the pulp of several fingers a few weeks previously. He gave a history of rheumatic fever when eighteen years old and again five months prior to admission.

The findings on examination were—Pulse 104 per minute, temperature 100.6°F., B.P. 120/80, mitral stenosis, palpable spleen, liver enlarged three finger-breadths below right costal margin, slight œdema of ankles, and clubbed fingers. The erythrocyte sedimentation rate was 145 mm. in one hour. Teeth were satisfactory. There was a fine petechial rash on the legs and thighs. Str. viridans was isolated from the blood on three occasions before treatment with penicillin was given. The probable duration of infective endocarditis was thought to be about twelve weeks.

Treatment with penicillin was commenced on 22/9/45. The rate of dosage was 250,000 units daily for twenty-eight days (total dosage seven million units). The immediate clinical response was good. The blood stream became sterile within three days of treatment and remained sterile during the patient's stay in hospital. The E.S.R. had fallen to 75 mm. on the twenty-sixth day of treatment. No further petechiæ appeared once treatment had been begun. On 20th November, 1945 (fifty-ninth day of treatment), the patient was discharged to rest at home. He was subsequently admitted for review on 8th December, 1945. The cardiac condition had not changed, although slight œdema of the ankles had returned. The E.S.R. was 20 mm. in one hour. Blood culture was sterile. He was discharged four days later.

On 7th January, 1946, patient was re-admitted with signs of congestive heart failure with gallop rhythm. Two cultures examined at this stage were sterile. No clinical evidence of active infection was present. Death occurred four days later, twelve weeks from the end of treatment.

Post-Mortem Findings.—Sections from the mitral valve showed healed vegetations. In the superficial tissue of the valve there was a small collection of Gram-positive bacteria surrounded by a zone of polymorph leucocytes. Other organs showed signs of congestive heart failure.

One of the major branches of the right renal artery was the site of a mycotic aneurysm of some duration. This aneurysm showed early calcification, though in other fields active infection was still evident.

The direct cause of death in this case was congestive heart failure. In view of the histological findings post-mortem, it is probable that had this patient lived a few weeks longer signs of infection might have become evident.

CASE 14.

A moderately nourished girl aged 21 was admitted on 3/11/45 with a history of growing pains and a heart murmur in childhood, breathlessness on exertion during the previous two years, and an attack of acute rheumatism two months before

admission. The presenting symptoms were pains in the arms and legs, swelling of the ankles, and fever. Examination revealed the presence of mitral stenosis, B.P. 130/50, slight œdema of the ankles, and slight clubbing of the fingers. No petechiæ were present and the spleen was not palpable. Hb. 50 per cent., E.S.R. 22 mm. in one hour. White corpuscles 4,500 per c.mm. Pyrexia persisted in spite of administration of sodium salicylate. Blood cultures on two occasions yielded a growth of str. viridans.

18/11/45.—Treatment with penicillin was begun; 250,000 units daily by three-hourly intramuscular injections were given for a twenty-eight-day period. The temperature became normal on the second day of treatment and blood culture was sterile on the third day. Cultures remained sterile while the patient was in hospital. She was discharged from hospital on 23rd December, 1945.

On 12th February, 1946, patient was re-admitted to hospital (eight weeks after the conclusion of her course of penicillin). She complained of increasing breathlessness, swelling of her ankles, abdominal distension, anorexia, vomiting, and cough with sputum.

On examination slight cyanosis and slight malar flush were noted. There was now considerable clubbing of the fingers. Œdema was present over the sacrum and to a slight degree over the ankles. The liver was enlarged two finger-breadths below the costal margin, but the spleen was not palpable. The patient was afebrile. There was tachycardia (pulse 100 per minute). Pulse regular and waterhammer in type. Heart enlarged to the right of the sternum, gallop-rhythm present. B.P. 150/55. Mitral systolic and diastolic murmurs and also a double aortic murmur were found. No petechiæ were present. There were no red cells in the urine.

Despite treatment with digitalis and aminophylline the patient's condition deteriorated, and she died on 16th March, 1946 (thirteen weeks after the conclusion of the course of penicillin). Blood cultures were sterile while the patient was receiving penicillin treatment, and remained sterile throughout the course of her illness.

Post-Mortem Findings.—Two healed vegetations were present on the mitral valve. They were rounded, covered by endothelium, and partly calcified. There were fresh rheumatic vegetations on the mitral and aortic valves. Histological examination of these revealed evidence of three distinct epiosdes of acute rheumatism, two of which had occurred subsequent to the administration of penicillin and were the cause of death. The age of the oldest lesion corresponded with the patient's first clinical attack of rheumatic fever in September, 1945. Of the more recent lesions, one was about two months old, and the other was progressing when death occurred.

This case was of interest, as post-mortem examination showed that the patient had an attack of acute rheumatism at the time of death, in spite of the fact that this was not clinically apparent. Her condition suggested congestive heart failure, and it would be of considerable importance to know how many cases apparently dying from congestive heart failure have had in fact a subclinical attack of acute

rheumatism. This case further emphasizes the necessity for post-mortem examination in all treated cases.

CASE 15.

This patient, a poorly nourished male of 33 years, was admitted on 17/8/45 suffering from subacute bacterial endocarditis. Str. viridans had been isolated from his blood in May, 1945, elsewhere, and 3.32 million units of penicillin had been given in a course lasting twenty-one days. Before its commencement, emboli had produced infarcts in the motor-speech area and right retina. At that time the red cell count was four million per c.mm., white cell count 10,800 per c.mm., and hæmoglobin 75 per cent. Petechiæ had appeared on several occasions during treatment and subsequently, but his temperature had fallen from an average of 102°F. to normal by the second day, and he remained apyrexial until discharged from hospital on 28/6/45 except for one evening rise to 99°F., when treatment had been omitted for twenty-four hours.

He was admitted to Royal Victoria Hospital on 17/8/45, with a history of pyrexia, petechiæ, and Osler's nodes during the preceding three weeks. He had suffered from rheumatic fever in childhood. The estimated duration of infection was fourteen weeks. Mitral stenosis and aortic regurgitation were present. The blood pressure was 130/30, hæmoglobin was 53 per cent., white cell count 10,000. There was no sign of focal sepsis in mouth or throat.

Positive blood cultures were obtained without delay. The infecting agent was str. viridans.

Penicillin treatment was commenced on 20/8/45, and a dose of 250,000 units per day was given for twenty-eight days. The blood stream was sterile twenty-four hours later, and on each subsequent occasion.

No further major embolism occurred, but fresh petechiæ and Osler's nodes were noted several times during the course of treatment, which was otherwise uneventful. This patient was discharged on 29/10/45. He was seen on 8/11/45. Hb. was then 80 per cent., the E.S.R. 10 mm. in one hour, and culture of the heart was sterile. He was allowed to proceed to his home (in Eire) and was advised to avoid all but the slightest exertion. He had arranged to attend for review in February, 1946, but was unable to do so because of the onset of congestive heart failure. Blood culture was stated to be sterile at this stage. The patient died on 7/3/46 (twenty-four weeks following treatment), with signs of cardiac failure. A crop of petechiæ appeared shortly before his death. Post-mortem examination was not carried out.

This patient's first course of penicillin was inadequate in duration by present-day standards, and was followed by the reappearance of signs of the disease. Apparent cure for a period of at least twenty weeks followed the second course, but it would appear that the infection may have been reactivated before death.

These points are taken up in the comment which follows.

COMMENT.

That the infection has been arrested in eleven cases demonstrates that penicillin has led to a revolution in the treatment of this condition. The case-histories of four

patients who died have been presented. Case 12 and probably Case 15 died from a reactivation of infection in their valves. Case 13 may have been about to sustain a bacteriological relapse, but it cannot be accepted that infection was the cause of death; in Case 14 death was the result of acute rheumatism.

Even in this short series it is apparent that a number of factors other than mere sterilization of the blood stream operate to determine the ultimate value of penicillin treatment. Blood-borne infection from a septic focus may lead to deposition of bacteria on the surface of a heart valve damaged previously by a rheumatic episode, and a vegetation composed of fibrin and bacteria gradually form. While this process continues untreated and active, the valve and its chordæ tendineæ sustain progressive damage and fibrosis, which lead to increasing functional impairment, and hence the pre-existing valvular defect is aggravated. This in its turn imposes a further strain on a myocardium the efficiency of which is reduced by toxæmia. Thus it is probable that the longer the duration and the greater the severity of uncontrolled infection, the greater will be the possibility of congestive heart failure developing at a later date on a purely mechanical basis, even when the infection has been abolished.

In a favourable case the vegetations become completely free of living bacteria during treatment and slowly heal. Consequent fibrosis may result in a further degree of stenosis or incompetence of an affected valve. At the same time, however, the myocardium should gradually improve in function as toxæmia lessens. During this period of adjustment the heart should be relieved of all possible strain. To achieve this aim prolonged rest in bed with very carefully regulated return to activity is thought desirable. This period of rest also allows time for vegetations to become completely endothelialized.

Cases with damage to more than one valve may present themselves for treatment. Three such cases are included in this series. When the aortic valve is seriously involved there is a greatly reduced chance of attaining functional compensation, and treatment with penicillin cannot be expected to yield such good results as in those cases where toxæmia is an important factor and the initial degree of valvular damage minimal.

The estimated duration of the disease before treatment in seven patients ranged from nine to twenty-six weeks. Of these patients, four died (Cases 12, 13, 14, and 15), one having aortic- and mitral-valve lesions. Two patients are cardiac invalids (Cases 8 and 10), of whom one has double valvular lesions, and one patient (Case 1) is clinically well, one year and five weeks following treatment.

The duration of infection was considered to be less than nine weeks in eight patients, four of whom show clinical improvement (Cases 2, 3, 6, and 7); among them is one patient (Case 6) who has both mitral and aortic involvement. The cardiac status in two patients is unaltered, and in two it has deteriorated. From this analysis it would appear that the prognosis in cases with duration of infection of nine weeks or longer, and more than one valve lesion, is less favourable than in those with a shorter period of infection and a single valve lesion.

BACTERIAL PERSISTENCE IN DAMAGED VALVES VERSUS REIMPLANTATON.

The valves may fail to heal because after a time bacteria which have persisted in the valve itself throughout treatment again multiply, or because the valves, as yet inadequately healed, serve as a suitable site for implantation and proliferation of any organisms which may be circulating in the blood stream. These organisms may even come from the original focus, such as a tooth, if this has not been sterilised.

In his analysis of the results obtained in treatment of subacute bacterial endocarditis with long courses of penicillin at different centres in the British Isles, Christie (1946) found that most relapses occur within thirty days of cessation of treatment, relapse after fifty days being rare. He also stressed the fact that duration of treatment is of much greater importance than the total amount of penicillin given.

In the series here reviewed one patient (Case 12) showed evidence of reactivation of infection after treatment, and again after a further course. Another (Case 14) had a recurrence of the disease following the original treatment elsewhere, and signs of probable reactivation of the condition appeared a short time before death, after a second course of penicillin had been given. In these two cases the initial course of therapy extended over twenty and twenty-one days respectively, Case 12 having received 250,000 units daily (total 5 million units), and Case 15 a dose of 160,000 units daily (total 3.32 million units). Active infection re-appeared approximately nineteen weeks later in Case 12, and five to six weeks later in Case 15. The proliferation of bacteria incarcerated within old vegetations which had not been sterilised as a result of the failure of penicillin to diffuse into their interior during a relatively short period of treatment may have been responsible for this return of symptoms in Case 15. Treatment lasting three weeks or less is now generally regarded as being inadequate. Nevertheless, re-implantation from a focus elsewhere in the body cannot be excluded as a possibility. In Case 12 re-infection of the damaged valve, probably due to a fresh implantation from the blood stream, appears to be a more probable explanation. It is unlikely that a valvular infection would remain dormant for a period as long as nineteen weeks without producing symptoms. At the same time it is difficult to accept the absence of symptoms and the finding of negative blood cultures as satisfactory evidence that the valvular infection had really been abolished.

Both cases were given a second course of therapy, the dosage being 250,000 units per day. This lasted eleven days only in Case 12, giving a total of 2.75 million units, but Case 15 received a total of 7 million units in twenty-eight days. Cultures on the third day showed the blood in each case to have become sterile once more. Subsequent cultures in Case 12 were sterile while she remained in hospital. The date on which the disease again manifested itself is unknown, but it was estimated to be not less than nine weeks after the patient left hospital of her own accord. Had she remained in hospital, control of infection might have been achieved by completion of the second course of penicillin and removal of some teeth which might have been acting as a focus persistently discharging organisms into

the blood-stream. As the case stands it may be regarded with reasonable certainty as an example of true relapse on two occasions, following inadequate duration of therapy in each instance. In Case 15 blood culture was reported to have been sterile approximately twenty weeks after discharge. Petechiæ were apparently the sole clinical manifestation of active endocarditis appearing shortly before death, which occured after the patient had been confined to bed for a number of weeks with heart failure. If such a sign be taken as indicative of the recurrence of the disease after an interval of at least twenty weeks following re-treatment, the probability of reimplantation from the blood stream must be considered as opposed to a probable relapse of valvular infection following the original treatment.

Reimplantation might be regarded as the explanation of the histological findings in Case 13, but it is difficult to explain the negative bacteriological findings in blood cultures taken immediately before death, and the failure to cultivate organisms from the vegetations at post-mortem examination. In this case death was certainly not due to any active bacterial infection of the valve.

Such examples show how difficult it may be to decide between persistence of infection in a valve and reimplantation of bacteria in an existing valvular lesion. In Cases 12 and 15 the initial treatment, now regarded as inadequate, led to the sterilization of the circulating blood, but apparently failed to sterilise the vegetations, so that following the cessation of treatment, organisms still present in the cardiac focus were permitted to multiply.

A fresh infection of a valve could readily occur from septic foci in the mouth or pharynx, and it would seem to be difficult to decide whether a str. viridans obtained from such a case is in any way different from the original infecting strain. It finds its origin in the same septic focus, the mouth, it is the same patient, and bacteriological classification is insufficient for the identification of solitary strains.

Measures to eradicate such foci were taken whilst the patient was under penicillin treatment or at a later date whilst the patient was protected by penicillin. This is thought to be of considerable importance in minimising the chances of reinfection; but the finding or eradication of all potential foci is difficult.

The importance of post-mortem examination in determining the cause of death in treated cases of endocarditis is exemplified in Case 14. From the heart of this patient histological evidence of rheumatic fever on at least three occasions was obtained. Judged by the approximate age of the Aschoff nodules which were present, two of the rheumatic episodes were considered to have occurred subsequent to penicillin therapy and were the immediate cause of death. There was no histological evidence of active bacterial infection in the vegetations attached to the mitral valve.

Christie in his analysis of the results of all cases treated finds support for the recommendation that the minimum scale of treatment should be a period of four weeks with a daily dose of 250,000 units of penicillin. Half a million units daily for four to six weeks would increase the probability of a favourable result in this disease.

In order to increase the percentage of cases successfully treated, the importance of early diagnosis cannot be over-emphasised. Penicillin can, in many cases,

eradicate the bacterial infection, but can do nothing to ameliorate the mechanical inefficiency produced by scarring following upon vegetative and ulcerative lesions.

Summary.

The results of treatment of subacute bacterial endocarditis with penicillin in fifteen patients are reviewed.

In fourteen the infecting organism was str. viridans, in one it was a diphtheroid (C. hofmanni). Four patients died within eleven, twelve, thirteen and twenty-four weeks following the cessation of treatment. Details of their case histories are given. Two of these cases showed a relapse and received further treatment. Following this, signs of re-activation of infection occurred in both. Whether this represented a fresh infection or the persistence of bacteria in the valve is discussed. In the other two it is considered that bacterial reinfection played no part in determining death, which was due to congestive heart failure and acute rheumatism respectively.

Of the remaining patients, five showed definite improvement in respect of cardiac function, and have been enabled to lead a sheltered life. Three patients show no material change in cardiac reserve following treatment, and three cases have suffered some degree of cardiac decompensation as a result of the disease.

The following points are emphasised—

(a) Early diagnosis and institution of treatment.

(b) Eradication of focal sepsis.

(c) Rest after treatment and the realization of the need for a graduated return to normal activity.

Thanks are due to the honorary physicians of the Royal Victoria Hospital for their willing co-operation in the treatment of these cases. We are grateful to Professor J. H. Biggart, Dr. N. C. Graham, and Dr. J. E. Morison for their valued help and advice in the preparation of this report.

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Some Reflections on The Ideal Hospital of the Future

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INTRODUCTION.

I ASSUME that in any co-ordinated hospital system of the future there should be *two distinct and separate types* of hospital, each with its own specific function : (1) General practitioner, or family hospitals as they have been called; and (2) Specialist hospitals.

I believe we should all agree that an adequate *general practitioner hospital* system is an essential part of any comprehensive health service. The main function of the family hospital is to provide those facilities for nursing and general practitioner treatment which cannot be introduced into the home of the patient. These hospitals which are essentially not departmentalised, would include the majority of existing cottage hospitals, new institutions of the cottage hospital type, and sick bays attached to such Health Centres as may become the strategic headquarters of certain types of general practice. It is manifest that the general practitioner hospitals and the specialist hospitals must be complementary to each other. One of the main problems in hospital strategy which lies before us is the creation of strong and useful links between the two systems.

The function of the *specialist hospital* on the other hand, is determined by the fact that it is fully departmentalised—i.e., it is made up of clinical and ancillary departments or units directed by specialists engaged only in consultant practice. Amongst the specialist hospitals, *three* types of institutions must be distinguished : (1) Hospitals in the key centre of an area or district serving natural population units of from 50,000 to 150,000; (2) Hospitals in the key centre of a region or division providing certain highly specialised services which for obvious reasons cannot be duplicated or multiplied; (3) Teaching Hospitals (University Hospitals)—hospitals pre-occupied with medical education and research, and in which the *freedom of selection* of patients must always over-ride the obligation to provide an open door for all and sundry.

I believe that both the functional pattern and the spirit of what may be called *University Hospitals* should ultimately permeate all hospitals of the specialist system, no matter by whom they are administered. I shall therefore attempt to describe what I regard as the ideal specialist hospital of the future—from two aspects : (1) Design and lay-out; (2) Staffing.

DESIGN AND LAY-OUT.

GENERAL PRINCIPLES.

The basic principle in design and lay-out to be emphasised is that *structure should always be subservient to function.* In the fulfilment of this principle I hold

that for a large *city general hospital* providing a complete cross-section of specialist departments or clinics, the hotel or industrial type of *single building* on a circumscribed site, is not the ideal lay-out for the future. The disadvantages of the hotel hospital are many. When newly constructed, though modern and up-to-date as a whole, it becomes obsolescent as a whole at a later generation. During the period of gradual decline, such a structure cannot readily expand as a whole or extend its individual departments. New clinical departments called for by advances in clinical science and practice cannot be set up without the sacrifice of accommodation by existing departments. A rigid pattern tends to determine function, which I believe to be fundamentally wrong. Administrative accommodation, apparently adequate at first, always needs increasing living space as a hospital's domestic and foreign affairs increase in complexity.

The complete rebuilding of the hotel or factory type of hospital every *thirty years*—the period in which all hospitals tend to become in large part obsolescent—clearly involves a capital outlay which cannot easily be justified. Remodelling of the interior within the original shell is possible to some extent, but this policy is too often a makeshift, and not always an economical undertaking.

There is another factor, not concerned with design and structure, which often contributes to the lack of adaptability in function—this is the traditional method of staffing whereby a fixed establishment of so-called honorary officers—perhaps appropriate enough in the Victorian era—is perpetuated in the constitution and by-laws. A second principle thus to be emphasised is that *fluidity in staffing is not less essential than fluidity in design.* Of this I shall say more later.

The Multi-Block Hospital.

The type of hospital lay-out which, in my judgment, affords the greatest degree of elasticity of function, is the general hospital composed of a number of separate *units* or *blocks* representing the major fields of medical and surgical science, and *largely self-contained as regards ancillary services.* These blocks, which in a large modern Hospital Centre may be complete hospitals, general and special, should be placed on an island site with space for future expansion, but within the confines of the city. The island site should be zoned and encircled by a green belt or parkway. It should be noted that this type of lay-out differs in principle from the conventional nineteenth century pavilion hospital, which is often a hotel hospital spread out horizontally.

The multiple block hospital is of course an old design. It can be seen in many Continental and Americal hospitals which often present a conglomeration of old-fashioned and modern buildings. This mixture of style, not necessarily displeasing to the eye, indicates the essential fluidity of the whole conception. It shows that individual units representing medicine, surgery, neurology, obstetrics, orthopædics, pædiatrics, and so on, have been remodelled, or demolished and replaced at different periods; and that new clinical units have arisen, in accordance with the dictates of *function,* and mirroring the ever-changing pattern of medical science. In actual fact, multiple buildings erected in different generations, may conform to one period of architecture. An excellent example of a harmonious lay-out can be seen in the

University Hospital in Lund in Sweden, where the separate clinics are Georgian in style, though widely differing in age.

University Hospital Centre In Manchester.

I shall develop my theme still further by describing what we have in mind on the shape of things to come, in what we are beginning to call the *University Hospital Centre,* in my own city of Manchester. The new Manchester Royal Infirmary, built in a lavish style on the pavilion plan in 1908, with certain additions at a later date, occupies a site of some thirteen acres. After a short life of thirty-four years, the hospital is fast becoming obsolescent in every single particular as a University teaching hospital. Cheek by jowl with the Royal Infirmary are two large special hospitals, the Eye Hospital and the St. Mary's Hospital for women and children, independent institutions and both structurally out-of-date. The University owns a considerable site adjacent to the Royal Infirmary, on which the Departments of Pathology and Bacteriology in a single building now stand, and on which a few years ago a Department of Experimental Surgery had been opened in two stucco houses, soon to be destroyed by Hitler. The Royal Infirmary also owns additional property on the fringe of its present site.

From the air a much larger potential island site can be seen—some one hundred acres—and most of its dingy property calls for dynamite. On this site, giving our imagination free rein, we have perceived the shadowy outlines of the many separate buildings which one day will replace the three teaching hospitals and will constitute the University Hospital Centre or Hospital City. The City Fathers have now agreed that this large area should be zoned, and dedicated for the high purpose for which it is so well suited. In the remarkable plan for the new Manchester, the University Centre and the Hospital Centre are to form one of the several cultural centres. It is interesting to find in the eleventh edition of the Encyclopædia Britannica (1910-11), Sir Henry Burdett—in his day a great authority—pleading for the Hospital City as the future design for the complete general hospital housing all the major departments of medicine and surgery. Burdett wanted to place his hospital centre on the outskirts of the city. He had not dreamed of the "city beautiful" and the "city smokeless."

What are the buildings, the separate hospitals, institutions, or blocks—call them what you will—which one day we visualise as forming a complete University Hospital Centre. These are (1) *University Preclinical Departments*—New Institutes of Anatomy, Physiology, Pharmacology, which at the present time are part of the old neo-Gothic Medical School a quarter of a mile away from the hospital site; (2) The separate *Clinical Units* or Departments which in the aggregate constitute in terms of function, a University General Hospital, i.e., a multi-block hospital. These will include—University Institutes of Medicine, Surgery, Obstetrics, Child Health, Orthopædics, Neurology, Ophthalmology, Otolarynology, Radiology, Dermatology, an institute for the chronic sick, a Health Centre, and so on; (3) A group of administrative, educational, and residential blocks—the administrative G.H.Q. of the Hospital Centre; Preliminary Training School for nurses; Students' hostels; residential flats; a Medical Institute and Library. We

can also be certain that other amenities such as a shopping centre will ultimately be needed. But before such a University Hospital City can emerge in all its glory—a long-term policy—there will be a period during which the gradual remodelling in whole or in part of existing buildings must be the main concern of our Christopher Wren. The first stage will be what our distinguished University and hospital architect, my colleague Hubert Worthington, A.R.A., has called the "shack period."

The Design of a Typical Institute.

The first of the new blocks to be contemplated in our hospital city is the Neurological Institute. Its pattern will illustrate the principles of the functional design of the separate units of a multi-block general hospital.

(1) This Institute with some 120 beds will contain both *public wards* and *pay beds*. The pay-bed patients will share all the advantages of the ward patient—the same operating theatres and its specially trained staff; the care of resident medical officers; nursing by sisters and nurses with special experience; highly specialised ancillary services; and the advantages of the atmosphere of research and teaching. The privileges of a pay-bed patient will be privacy ("a room of my own")—more frequent visitors, and certain extras in his dietary; but *nothing more*. This combination of public and private patients in the same clinical unit—even on the same floor—is of course not a new idea. It obtains in many of our hospitals to-day. But if adopted as a principle in future hospital design, it cuts across the policy of separate pay blocks for the larger hospitals. (In reference to pay beds I am speaking under the shadow of impending political events.) (2) The Institute will house its own *out-patient clinics*. This will allow those much-needed reforms —the staggering of attendances, and ultimately the complete appointment system. Here we see the principle of the *decentralisation* of out-patient services in a *general hospital*. The large centralised out-patient building of the dispensary type thus becomes obsolescent. In the transitional stage, however, towards the multi-block hospital, an existing out-patient building can be adapted to serve other centralised purposes; e.g., administration; a clearing house for information; a reception bureau. (3) The Neurological Institute will contain its own *ancillary technical* services, to provide for its special diagnostic needs. The two main services are Pathology and Radiology, and they will offer facilities for research as well as routine diagnosis. Here again we see the principle of functional decentralisation. (4) And lastly, the Institute will contain an office-consulting room suite for its director, and similar accommodation for the associate staff, if need be. There will also be rooms which will serve the intellectual needs of the staff as a whole, e.g., departmental library, research rooms. In a word, all the essentials of a *true University Department*.

The University Hospital Centre Design in Smaller Cities.

The question to be asked is whether the ideal design of a complete University Hospital Centre can be adopted as a guiding principle in hospital planning to suit the local needs of the larger non-University cities and of the smaller centres. I believe this is possible if it is agreed that function should always determine structure,

and lay-out and design should be fluid. In my judgment the pattern of the multi-block or multi-institute hospital, when combined with fluidity in staffing, best fulfils these ideals for large hospital centres. How these principles can be applied on a miniature scale is a matter for further enquiry and discussion.

New Hospital Techniques.

I have of course been describing a long-term policy in the principles of hospital design, and whilst the functional notions behind it may remain unshaken for many years, revolutionary changes in building techniques, in design, and in the internal arrangements which provide the amenities of those who have to live and work in hospitals may perhaps in the end determine a very different lay-out from the one I have put before you. I do not feel so certain about the future as I did some two or three years ago—the principle of fluidity of mind! We are clearly on the eve of rapid technological advances, many of which will first be tried out in the United States, and in due course we shall be able to profit from that experience. We can already envisage the use of new plastics, new metals, new forms of lighting, heating, air-conditioning and so on. In the hospital world we shall soon be leaving behind the last traces of what Lewis Mumford[1] has called the paleotechnic age, and we shall enter the neotechnic age without any reservations. We must also contemplate æsthetic experiments in outward form by architects influenced by modern sociological concepts.[2] Of the changes in internal amenities which we do not yet see so clearly, there will be the profound influence on the whole complex of the storage of food, of catering and of cooking, of the remarkable mechanisms which are expected to be installed in both homes and institutions in the United States during the next few years. Amongst these are the quick freezer, the refrigerator locker plant, zero cabinets, and newer forms of dehydration. We are told that completely cooked meals can be stored for a month! These techniques no doubt will not be transplanted *in toto* to this country, but one day those which suit our climate and traditional habits will undoubtedly find their way into our hospitals and homes.

With all these facts in mind, if I were given five million pounds now to build a new hospital or hospital centre, I should not embark upon the adventure for some years. Our architects, as far as I know, are not ready to synthesize all the new ideas and new techniques. It would be a good plan if a hospital architect were selected, subsidised, and given five years to study and to travel. He would be of great service to the nation.

My present view is that we should be well content with the shack period, and *concentrate on personnel.* For the latter we need much more money, either from the philanthropists or the Treasury or both.

Staffing.

The problem of the future staffing of both the family and the specialist hospitals has been closely studied by organised bodies of the medical profession during the War years, and we now have the powerful influence of the Goodenough Committee Report in this field. I would say that certain conclusions seem to have been fully

established. (1) All hospitals of the *specialist system,* large or small, should ultimately be staffed by consultants or specialists engaged in specialist practice. This means the creation of new specialist appointments in hospital centres where at present none exist, so that specialist services can be distributed throughout the country in accordance with the needs of each natural "catchment area" of the population. Such appointments should provide a satisfying career for able men and women in hospital centres, large and small. (2) That these appointments should be salaried and pensionable. (3) That the staffing of a hospital should be fluid, i.e. that it should correspond to the needs of the time both in clinical services and in medical science. (4) That all appointments should be open, and the inbreeding due to the system of automatic promotion within a hospital should be abolished.

In conclusion, I would say that a staff so selected has certain inescapable obligations to the hospital service and to medical science. (1) They should spend some time every year in travel, visiting hospitals at home and abroad; (2) They should be members of an association or society representing their chosen field of medicine or surgery; (3) They should devote part of their working time in the hospital—and if need be outside the hospital—to clinical investigation and research. The linking of smaller peripheral hospitals to University Centres should provide opportunities for their staffs to work in University Research Departments, and particularly on problems which have arisen in their daily work in their own hospitals. The furtherance of knowledge by purposive research is not the exclusive province of the staffs of teaching hospitals in a University Centre. There is far more clinical material available for observation and research in the great body of non-teaching hospitals than in the much smaller number of teaching hospitals. To-day much of the material is largely wasted. Every educated and well trained specialist is capable of contributing his quota to the attempt to remedy the imprecision of our knowledge. The same may be said of the general practitioner if he is given the best working conditions. I need only mention as observers the great James Mackenzie and in this generation Dr. William Pickles of Wensleydale. There must be men of this calibre in Ulster. When the tradition of research and investigation is established as one of the fundamental obligations of every hospital, large or small, University standards will be a common tradition, and like the Universities the hospitals will remain free institutions in a changing world.

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Some Reflections on the Evolution of Medicine

By G. F. CAMPBELL, M.B., D.P.H.

Presidential Address,
The Northern Ireland Branch of British Medical Association, in October, 1945

UNLIKE the specialist, who learns more and more about less and less, I belong to that category of medical men who are expected to know less and less about more and more. Throughout my years in general medical practice, while I tried as far as possible to keep abreast of the advances in general medicine, my chief consideration was the individual patient and his reaction to illness. I always felt that to do the best for him it was most essential to have a thorough understanding of his constitution, his mental make-up, and not least a good acquaintance with his relatives, their peculiarities and their attitude towards the medical profession. Because of the diversity of human nature and their constitution, no two patients can be treated alike. It is one thing to treat a disease, it is another thing to treat the patient. I cannot be expected, therefore, nor do I feel qualified to read an address on any specialized subject, so you are not going to hear from me "anything new under the sun." Rather shall I try to make a few observations of a general character on the subject of medicine as a whole. At this critical period in the history of a noble profession, when changes of a far-reaching nature are impending which will affect the interests of the doctor and patient alike, I have thought it would not be inappropriate to invite your attention for a short time to some reflections on the evolution of medicine and to a consideration of a few of its future problems.

Winston Churchill, in a recent address to The Royal College of Physicians, remarked that "the longer you can look back the further you can look forward." These words might with advantage be borne in mind by those upon whose shoulders rests the responsibility of moulding the minds of the doctor of to-morrow and adapting them to the new conditions that will arise as the outcome of the proposed legislative measures relating to changes in the medical services of this country.

In the present-day trend of medicine is there not a danger that so much study and attention are given to a part of the patient that the whole picture is not seen in its proper light and perspective, and is there not much to be said for those who advocate a return to the principles of Hippocrates?

Sir William Osler has said that "by the historical method alone can many problems of medicine be approached profitably." "It is a dry age," he says, "when the great men of the past are held in light esteem." It seems to me that now, with so many great problems confronting us, much help would be derived from a glance backward and from a consideration of the influence medicine in its long and varied career has exerted on the growth and development of civilization.

In the sixth and fifth century B.C., there was a school of physicians in the Greek colonies, particularly in Cos and Cnidos. Many of their writings have been preserved

in the collection that was later attributed to Hippocrates. These old writers sought to elucidate the problems of health and disease. Health appeared to them as a condition of perfect equilibrium. When this balance was upset by atmospheric factors, faulty diet, wrong mode of living, it was manifested by pains, fever, swellings, and other symptoms of disease. It had to be decided which were the essential constituents of the body that balanced each other in health. The theory was advanced that there were four cardinal humours in the human body—blood was said to originate in the heart, phlegm in the brain, yellow bile in the liver, and black bile in the spleen. This theory was further developed by Galen and still more by the Arabs in the eleventh century. Man was part of nature, nature was constituted by the four elements, and the human body by the four humours. As a consequence of these views, the physician was taught to direct his entire treatment in such a way that it would assist the innate healing power of the body and avoid whatever might antagonize it. At the time of the writings of Hippocrates, another cult was in vogue in Greece—the Aesculapian, which emanated from the god of medicine. He is commonly represented standing, dressed in a long cloak with bare breast; his usual attribute is a club-like staff with a serpent coiled round it. While the Hippocratic cult was observational and dominated by the four humours, the Aesculapian attempted the cure of ills through mental influence and was suggestive.

Aristotle, who belonged to the guild of the sons of Aesculapius, distinguished between natural bodies that possess life and those that do not. By life he meant the power of self-nourishment and of independent growth and decay. He assumed that a body was living because it was endowed with a principle, which he called psyche or soul.

Another school of physicians sprang from Alexandria in the third century B.C. They made experience their guide and were known as Empiricists.

All these schools existed side by side for centuries until the time of Paracelcus. At that time the natural sciences had greatly progressed and there was a general trend towards realism. People began to distrust the traditional authorities and wanted to see things for themselves. Paracelcus, as well as being a physician, was a scientist in search of a philosophy of medicine. He was not satisfied with treating patients, but asked for the how and why of disease.

In 1628, William Harvey, in describing the circulation of the blood, demonstrated that a difficult problem of physiology could be solved experimentally by applying the principles of physics. Harvey was a great man not only because he made a great discovery, but also because he knew his own limitations and explained only what he could prove experimentally. Medical science progressed very slowly, and therefore physicians at all times were inclined to supplement their scientific knowledge with philosophic speculation.

Disease manifests itself in disturbed function. Hence it was necessary to investigate normal function before it became possible to establish a new, a scientific pathology. In other words, pathology had to be preceded by a new physiology. Since function is nothing less than the vital manifestation of the organs, the new

physiology could not develop before the foundations of a new anatomy had been laid. This took place at the time of the Renaissance, which marks the beginning of a new era in medicine. The scientific study of medicine began with Vesalius and his anatomy, to be followed by Harvey's application of physics to physiology. Yet in the seventeenth century disease was still interpreted in the traditional philosophical way, until Morgagni related disease to a lesion in some organ. From the organ, pathology proceeded to investigation of the tissues and then of the cell.

Like physiology, pathology had become anatomical, and this new approach, although it left many problems unsolved, yet marked a great progress. Diseased entities could now be defined much more sharply, not only by the manifestation of clinical symptoms but by typical anatomical changes. This new attitude was responsible for the development of such methods of physical diagnosis as percussion and auscultation. By knocking on the thorax, by listening to the heart-beat and the respiratory murmur, the physician could form an opinion on the anatomical condition of these organs. Ingenious instruments were invented, such as the ophthalmascope and laryngoscope, that permitted him to look into the organs and see the changes directly. Electric bulbs and mirrors were introduced into all cavities of the body, and the physician's eye could penetrate into bronchi, stomach, duodenum, bladder, and rectum. The triumph in this development was the application of the X-ray to diagnostic purposes. There was only one field of medicine that had not yet been touched by this new approach, viz. therapy. The treatment of disease was still following traditional lines, and in the early nineteenth century was hardly more advanced than in the Hippocratic day. It was obvious that the anatomical pathology would call for an anatomical therapy, and this explains the tremendous development that surgery made from the middle of that century. I shall not attempt to describe the rapid strides that surgery, with the aid of anaesthetics and antiseptics, made from this period, and the amazing results it has achieved in the eradication of disease and the restoration of function from injury and disability. Even at this period little attention was paid to therapeutics. A few effective new drugs had been introduced empirically, but doctors were said then to be interested in a patient only twice, when they made the diagnosis and when they performed the autopsy.

Pathological anatomy, however, was unable to explain the cause of disease. Some diseases could be understood as the result of faulty diet or the wrong mode of living of an individual. The acute infections and especially the epidemic diseases, which were so prevalent in those days, were attracting people's attention, and it was natural to try to determine what was the nature of the substance that caused the spread of them. It was at this time that Pasteur in studying the various types of fermentation, found that other fungi, the bacteria, had effects similar to that of yeast. He could demonstrate the ubiquity of bacteria and he found that many of them were pathogenic and caused disease by invading the organism and living on it as parasites. Bacteria did not solve all problems of infectious disease, and it was found that some were caused by smaller agents that pass the finest filters—the so-called viruses.

The consequences of all these discoveries were tremendous. Hygiene and public health were put on a new foundation, surgery was freed from the nightmare of secondary infection. With vaccines and serums it became possible to immunize people against an increasing number of diseases.

Towards the end of the eighteenth century, chemistry had its great revolution when it became a qualitative science. In biology it has opened up new fields of physiology and pathology, making it possible to investigate the metabolism of the healthy and sick organism. Tests have been devised that permit us to form an opinion on the functional conditions of various organs. Nutrition, empirical in the past, has become a science through bio-chemistry, which has also explained the cause and mechanism of many very obscure diseases associated with the functions of the hormones and vitamins. But bio-chemistry has done much more than explain certain diseases, it has provided means for their prevention and cure.

Chemistry finally became the core of a new pharmacology which investigated the action of chemical compounds on the normal and diseased organism, and at the present time chemotherapy, which aims at bringing about bacteriostasis without injury to the tissues, is yielding impressive results, as proved by Fleming in his discovery of penicillin. The latest extension of this work is the search for anti-bacterial substances with an absence of undue toxicity in fungi and the higher plants such as the ranunculaceæ. It may be that soon extracts will be discovered to inhibit the growth of those micro-organisms such as the B. coli, which are insensitive to penicillin.

As bacteriology and chemistry became the chief weapons against infectious diseases, so from bio-chemistry we may expect the solution of many more pathological problems. Now that the acute diseases of childhood and youth have receded and more people are becoming old, the chronic diseases of maturity and old age—the wear and tear diseases such as the cardio-vascular—are in the foreground. With an increasing knowledge of bio-chemistry, these diseases may be prevented or at least postponed. Cancer is still an unsolved problem. Its incidence has increased in proportion to the ageing of the population. Although many early cases can be cured through surgical operations, X-ray, and radium, yet a large-scale attack is impossible unless its cause and pathogenesis are known. This problem may be solved also by bio-chemistry.

I wish now to invite your attention for a few minutes to the effects of disease on the individual's social life. The attitude of society towards the sick man and its valuation of health and disease have changed a great deal in the course of history. All forms of disease invariably affect the individual's social life. I should like to consider briefly the influence of some special diseases on the sick man's position in the social structure.

No disease has ever had more dire consequences for the patient's life than leprosy. Society has always reacted strongly against it, because of the terrifying sight of its victim. A skin disease reveals to everybody that a system is sick, while many much more serious conditions may remain hidden to the superficial observer. A relatively harmless skin affection can render an individual unemployable, and mere pimples

can poison a girl's social life. In the case of leprosy, since it was incurable and in the Early Middle Ages was a menace to society, the only way to attack it was by social means. Segregation of the lepers for life seemed the only measure available for the protection of society. Many modern institutions are very well equipped with facilities for education and recreation, with the result that many cases are arrested and the patients are released on parole.

The attitude of society towards sufferers from venereal diseases has changed a great deal in the past centuries. Syphilis was clearly recognised at the end of the fifteenth century in Europe. It was widespread and presented much more acute symptoms than it does to-day. At first, the venereal source of the infection was not understood. Some attributed its origin to natural factors, to swampy exhalations, or to cosmic factors, to a special configuration of the planets; others looked upon it as a divine punishment. In the decade from 1520 to 1530 the sexual character of the infection was generally recognised, and from then on the attitude towards the disease was largely determined by the general attitude towards sex. The Renaissance was very tolerant in sex matters, and brothels were generally accepted institutions. Emperors and kings, noblemen, lay and ecclesiastical scholars, and poets were known to be sufferers from syphilis. The venereal patient was neither better nor worse than other men. The attitude of the upper classes towards syphilis became decidedly frivolous in the *siècle galant*. With the improvement in treatment, the symptoms were apparently less acute, and in a century of great sexual licentiousness syphilis was taken as an unavoidable little accident. It was the cavalier's disease, the wounds caused by the dart of Venus, which Mercury cured. In the course of the eighteenth century a new attitude towards the venereal diseases developed, and the middle classes condemned sexual licentiousness and emphasised the sanctity of the family. At this time they were not regarded as ordinary diseases. They were shameful, not to be mentioned aloud, and certainly not in good society. The young man who after a spree found himself contaminated hid his illness, and if he had not the money for proper medical treatment, he went to a quack rather than ask his father for help.

With a growing social consciousness, venereal diseases were recognised as a menace not merely to the individual but to society at large, and in some countries strict laws have been enacted for the purpose of eradicating these diseases.

Unlike leprosy, tuberculosis is not an awe-inspiring disease and no moral condemnation is attached to it as in the case of the venereal diseases. More than any other sick person, the tubercular patient was considered a tragic figure, especially as the disease attacks with preference people in the prime of life. The mental faculties of the patient remain unimpaired and are perhaps even stimulated by the slightly increased temperature. I remember reading some years ago a letter written in the *B.M.J.* by Mr. S. T. Irwin suggesting a theory that the genius of some people is accounted for by the tuberculous toxin. This aroused a good deal of controversy both in the medical journal and the lay press. Whatever the explanation may be, it is an undoubted fact that many men and women of genius suffered from tuberculosis, but this is no argument that disease gave them the

creative power. Tuberculosis is an extremely social disease, and the best medical and surgical treatment in a sanatorium is wasted if it is not continued with measures directed towards the education and social rehabilitation of the patient. There is no point in curing him only to send him back to the slums. As Dr. Carnwath has truly said, what many people need more than advice, is material help.

At the present time one-third of the deaths from tuberculosis in children under five years of age are due to the bovine organism, with a much larger incidence of invalidism and crippling. The consensus of opinion of those authorities best competent to judge is that the perils of raw milk can be overcome only by a national requirement that all milk sold for liquid consumption shall either be effectively pasteurized or shall be from disease-free animals.

The report drawn up by a special committee of the Council of this Branch of the B.M.A., on the treatment and prevention of tuberculosis in Northern Ireland, is well worthy of consideration, and it is to be hoped that the scheme it has outlined will in the near future be put into operation.

The history of those suffering from a mental disease is a sad chapter in the medical history of society. Time does not permit even a brief description of the abominable and even brutal treatment of such patients in the past centuries. At the present time no other disease group requires such an enormous amount of hospital accommodation. Mental diseases very profoundly affect the social life of those afflicted with them, and mental patients have in the past been regarded as conspicuously different from normal people. Medicine was concerned primarily with physical ailments, and a man who looked normal but acted irrationally did not necessarily attract the attention of the physician. This is no longer true, since so much more is known now about the workings of the normal and diseased mind. It is much to the credit of Greek medicine that it recognised insanity as a diseased condition which did concern the physician, and in recent years psychology has come to the fore and is progressing, so that it is possible to keep in adjustment with their surroundings many neurotic individuals who in the past would have remained hopelessly intractable.

This brings me to quite a different approach to the study of medicine. It is a change from the materialistic outlook to the recognition of the psychological aspects of disease and a revived interest in the teaching of the ancient physicians and their conception of the Archeus, the sensitive soul, nursed in the solar plexus. There is one great difference, however, in that the modern psychomatic approach attempts to substitute a scientific basis for things sensed intuitively by the older physicians. Before this came about, much had to be accomplished in the basal sciences of anatomy, physiology, pathology, and clinical medicine.

The criticism has often been made that the medical schools give too scientific training and neglect the study of the individual patient. Here let me give you the views of Sir Francis Fraser, himself strictly trained in organic medicine. The following are his own words written ten years ago.

"I am sure it is a just criticism, but maintain that hospital practice is not 'too scientific,' it is not sufficiently scientific. Treatment based on the deduction that

one patient's inefficiency is due to family troubles is just as scientific as that based on X-ray evidence of duodenal ulcer in another patient. To say there is 'nothing the matter' because the physical examination, X-ray evidence, and laboratory tests fail to disclose a cause of the trouble is, on the other hand, unscientific. If there was more exact knowledge of how the material and mental surroundings of our patients affect their functions and activities, clinical instruction would more nearly meet the needs of private practice, and it would be more scientific, not less."

Since those words were used it has been shown that psychological factors play a considerable part in the causation even of organic disease, and it would seem that this approach will continue to revolutionize our conception of disease. Greater stress will be laid upon the training of the student's power of observation and greater insistence be made on attention to the patient as an individual and not a mere vehicle for disease. Too often, in the past, psychoneurotics have been objects of ridicule and contumely, and because no lesion could be found to justify their many complaints they have been neglected and avoided and allowed to drift into the hands of the irregular practitioners.

"The fine technique of the initial approach to the person must be wrought from special qualities within the personality of the doctor and through his cultivated talents." That is the high ideal of the role of the physician.

Psychological medicine is apt to be regarded by the general practitioner as an esoteric mystery and one to be possessed only by the psychiatrist. Actually, the family doctor is well fitted for this kind of work. As roughly twenty-five per cent. of his patients belong to this class, whose illnesses and ailments cannot be attributed to manifest organic disease, he has many opportunities of acquiring a good working knowledge of human nature and he has constantly disclosed to him the shortcomings, fears, and distresses of those who come under his care. Indeed, psychiatry is the chief instrument of his success, even though he may practise it unconsciously. If he has a sound knowledge of the general principles of medicine and surgery, if he has ordinary common sense and is endowed with a character that merits the confidence of his patients, he can save them the expense and trouble of many unnecessary scientific examinations such as X-ray and laboratory tests. On the other hand, where further skilled investigation is deemed by him essential, he can direct them into the proper channels and steer them from the pitfalls in the domain of the unscrupulous charlatan.

Confronted as we are to-day with great changes in the medical services of the country, it is essential for the profession to maintain its prestige and live up to its highest traditions. Much consideration is now being given to the reform of medical education.

To quote Dr. Walsh, an eminent authority on this subject :—

"It is the fundamental defect of our teaching that we have not given the student a firm grasp of general principles, we have not taught him to weigh evidence, to discriminate or think logically, and we too often have failed to imbue him with that keen desire for understanding that is the essence of true education. We have been content to pre-occupy him with feats of memorizing and with the acquisition

of an increasing number of techniques. The indiscriminate use of almost every newly discovered product of chemical ingenuity is another disturbing feature of modern practice. Few middle-aged women in ill-health can now hope to escape a course of Stillbœstrol; the sulphonamide drugs are not always used with conspicuous judgment; and our wholesale employment of vitamin preparations might lead the naïve observer to suppose that we have found in them a panacea for a wide range of human ills."

Already certain recommendations have been made, involving a new re-orientation of medical teaching. One is the pruning of the curriculum of the medical student, the preliminary subjects to be taught at school as part of general education, and another is compulsory hospital appointment after qualification and before entry into independent practice. The importance of a good knowledge of general principles has been emphasized, the highly specialized and technical studies to be deferred to the post-graduate years according to the bent of the student. The ultimate object of medical science is prevention, not cure. The ultimate aim of any curative system is to influence a morbid process while it is still in a stage where skilful interference will do good. Sir James Mackenzie was fond of insisting that our present methods of investigation are not sufficiently directed towards the discovery of disease in its earlier stages, that we are content impotently to contemplate the full-blown, whereas we ought to search for buds and tendencies. In order that the minor ailments might be detected, all members of the family should be overhauled periodically. Their own doctor must see them through every illness, because he can best assess the success of any treatment. The sick person is the doctor's patient and the specialist's case.

Incidentally, I would suggest that before a student commences his course he should be required to submit himself to a medical examination and also to an investigation as to his aptitude for the study and practice of medicine. This would only be fair to him and his parents alike, and by eliminating the unfit and unsuitable the standards of medical practice would be raised.

The trend of medicine is more and more towards the promotion of health and not just the elucidation of the problems of disease. More attention will be given to the inter-related subjects of social medicine, child health, and mental hygiene. In other words, medicine is basically a social science.

The history of medicine reflects the general history of civilization, and this relationship will continue while disease is allowed to disturb the natural routine of life. Disease was interpreted with the aid of all intellectual resources available at the time. Medicine had a long way to go—from magic, religion, philosophy—before it participated in the great rise of natural science and thus became more effective than in the past. More advances have been made in the last hundred years than in the previous four thousand. Smallpox, which used to wipe out entire populations, declined in the eighteenth century, and became a preventable disease with Jenner's discovery of vaccination. By the methods of immunization there has been a great reduction in the incidence of diseases such as rabies, diphtheria, tetanus, typhoid fever, cholera, and yellow fever. Tuberculosis has

lost much of its terror, and will or ought to die out in a not too distant future. The venereal diseases are receding rapidly because their ætiology and pathogenesis are known and more effective treatment has evolved. Pneumonia yields quickly to chemotherapy. Puerperal fever and other streptococus infections will soon be considered diseases of the past. It is not in the field of infectious diseases alone that great advances have been made. The insulin treatment of diabetes and the liver treatment of pernicious anæmia have kept thousands of people alive who until a short time ago would otherwise have died.

The discovery of vitamins has made possible the cure of such diseases as rickets, scurvy, pellagra, and beri-beri. Diseases of the endocrine system were brought under control when the nature and function of the hormones became known. As the result of improved health conditions, the general death-rate has been decreasing steadily. In the eighteenth century it was hardly ever under 50 in a year for every 1,000 of the population, while to-day it is between 8 and 15 in the countries of western civilization. In the past, mortality was particularly high among infants, and was about ten times higher than in most countries to-day. At the present time, the infantile death-rate, that is the number of children dying in the first year of life for every 1,000 born, is between 50 and 70 in most countries. There are two exceptions to be mentioned, viz. Glasgow and Belfast. Notwithstanding the immense strides of the past few decades, many great problems still remain for medical science to solve. Among the infectious diseases, influenza, which took a toll of ten million lives in the pandemic (1914-1918), still invades the world with great regularity, and another visitation may be expected at any time. Poliomyelitis has increased in recent years, and not much can yet be done to prevent its crippling effects on the young people. The common cold creates more temporary disablity than other diseases, and yet very little can be done in the way of prevention and cure.

Since more people become old to-day than in the past, more people die of diseases of maturity and old age. I have already mentioned the high incidence of cancer among people advanced in years. Another group of diseases common in the aged are those of the cardio-vascular system as well as arthritis, rheumatism, and those chronic ailments accelerated by the stress and strain of modern life. It is difficult to define when the process of ageing actually commences, but for practical purposes its onset is usually regarded as the first impairment of bodily functions, for reasons not obviously pathological. The physiological or bio-chemical factors involved in such impairment will have to be elucidated before any rational approach to the problem of retarding the process can be made. This is not only a medical problem but one of great social and economic importance. The decrease in the birth-rate generally and the increase of longevity in the last few decades have led to ominous changes in the age distribution of the population. According to the Beveridge report, men of 65 and over and women of 60 and over, who in 1941 comprised 12 per cent. of the population, will in 1971 comprise 20.8 per cent., with a corresponding decrease in the proportion of those at productive ages. It is, therefore, of the greatest importance that the productive capacity of the aged

should be retained as long as possible, otherwise the burden on the younger members of the community will increase. The present policy, especially among the professional classes, of having a rigid retiring age of 60 to 65 may have to be revised. It is quite evident that at the present time further increase in longevity, whether due to prophylactic or therapeutic measures, will have serious consequences for the nation unless there is a comparable increase in the duration of working capacity. One of the obvious solutions would, of course, be an increase in the birth-rate. For the solution of other problems such as I have mentioned, greatly increased exchequer grants will be required to assist medical education and to further research, which is really the keystone of medical progress.

Every medical advance achieved reduces the incidence of illness, and by preserving human lives saves society considerable financial outlay. It is a truism to state that the prevention of illness is infinitely cheaper than its cure.

Health conditions have not improved in the same proportion as the progress of medical science. The major causes of disease are only too well known. Poverty, ignorance, malnutrition, poor housing conditions with all their attendant evils, are all economic factors which are finally determined by the effectiveness of the health services of the country. Medical science has infinitely more to give than the people actually receive, and this maladjustment can to a great extent be remedied by devoting more attention to the sociology of medicine, the aim of which is to promote health, to prevent disease, to treat the sick when prevention has broken down, and to rehabilitate the people after they have been cured.

The health and welfare of every individual is the concern of society, and human solidarity beyond the boundaries of nationality, race, and creed is a true criterion of civilization.

REVIEW

SOME MINOR AILMENTS OF CHILDHOOD, BEING HINTS TO MOTHERS. Beryl Twyman, M.B., B.S. 32 pages. Edinburgh: E. & S. Livingstone. 9d.

THE value of this brochure is not to be judged by its slender bulk or its low price. It is simply and beautifully written and reveals a wide and sympathetic experience of children and their mothers. It may be recommended with confidence to those who contemplate parenthood.

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Cyclopropane Anæsthesia

By JOHN BOYD, M.D., D.A.

THIS paper is based on my experience of one thousand cases of cyclopropane anæsthesia personally conducted by me since October, 1938, both in hospital and in private. But before discussing these it might be convenient for me to mention here something about the drug itself.

HISTORY.

Cyclopropane was first isolated in Germany in 1882 by Freund, who also demonstrated its chemical structure, C_3H_6. He did not, however, describe its anæsthetic properties. Following its discovery it seems to have been forgotten until 1928, when Henderson and Lucas of Toronto, in investigating contaminants of propylene, another anæsthetic with undesirable side-effects, and itself an isomer of cyclopropane, found that the supposed cause of the cardiac disturbances was in reality a better and less toxic anæsthetic. They demonstrated its anæsthetic properties first on animals, and then, before releasing it to the medical profession for clinical trial, they anæsthetised each other, and determined the quantities necessary for administration to man.

In 1933 the first clinical trials of cyclopropane were made by Waters and his associates of the University of Wisconsin. In October of that year Waters presented a preliminary report on its anæsthetic properties in man,[1] confirming the findings of Henderson and Lucas.

Rowbotham introduced it to England first in 1935, and since then its use has spread rapidly throughout the country.

PREPARATION.

Cyclopropane is prepared commercially by the reduction of trimethylene bromide in the presence of metallic zinc in ethyl alcohol. It is also made commercially from propane in natural gas by progressive thermal chlorination.

PROPERTIES.

At room temperature it is a colourless gas with a characteristic naphtha-like odour. Its boiling-point is—32°C, and its density one and a half times that of air. It is relatively inert chemically, and is insoluble in water, but soluble in lipoids and in concentrated sulphuric acid. It liquefies at a pressure of 75 lb. per sq. in., and as such is stored in cylinders. Storage at this pressure obviates the need for a reducing valve. This is of importance, as cyclopropane would produce deterioration in the rubber used for reducing valves. It is very explosive, especially when mixed with oxygen, the range of explosibility being from 2½ to 63 per cent.[2] As the anæsthetic range varies between 3 and 40 per cent., it will be appreciated that the anæsthetic mixture is at all times within these limits. It costs approximately three shillings per gallon, but as it is always used in closed circuit machines, one or two gallons suffice for an hour's operation.

PHARMACOLOGY.

The pharmacology of cyclopropane has been extensively studied in America

since 1934, when Waters and Schmidt[3] presented their first report following its administration to over two thousand unselected patients for a great variety of operations. They summed up their findings in these words: "The ability to produce deep anæsthesia without respiratory stimulation, irritation, or the possible necessity of producing oxygen-want, gives the anæsthetist a feeling of safety and assurance not experienced with any other agent." Another investigator, H. R. Griffith, of Montreal,[4] expresses his opinion of cyclopropane as follows: "My conception of anæsthesia with the older gases is that we administer the gas, plus enough oxygen to keep the patient alive and in good condition. With cyclopropane, on the other hand, we administer oxygen with just enough of the anæsthetic gas to keep the patient asleep."

Cyclopropane is non-irritant to the mucosa of the respiratory tract. In this respect it stands out in marked contrast to the more commonly used chloroform and ether. For this reason the anæsthetist must be very careful in its administration, for he lacks the warning signs given, for example, in an ether induction. With ether the patient draws the anæsthetist's attention to a too rapid increase in concentration by holding his breath. This is absent in the cyclopropane induction. There is also much less salivation with it than with the other inhalation anæsthetics. The most marked effect of cyclopropane on respiration is the depression of the respiratory centre. Both the rate and depth of respiration are reduced as the anæsthesia deepens in the third stage. Unlike ether, the rate of breathing does not increase just prior to respiratory arrest. Some observers are of the opinion that much of the respiratory depression observed with cyclopropane is due to the high percentage of oxygen with which it is administered. Despite this depression of respiration, the patient remains quite well oxygenated, because of the high oxygen content of the anæsthetic mixture. Fortunately, respiratory arrest takes place with cyclopropane long before cardiac arrest. Following a long cyclopropane anæsthesia, a partial or even a total collapse of one lung has been observed, because during the deeper levels of anæsthesia the distal alveoli are not functioning. These alveoli contain only oxygen and cyclopropane without any inert gas, e.g., nitrogen. As these two gases are rapidly absorbed at the end of the anæsthetic, the alveoli collapse.

Cardiac irregularities are sometimes observed in cyclopropane anæsthesia, the more usual being bradycardia, tachycardia, and ventricular extra-systoles, the last-mentioned predominating. It is thought that these are produced by too sudden an increase in the cyclopropane content during induction. They are easily brought under control by adding some more oxygen. These arrythmias are not so frequently observed if the patient is premedicated with a barbiturate rather than morphine. In those cases where arrythmias occur and disappear when oxygen is added there is no permanent damage to the heart. Animal experiments by Robbins[5] show that there are no electro-cardiographic changes until near the stage of respiratory arrest, also that dogs anæsthetised with cyclopropane after premedication with barbiturates do not show electro-cardiographic changes until long after respiratory arrest. Even after respiration has ceased, by carrying out

artificial respiration the blood cyclopropane content can be increased by thirty per cent. over that needed to produce respiratory arrest without disturbing the electrical mechanism of the heart.

The pulse rate and volume remained within normal limits in a series of experiments on dogs.

Opinions vary as to the effect that cyclopropane has on blood pressure. Waters[6] states that there is no change; Rovenstine[7] says there is a slight fall when it is used for thoracic surgery; while Rowbotham[8] thinks that there is always a definite rise. Robbins,[5] experimenting on dogs, finds a rise when no premedication is used, a fall after morphine, and no change after barbiturates. Robbins also established the fact of an increased cardiac output of forty-five per cent. during moderate surgical anæsthesia, but noted a decrease in the deeper planes of anæsthesia.

There is little, if any, change in the blood under cyclopropane anæsthesia, except for an increase in the white cell count, as is found with ether and other inhalation anæsthetics. The blood sugar seems to rise slightly in the normal patient, but remains level in the controlled diabetic.[3] The clotting time of blood is not affected, the slight increase in capillary bleeding being due to a capillary vaso-dilatation.

Cyclopropane seems to have no effect on the liver or kidney function. Contractions of the gravid uterus are either not affected, or may be slightly increased. Less post-delivery bleeding is noticed in patients under cyclopropane than in patients under other agents.[9] Griffith[10] states that after considerable experience he was convinced that "there is better uterine contraction under cyclopropane. This is true with normal and forceps delivery, as well as cæsarean section, and we do not now see the alarming post-partum hæmorrhages which occasionally used to worry us."

Premedication.

Premedication follows much the same lines as with other inhalation anæsthetics. Atropine gr. 1/100, or scopolamine gr. 1/150 is given to reduce the secretion of the glands of the oral and respiratory mucosa. With regard to sedation, it is generally agreed that too much premedication with drugs that depress respiration is inadvisable. Waters[3] prefers to decrease the dose of the opium derivative generally used before anæsthetic agents by at least one-half, while retaining the full customary dose of scopolamine, giving both one and a half hours pre-operatively. Some give preference to barbiturates rather than opiates, considering that the former abolish cardiac irregularities.[11] Rowbotham[8] prefers omnopon gr. 1/3 and scopolamine gr. 1/150. Wood[12] favours avertin, .9 gm. per kgm. body weight, for premedication, combining it with atropine.

Technique of Administration.

Owing to the high cost of cyclopropane as compared with other gaseous anæsthetics it is generally administered by means of some sort of closed circuit apparatus, with total rebreathing and carbon-dioxide absorption. This also obviates to a large extent the danger of explosion associated with a cyclopropane-oxygen mixture. The principle underlying carbon-dioxide absorption is the

supplying of sufficient oxygen necessary for the patient's metabolic requirements, and the removal of the resultant carbon-dioxide, which would tend to dilute the mixture, and cause hyperpnœa. The percentage of gases in the mixture remains constant, as the patient uses up the oxygen only, cyclopropane not being broken down in the body. Thus the anæsthesia remains stable. The net result of all this is less respiratory effort on the part of the patient, who stands a prolonged operation better, less anæsthetic is needed to maintain anæsthesia, and less anæsthetic is inhaled by the surgeon and anæsthetist.

Four essentials are required in an anæsthetic machine for the administration of cyclopropane : (1) Some form of flow-meter capable of measuring and delivering as small a volume of gas as 50 cc. per minute; (2) A rebreathing bag of one to two gallons capacity; (3) A leakproof facepiece; (4) A canister containing soda-lime, to absorb the carbon-dioxide. Carbon-dioxide absorbers are of two types : (a) the to-and-fro absorber, where the rebreathing bag and absorber are attached to the facepiece, the anæsthetic gases being led to the facepiece by a narrow-bore tube; (b) the circle absorber. In this type the absorber and rebreathing bag are attached to the machine, and wide-bore tubes carry the anæsthetic mixture to and from the facepiece, uni-directional valves maintaining a one-way gas flow. The to-and-fro absorber gives more efficient absorption, but is more cumbersome to use. Soda-lime is a mixture of 65 to 95 per cent. calcium hydroxide and 5 per cent. caustic soda. One pound of this will absorb carbon dioxide efficiently from the gas mixture for about six hours.

There are several methods of inducing anæsthesia with cyclopropane. Some anæsthetists partly fill the bag with oxygen, and then run in cyclopropane at a rate of 300 to 700 cc. per min. with 250 cc. of oxygen. After a period of from one to five minutes, varying with the rate of flow of cyclopropane, the anæsthetic gas is stopped. By this time the patient is in the third stage of anæsthesia. Another method of induction is to give 1,000 cc. oxygen plus 400 cc. cyclopropane for one minute. Then the oxygen is reduced to the basal flow of 250 cc. per minute, and 200 cc. of cyclopropane per minute is run in for four minutes. After a further four minutes, during which the cyclopropane is given at the rate of 100 cc. per minute, the patient is usually in the third stage.

The maintenance of anæsthesia is carried out as follows : The patient continues to receive 250 cc. to 300 cc. of oxygen, sufficient for his metabolic requirements, and either a constant trickle of 50 cc. of cyclopropane per minute is added, or 100 cc. per minute is given for two or three minutes at intervals during the operation, when the anæsthesia tends to get lighter. At no time subsequent to the induction should the patient be given cyclopropane at a faster rate than 100 cc. per minute, on account of the risk of respiratory depression due to too sudden an increase in its concentration. Theoretically there should be no need to add cyclopropane once anæsthesia is stabilised, but despite close-fitting facepieces, etc., there seems to be a slight constant leak of gases. In addition to the mechanical loss through the imperfections of the machine, some cyclopropane is lost through the skin wound due to hæmorrhage, etc. At the end of the operation

a little air should be added gradually to the system, to ensure that the change over be not too sudden from the high oxygen content of the anæsthetic mixture to the normal oxygen content of air.

Constant and undivided attention must be paid to the details of the administration of cyclopropane because of its potency in low concentrations, the absence of respiratory stimulation, and the fact that dangerous concentrations might be reached without receiving the timely warning that cyanosis or laryngospasm affords. A gradual induction and a gradual deepening of anæsthesia when necessary, combined with a close supervision of the patient, are essential with an anæsthetic which is lacking in the usual physical signs associated with the various stages of anæsthesia.

Signs of Anæsthesia.

The physical signs of anæsthesia with cyclopropane follow much the same pattern as with ether, with one or two slight differences. These differences are due to the fact that two properties associated with ether are not observed with cyclopropane, namely, respiratory irritation and stimulation.[3] The respiratory irritation of ether is largely responsible for the excitement of second stage anæsthesia with that drug. With cyclopropane the second stage is seldom well defined, the patient passing quietly and rapidly into the third stage. As it has no irritant effect on the respiratory tract it does not produce the laryngospasm that is a protective mechanism against the inhalation of too high concentrations of ether. The stimulation of ether produces an increase in the respiratory rate up to the point at which the depression of an overdose of the drug, or of oxygen-want, supervenes. Cyclopropane administered with carbon-dioxide absorption does not increase the respiratory rate even when the depressive doses associated with respiratory paralysis are reached.

The pupils are of little value in estimating the depth of cyclopropane anæsthesia. Usually the first sign that the patient has entered the third stage is the fact that the breathing has become automatic, with the loss of the pause at the end of expiration. The pupil is still roving about. This occurs when the cyclopropane content is about 7 per cent.[5] As the patient passes through the first plane of the third stage the pupil becomes fixed and central. About 13 per cent. cyclopropane is necessary for this level. The demarcation of the third and fourth planes of the third stage is very vague, and the patient with little warning enters the fourth stage, the stage of respiratory arrest. This occurs with a 43 per cent. cyclopropane concentration. A valuable guide is found in the blood pressure and pulse rate, as I hope to mention later. Fortunately the respiratory arrest of the fourth stage can be quickly overcome by the addition of some oxygen, coupled with rhythmic compressions of the rebreathing bag. The respiratory arrest that can be easily produced with cyclopropane is often used clinically under the name of controlled respiration. By means of ample premedication with sodium pentothal and omnopon the respiratory centre is depressed. Efficient carbon-dioxide absorption removes another stimulus to respiration, with the result that respiratory arrest takes place with relatively low concentrations of cyclopropane. The anæsthetist then carries on

respiration for the patient by squeezing the rebreathing bag at the rate of fifteen to twenty times per minute. This can be kept up for long periods. It is employed largely in thoracic surgery, where it produces adequate oxygenation by preventing paradoxical respiration when one side of the chest only is opened. This is not true fourth-stage anæsthesia, for, despite the fact that the patient is making no voluntary respiratory effort, he may be kept in a light plane of anæsthesia. Controlled respiration is sometimes employed to procure adequate relaxation for upper abdominal surgery.[13]

The muscular relaxation produced by cyclopropane compares favourably with that during ether anæsthesia, with the possible exception of upper abdominal surgery, when it is suggested that ether be added to secure adequate relaxation

Sequelæ of Cyclopropane Anæsthesia.

Unpleasant post-operative sequelæ are, generally speaking, less frequent than with other anæsthetics of equal potency. Waters and Schmidt,[14] comparing a series of 2,200 cyclopropane anæsthesias with a similar number of nitrous oxide, ethylene, and ether anæsthesias, came to the conclusion that as far as circulatory complications were concerned cyclopropane was better than ethylene or ether but inferior to nitrous oxide. Respiratory complications and vomiting were much less frequent after the cyclopropane than after the control series. Nausea and vomiting were less in major surgery, but possibly greater in minor surgery. They concluded their report as follows: "The impression gained by surgeons, anæsthetists, nurses, and patients who have had experience of cyclopropane is distinctly favourable."

Indications and Contra-Indications.

Owing to the fact that cylcopropane is non-irritant to the respiratory tract. it is the ideal anæsthetic in thoracic surgery. The control that the anæsthetist has over the respiration enables the surgeon to get short periods for delicate work, when the lung is absolutely quiet. With cyclopropane the presence of active pulmonary tuberculosis is no longer a contra-indication to general anæsthesia. It is eminently suitable for thoracoplasty in pulmonary tuberculosis. It is ideal also in patients suffering from bronchitis or asthma, who need an operation for some intercurrent malady.

The adequate oxygen supply with which cyclopropane is administered makes it the ideal anæsthetic in cases of cardiac decompensation, in anæmias, in goitres, and in severely shocked or toxic patients. Generally speaking, most of the bad operative risks met with in surgical practice are quite easily anæsthetised with cyclopropane. It is of equal toxicity with nitrous oxide, and yet it supplies that essential component of good anæsthesia, relaxation, which is sadly lacking in nitrous oxide-oxygen anæsthesia. To obtain anæsthesia, nitrous oxide must be administered with a percentage of oxygen insufficient for the requirements of a bad risk case. Thus, instead of nitrous oxide being a good anæsthetic in bad risks, it is a highly dangerous one. Cyclopropane, on account of the high oxygen percentage with which it is administered, provides sufficient relaxation with ample oxygenation, and is a god-send to the bad surgical risk.

Cyclopropane is the ideal anæsthetic in midwifery, especially in those cases where there is an associated toxæmia of pregnancy. Here the need for an anæsthetic which causes no further damage to the liver is amply met. Wesley Bourne[15] of Montreal gives his impressions of the value of cyclopropane in obstetrics as follows: "I may say that cyclopropane seems to be very suitable for the relief of pain in obstetrics, for the following reasons—(1) An abundance of oxygen is given with the cyclopropane. (2) Circulation and respiration are not depressed. (3) Anæsthesia is produced without appreciable metabolic disturbance. (4) Liver function is not impaired. (5) Anæsthesia is quickly and easily induced, satisfactorily maintained at any desired depth with ready flexibility, and with minimal danger to the mother and child, and recovered from easily and uneventfully." On account of the fact that with cyclopropane there are better uterine contractions, it causes less post-partum hæmorrhage,[6] and fewer cases of retained placenta than had been experienced when chloroform was given for the delivery.

Griffith[10] states that a marked improvement in the post-operative course of cæsarean section after cyclopropane was noticed, particularly with regard to vomiting and abdominal distension. Paralytic ileus, which hitherto he had found a fairly common complication, was absent after cyclopropane.

Rosenfeld and Snyder [16 17] carried out an interesting series of experiments on pregnant rabbits. They demonstrated that the normal fœtus, both in the experimental animal and in woman, has active respiratory movements. They investigated the effects of ether, nitrous oxide, and cyclopropane upon the fœtal respiration. With ether this was abolished during the period when the mother was anæsthetised. In nitrous oxide anæsthesia 90 per cent. nitrous oxide and 10 per cent. oxygen abolished fœtal respiration, even though the mother was not fully anæsthetised. A mixture of 85 per cent. nitrous oxide and 15 per cent. oxygen did not abolish fœtal respiratory activity, but it did not anæsthetise the mother. With cyclopropane alone, with its high percentage of oxygen, were they able to produce anæsthesia in the mother without depressing or abolishing fœtal respiration. They concluded, "Most anæsthetics of both non-volatile and volatile types suppress intra-uterine respiration long before surgical anæsthesia is reached in the mother. The result with cyclopropane illustrates the attainment of one important objective in obstetric anæsthesia, namely, the production of full surgical anæsthesia in the mother without interruption of fœtal respiration." These observations are interesting in view of the clinical experience that babies suffer less from asphyxia neonatorum after cyclopropane than after other anæsthetics administered to the mother.

There are three well-defined contra-indications to the employment of cyclopropane for anæsthesia. (1) When the operation necessitates the use of the diathermy current, either for cutting or for coagulation. This is because of its liability to explode when mixed with oxygen. This applies particularly to its use about the head or chest, but it may be used in the vagina when a completely closed circuit is employed in the administration of the gas. No form of apparatus, where there is an electric spark, should be used in close proximity to an apparatus for the

administration of cyclopropane. It should not be used near an X-ray machine. (2) In operations where adrenaline is being employed, for example, where a local is added to the general anæsthesia, or where adrenaline is being used for its vaso-constrictor effect on mucous surfaces. It is apt to cause ventricular fibrillation, and adds greatly to the anæsthetic risk. (3) Where the closed circuit system cannot be employed, e.g., for tonsillectomy. This is on account of the relatively high cost of the gas. Apart from these contra-indications, cyclopropane may be employed in the vast majority of surgical operations.

I now wish to present to you some conclusions which I have formed following an extensive personal use of cyclopropane. I have used it almost exclusively since 1938, apart from the contra-indications just mentioned. The great majority of patients I anæsthetised privately received cyclopropane, but its use in hospital was confined to bad-risk cases only, owing to the difficulty in procuring supplies in the early days of the war.

The one thousand anæsthesias consumed 1,178 gallons of cyclopropane, that is, about 1.2 gallons per anæsthetic. I found that an average of 1.4 gallons were sufficient for an hour's operating. Some of the operative procedures for which it was used were longer than others. The average duration was fifty-two minutes, with the longest just over three hours.

It was employed in most of the operations done by the general surgeon. The list includes 29 prostatectomies, 120 lower abdominal operations, and 109 upper abdominals; 322 of the cases were gynæcological, including 84 hysterectomies. I have used it 105 times in midwifery, 55 being for normal labour, and the rest for cæsarean sections; 125 were orthopædic operations, including 14 for the insertion of a Smith-Petersen pin for fractured neck of femur, generally speaking a very bad anæsthetic risk. In thoracic surgery it was employed 17 times, and, finally, to complete a very varied list, once for the removal of adenoids, and once for the extraction of teeth.

For lower abdominal surgery cyclopropane produces ideal anæsthesia. The patient goes to sleep quietly, and the relaxation is quite adequate. Soon after he is put back to bed the patient is awake, with very little post-operative nausea. Relaxation is a little more difficult to obtain for upper abdominal work, especially when the sub-diaphragmatic region is being explored. At first I was inclined to add a little ether to produce the required relaxation. This I found necessary in eight cases. With further experience I found that I was able to get the patient sufficiently slack by pushing the anæsthetic in anticipation of the need for relaxation, or by passing an endotracheal tube. This latter procedure enables one to keep the patient well relaxed without having to deepen the anæsthesia unduly, and is the technique I now employ when the upper abdomen is the site of operation. Another very satisfactory method of securing good upper abdominal relaxation is the use of one per cent. novocain solution, without adrenaline, as a field block of the abdominal wall. This is a method that I feel ought to be employed more often than it is: the muscles are beautifully slack, although the general anæsthesia may be quite light. On four occasions I used a low spinal, heavy percaine, in association

with the cyclopropane, for excision of the rectum, and for hæmorrhoids, where the spasm of the sphincter was difficult to overcome.

Almost one-third of the anæsthesias were for gynæcology, a branch of surgery eminently suitable for cyclopropane, both for abdominal and for vaginal work. Even the use of the diathermy machine is not contra-indicated, because of the distance of the spark from any great concentration of the gas. Hysterectomies do very well with cyclopropane; most patients are sitting up and feeling fairly well the next day.

But it is in midwifery that we best see the superiority of cyclopropane over the other anæsthetics in common use. Labour pains are not interrupted, except when the patient is anæsthetised deeply into the third stage, a condition only necessitated by version. I feel that this is the one condition when one would prefer to use chloroform in midwifery, as cyclopropane does not relax the patient's voluntary muscles nearly so well. In every other respect chloroform must take second place. The patient's metabolism, so often strained in pregnancy to the verge of pathology, is unaffected. Her need of extra oxygen at term is readily supplied. The toxæmic patient, dehydrated after a prolonged labour, with a grossly damaged liver, does not run the risk of delayed chloroform poisoning, an ever-present menace of the past. There is a marked reduction in the incidence of post-partum hæmorrhage, the uterus contracting down quickly and well. There is a much shorter third stage. Generally speaking, the placenta is separated within five minutes of delivery. There are fewer retained placentæ; in fact, I have yet to see one with cyclopropane. The employment of sedatives for twilight sleep is enhanced with cyclopropane. One of the great disadvantages of twilight sleep was the difficulty in getting the baby to breathe soon after delivery. This was usually blamed on the sedatives used. But it seems to me that the fault really lies with the anæsthetic used for the delivery. With cyclopropane, no matter what sedatives were given beforehand, during labour, the child is a good pink colour, and breathes soon after birth. This may be due to the high percentage of oxygen with which it is administered. Even when the mother has received three grains of seconal and four or five doses of 1/150 gr. of scopolamine, the babies showed no signs of prolonged apnœa, as is often seen when chloroform is given after any of the normal sedatives employed in twilight sleep. Thus the patient can have perfect amnesia, and yet give birth to a healthy baby.

As I have mentioned already, cyclopropane is the ideal anæsthetic for thoracic surgery. I have used it some seventeen times; fourteen times for thoracoplasties, twice for lobectomies, and once for the exploration of the thorax in a patient found to have an inoperable carcinoma of the lung. Five of the thoracoplasties were in one patient, over a period of eight months. All of these operations he stood perfectly well, the last one being the most severe test of all, in that it lasted over three hours. On each occasion he was sitting up and feeling fairly well the next day. Most of these thoracoplasty patients did quite well, but two of them call for comment. (1) A woman of 32, who was slightly cyanosed throughout most of the operation. This was found to be due to muco-pus partially blocking the trachea,

and did not clear up until the trachea was aspirated at the end of the operation. (2) A very ill, toxic patient, who came to the table with a pulse rate of 160 and a blood pressure which was barely perceptible. Despite his condition it was decided to go on with the operation. This lasted for one hour, and the patient seemed to stand it fairly well, his condition at the end being no worse than it was at the start. Next day he recovered a bit, but died on the fifth day. His death was not in any way due to the cyclopropane. Rather, this case shows how a seriously ill patient may be anæsthetised for a big operation, and be little the worse for it.

Two of the thoracic cases were for lobectomies, because of bronchiectasis. Both were children. The first case was a small girl aged five years, who had a bad bronchiectasis. She had cyclopropane for only twenty minutes, as the facepiece did not fit well. Anæsthesia was then continued with oxygen and ether. The second was a boy, aged 13 years. He was given omnopon-scopolamine and sodium pentothal for pre-medication, and an endotracheal tube inserted through his mouth. The idea in this was to abolish his own voluntary respiration and to carry on with controlled respiration. This was found impracticable, as the facepiece was not a good fit. His condition remained quite good throughout an operation lasting over two hours, apart from a fast pulse rate, running between 100 and 120. As his systolic blood pressure kept up between 120 and 130 it was thought that carbon-dioxide accumulation due to paradoxical respiration was the cause. This condition occurs when one side of the chest is opened. At inspiration, instead of the exposed lung expanding, it contracts, and expands on expiration. The result of this is that the contents of the lungs are being shuttled from one to the other. Carbon dioxide then accumulates, as most of it never reaches the absorber, and the patient becomes anoxæmic. This is best overcome by abolishing the patient's voluntary respiratory efforts, and by carrying on controlled respiration by rhythmically squeezing the rebreathing bag, thus ensuring a proper entry and exit of gases to both lungs. Both lungs are inflated and deflated at will.

The advantages of controlled respiration are well exhibited in another case where it was employed. The patient, a man of forty-seven, had a carcinoma of the bronchus. It was thought that he would be a suitable case for pneumonectomy. For premedication he received 1½ gr. of luminal and one ampoule of omnopon-scopolamine. His throat was sprayed with ten per cent. cocaine. Then he was given .75 gm. of sodium pentothal, and an endotracheal tube passed through the mouth under direct vision laryngoscopy. When cyclopropane was added, his respiratory centre ceased to function, and its activity was taken over by the anæsthetist for the duration of the operation, voluntary breathing ceasing for almost two hours. This kept him a nice pink colour throughout. His systolic pressure kept between 110 and 120 throughout the operation except for one period when it dropped to 90, due to extensive intra-thoracic manipulations. His pulse rate did not rise beyond 80 during the whole operation. In this case, in addition to employing controlled respiration, the tracheo-bronchial tree was aspirated at definite intervals by means of a gum-elastic catheter passed down the endotracheal tube.

In the bad-risk patient cyclopropane is seen to advantage. Despite the fact that

in high concentrations it causes cardiac arrythmias, it is by far the best anæsthetic for cases of grave cardiac decompensation. In my series twelve patients had a history of myocardial involvement prior to operation, four of whom had gross decompensation. Notwithstanding this defect, all stood the operation well. It would seem that the high oxygen content of the anæsthetic mixture and efficient absorption of carbon dioxide help towards this end. One case in particular stands out. A patient, aged 33, with a badly decompensated heart, needed an anæsthetic to have her pregnancy terminated. She had many moist sounds at her bases, and was so distressed that she could not lie down on the table, nor could she tolerate a mask on her face owing to dyspnœa. She was given .35 gm. sodium pentothal in the sitting-up position. As soon as she was asleep she was put down flat on the table, and the anæsthetic continued with cyclopropane and oxygen. Even when she was put up into the lithotomy position for operation, her heart condition gave no anxiety. That evening she felt very well, was not sick, and had much less dyspnœa.

The importance of cardiac irregularities during cyclopropane anæsthesia is difficult to assess. They are easily abolished by adding some oxygen to the mixture, and lightening the anæsthesia. They also disappear if the anæsthesia is deepened. Some authorities[18] consider that there is a band in the planes of narcosis where arrythmias occur, and above and below which they disappear. I found that cardiac irregularities were present in twenty-eight patients. Of these, twenty-two (78 per cent.) occurred in the first five hundred cases, whereas only six were seen in the second half of the series. It may be that the slower induction and deepening employed later were responsible for the disappearance of this disturbing feature. At any rate I notice it much less frequently now than at the start. The usual irregularities I met were extra systoles, tachycardia, and bradycardia. Several times one found a patient coming to the table with a pulse rate of 72, and after the cyclopropane had been going for five minutes it would drop to 50, and remain at this rate for about ten minutes, to settle down again at 72 per minute.

Three of the cases were diabetics, two of them having rather lengthy operations. All stood the operation well. Only one had a little post-operative nausea, a factor of paramount importance in stabilising diabetics after operation.

Jaundiced patients have always presented a difficult problem to the anæsthetist. The patient's metabolism is seriously impaired, and yet the nature of his operation necessitates good relaxation, only provided by deep anæsthesia. In the days of chloroform and ether this was almost impossible without endangering the patient's life. With cyclopropane, however, good relaxation can be obtained with practically no metabolic upset, as it has no effect on the liver. My series included six patients with jaundice. In anæsthetising these I preferred to pass an endotracheal tube. This obviated the need for very deep anæsthesia, and yet gave good relaxation. I have only notes of three of these after operation, and none of these three had any post-operative vomiting.

Six patients needed operation despite a co-existent chest condition, but only

one of these had any exacerbation after the operation, and even this was of little consequence.

In 757 of the cases I kept ten-minute records of the patient's blood pressure and pulse rate. These follow a fairly regular pattern with cyclopropane. Most patients coming to the operating theatre have a fastish pulse rate, from 80 to 160 per minute. After anæsthesia is induced with cyclopropane it almost invariably falls to 72 per minute. This would suggest that the tachycardia is due to excitement. At the same time the systolic blood pressure rises about 10 to 20 mm. Sometimes the blood pressure comes down as well as the pulse rate at the start, if it had been raised due to nervousness. The subsequent course of the blood pressure and pulse rate graphs depends on a variety of factors. In the great majority of operations the pulse rate will remain constant at 72, and the blood pressure will also remain constant, round about 10 mm. above the level when the patient came to the theatre. In this respect cyclopropane differs from ether, with which there seems to be a great tendency for the blood pressure and pulse rate to vary a lot during the operation. With cyclopropane these both keep fairly constant for the first two hours' operating. After that the blood pressure usually drops a little. The best way to overcome this is to set up a glucose-saline drip, preferably beforehand, when one expects a longish operation. If necessary, blood can also be given to the patient through the drip. By varying these and the rate at which they are given, one can control the blood pressure during the operation. In my experience the usual analeptics, coramine, methedrine, etc., are not of much value in a falling blood pressure during operation. Any rise that may occur is but temporary. A better plan is to find the cause, and remedy it, for example, the anæsthesia becoming too light, or severe hæmorrhage, or rough handling of viscera. In prolonged operations one often notices that the blood pressure tends to rise soon after the surgeon commences to close the wound.

If the carbon dioxide is not being efficiently absorbed, due either to an obstructed airway, or to the soda-lime becoming exhausted, the presence of a rising carbon dioxide content in the anæsthetic mixture is indicated by a rise in blood pressure accompanied by a rise in the pulse rate. When this state of affairs is remedied both settle down quickly to their former levels. If the anæsthesia is becoming light, possibly the first indication one receives with cyclopropane is the fall in blood pressure of 10 to 20 mm. with an increase in the pulse rate of 10 per min. This is what one would expect, a slight degree of shock, as the patient is not being protected fully by the anæsthetic from the baneful effects of surgical stimuli. With avertin as a premedication before cyclopropane there is the usual fall in blood pressure and fall in the pulse rate associated with this basal anæsthetic. This continues until the patient comes to the table, when the administration of cyclopropane raises both pulse rate and blood pressure. This latter then keeps round the normal range, while the pulse rate remains about 100 throughout the operation. A similar fall is seen when pentothal is employed before cyclopropane. Here, however, the pulse rate varies little, but the blood pressure drops, about 20 to 30 mm., and remains down until the pentothal has been all eliminated from the system.

Contrary to what one might expect, patients with an initially high blood pressure do very well with cyclopropane. Six patients in my series had a systolic pressure of over 200 mm. These seemed to fall into two groups as far as the subsequent pressure records were concerned.

(1) Patients with an accompanying fast pulse rate. In these the blood pressure drops about 60 to 70 mm. simultaneously with the usual fall in the pulse rate at the start of the anæsthesia. In these the hyperpiesis was possibly caused by extreme nervousness.

(2) Patients with a normal pulse rate. In these the blood pressure chart corresponds to the normal picture, that is, a rise of 10 mm. keeping at much the same level throughout the operation. None of these patients had any post-operative cardio-vascular upset, their convalescence varying little from normal patients.

The patients who had a sudden excessive hæmorrhage during the operation present a fairly typical blood-pressure and pulse-rate chart. Such a picture is frequently seen in operations for the radical removal of the breast for carcinoma. In these cases there is a fairly smart hæmorrhage for a time, but it is quickly brought under control. When this occurs, the systolic pressure drops, often by about fifty per cent. After the bleeding is stopped the blood pressure rises steadily almost to the initial level, especially when the skin is being sutured over the large raw area. During this short period of lowered pressure the pulse rate often remains the same, round about 72. I have found that in these cases it is not necessary to give coramine or other analeptic, as the blood pressure rises quite well without it. It would seem that the blood-pressure recordings give a much earlier warning of serious hæmorrhage than the pulse rate, for it is only with persistent loss of blood that the pulse rate rises. Then it is more difficult to improve matters. Sometimes shock is present during an operation, apart from hæmorrhage. Shock is said to be present when there is more than a twenty-five per cent. fall in the systolic blood pressure accompanied by a rise in the pulse rate of over 25 per cent. One of my cases illustrates this well. A young lady of 19 was having an amputation through her hip joint under cyclopropane. All went well until the surgeon cut the sciatic nerve. Then her systolic blood pressure fell from 110 mm. to 60 mm., and the pulse rate rose from 84 to 120. Unlike the fall in blood pressure due to hæmorrhage, the patient did not recover from her shock until back in bed.

Another common cause for a fall in blood pressure during an operation is the unduly rough handling of viscera, especially those of the upper abdomen. One cannot stress too much the need for slow, gentle manipulations inside the abdomen. Much handling of the viscera calls for a considerable depth of anæsthesia. This, and the surgeon's rough handling, rapidly produce shock. The raising of the kidney rest on the table either for a nephrectomy or a cholecystectomy often shocks the patient. The condition, however, improves immediately the rest is lowered. Changing the patient's position on the table, say from the Trendelenburg to the lithotomy positions, may cause a fall in blood pressure, if not done gently.

One patient reacted adversely to the addition of adrenalin to the novocain used for

local infiltration. This was a very nervous and excitable woman of 34 with an exophthalmic goitre. Her pulse rate remained at 96 per minute for the first fifteen minutes, but when her neck was being infiltrated with one per cent. novocain to which a little 1 in 1000 adrenalin was added, her pulse rate rose suddenly to 180. For the next fifteen minutes, despite the administration of 500 cc. oxygen per minute, the patient was cyanosed. At the end of this period the cyanosis suddenly cleared up, the pulse rate came down to 80, and remained so till the end of the operation. Apparently the trouble here was that the adrenalin, being injected into a very vascular area, had entered a vein. When novocain is being used for a field block now I prefer that adrenalin be not added to it if cyclopropane is to follow.

It is quite a common experience with cyclopropane to find that a patient's blood pressure and pulse rate are perfectly satisfactory on table at the end of the operation, but when he is back in bed his condition has sadly deteriorated. Two factors may be responsible for this. (1) The too sudden change from the high percentage of oxygen which he has been breathing for the previous hour or more to the relatively low oxygen content of atmospheric air. This may be overcome by adding some air gradually to the anæsthetic mixture at the end of the operation, instead of removing the facepiece suddenly. It is a good plan, too, to allow the patient's carbon dioxide to accumulate while the air is being added. This ventilates the lungs, which have not been fully expanding during the operation, due to the quiet breathing associated with the adminstration of cyclopropane. (2) A second factor in the causation of post-operative collapse is rough handling in transferring patients to bed. Unfortunately, both in hospital and in private nursing homes, the methods employed in returning patients to bed after operation can only be characterised as crude and awkward, and detrimental to the best interests of the patients. They are either dumped at arm's length from the table to the trolley, and from the trolley to the bed, or else put on a flexible stretcher, and twisted and hauled round narrow corridors, up steep stairs, to be finally flung by exhausted carriers in a heap on the bed. Both of these methods produce shock to the patient, and unnecessary fatigue to those who make the transfer. This may be remedied by having a stretcher under the patient during the operation. This stretcher should have two channels in the edges running the full length to hold poles, which are then lifted gently and easily by two persons, preferably porters, one at either end. Failing this the patient can quite easily be lifted by two people only. These both stand at the same side of the patient, and between him and the trolley. They both put their arms underneath the patient, and while still on the table he is rolled gently over on to his side, facing the lifters. Then the patient is carried, not at arm's length, but on the lifters' chests, and carefully laid on the trolley or bed. The leverage on the arms is small, and the patient can be carried in comfort, and with gentleness. It is surprising how, after a little experience of this method, two persons can lift quite easily a man of fifteen stones weight. It seems to me a great pity that more attention is not paid to the transport of the unconscious patient. It is all wrong if, after the surgeon and anæsthetist have been concentrating their attention for one and a half hours to avoid producing shock, a five-minute transfer to his bed gravely shocks him.

I have used various combinations of drugs for premedication with cyclopropane. Over seventy per cent. of my patients received omnopon-scopolamine, chiefly because of the ease with which it is administered, usually by a nurse one hour before the operation is due to commence. Unfortunately it has several drawbacks. (1) The dose cannot be easily adjusted to meet the varying needs of patients. (2) In adults it is almost always inadequate as an amnesic, even in full doses. (3) Many patients have an idiosyncrasy for omnopon or morphine, and suffer much from post-operative vomiting. (4) Omnopon often so depresses the respiratory centre that the subsequent use of cyclopropane readily produces apnœa. These drawbacks can be overcome by using other drugs prior to cyclopropane.

The most accurate premedication, as far as dosage is concerned, is avertin. This I have used in eighty cases. The dose is measured according to the patient's weight, and administered per rectum. Avertin produces quiet basal narcosis, perfect abdominal relaxation, absolute amnesia, and an almost complete absence of post-operative vomiting. There is one serious drawback to avertin premedication. It must be prepared immediately before administration, and its use entails the presence of the anæsthetist at the nursing home at least three-quarters of an hour before the operation, an impossibility for the busy anæsthetist, who finds great difficulty in getting his day's work all fitted in. I have frequently used the barbiturates with cyclopropane. Here more accurate dosages are possible than with omnopon-scopolamine. Sodium pentothal is most useful. It is administered intravenously, when just sufficient is given to produce the desired result. Pentothal may produce some apnœa in the early stages of the subsequent anæsthesia, but it passes off quickly. The blood pressure is inclined to keep low until the pentothal is all detoxicated and excreted. Seconal I often employ in children, increasing the dose according to age. My experience with seconal is that, when the dose exceeds $1\frac{1}{2}$ gr., the patient needs 1/80 gr. atropine if the salivary secretions are to be adequately controlled. Sometimes one is asked to give cyclopropane in an emergency to an unpremedicated patient. Then I prefer to give the patient 1/100 gr. atropine, followed in five minutes' time with sodium pentothal, just prior to the commencement of the inhalation anæsthesia. This makes for a smooth, quiet induction, and often the patient has no sickness afterwards. Atropine alone makes for continual difficulty in the subsequent anæsthesia. Some narcotic drug is essential before cyclopropane.

The endotracheal technique is frequently of value in the administration of cyclopropane. I have used it in about ten per cent. of my cases. Besides being of advantage in operations about the head and neck, it produces smoother anæsthesia in upper abdominal surgery. Then the operation can be carried out at a lower level of anæsthesia, with the result that the patient is in better condition leaving the table. An endotracheal tube in situ makes the anæsthetist's task lighter if apnœa supervenes, and he is called upon to do artificial respiration by squeezing the rebreathing bag. Endotracheal anæsthesia is a *sine qua non* in thoracic surgery when controlled respiration is being employed. With cyclopropane alone the introduction of the tube through the glottis is a matter of some difficulty, due to

the shallow respiration. I have found it useful to add a little ether to the anæsthetic mixture for a few minutes at the start, as this stimulates the respiration, opens the glottis wider, and makes for easier intubation, which in most cases is performed blindly.

One of the great advantages of cyclopropane over chloroform and ether is the relative absence of post-operative nausea and vomiting. In my series I have records of the incidence of vomiting or of its absence in 606 cases. I have divided these into three classes: (1) No vomiting; (2) when the patient vomited a little during the first twenty-four hours after operation; (3) gross vomiting, when it was continued for several days. In these 606 cases 438 (seventy-two per cent.) had no vomiting whatever, 154 (twenty-six per cent.) vomited only two or three times the same day, while in 14 (two per cent.) the nausea and vomiting persisted for more than twenty-four hours. Only one of the patients had a severe bout of vomiting, for she continued to feel sick, and kept retching for almost a week. This I feel was largely neurosis, as she said that she had been sick for a week after a previous chloroform-ether anæsthesia, and was sure to be sick again. Her retching seemed to occur mainly when she had someone in the room with her. These figures, I believe, could be improved with a better choice of premedication, and a little psychological persuasion before the operation.

As I have mentioned already, in many patients the use of omnopon-scopolamine predisposes to nausea and vomiting. I feel that the use of the barbiturates rather than opium and its derivatives would reduce this tendency. In this connection it is interesting to notice that all the midwifery patients, with one exception, had no post-anæsthetic vomiting. This applies to normal midwifery cases, to those who had a forceps delivery, and to those submitted to cæsarean section. None of these patients had any morphia or omnopon. Most had seconal and scopolamine, a combination which seems to suit midwifery cases very well. The one midwifery patient who vomited had so quick a second stage that she had no scopalomine, and had been given some chloroform before my arrival.

Another factor in the causation of post-operative nausea is the long periods before and after operation during which the patient is deprived of food. This applies particularly to patients operated upon in the late afternoon, when the patient, after being without food the previous night, has had very little during the day, whilst awaiting the operation. I have found that when patients give a history of previous post-operative vomiting of any degree, it is a good plan to give them 100 cc. of concentrated glucose solution intravenously immediately after the operation. Frequently one noticed that the patient vomited a little either before leaving the table, or just after being put back to bed. This happened before the patient was fully conscious, and often he had no memory of the vomiting. One very satisfactory feature of cyclopropane anæsthesia was the fact that none of the diabetics vomited. This is of great importance, and it is desirable to get these patients' diets stablised as soon as possible after operation. The diabetics included in the series all did very well with cyclopropane. Ten units of insulin were given

with the premedication. One of these patients had a hysterectomy done, the operation lasting for two hours. She was in excellent condition afterwards.

I have not found that the incidence of vomiting is materially affected by the duration of the anæsthesia with cyclopropane. It seems to be much more common in women than in men. Of the 166 patients who were sick after operation, 140 were women and 26 were men, that is, five times as many women as men. This would point to a psychological basis for the vomiting. Another thing I noticed is that most patients who have had the cervix dilated vomited after operation. Also, the application of radium to the uterus invariably produced nausea and vomiting until the radium was removed. Thus, post-operative nausea and vomiting cannot always be blamed on the anæsthetic used.

One or two disadvantages have been noticed in the use of cyclopropane. A general capillary oozing from the skin wound is observed, particularly when the wound is being closed at the end of the operation. This, I believe, is due to three factors: (1) The patient's blood pressure remains fairly high throughout the operation; (2) the use of antiseptic solutions containing spirit applied to the skin edges; (3) the capillary dilatation produced by the cyclopropane itself. These all produce a dilitation of the cut capillaries, and the wound starts to ooze. This is somewhat annoying, but it is never of such serious proportions as to produce a hæmatoma of the wound afterwards. Cyclopropane does not alter the clotting time of the blood.[3]

Another disadvantage is the sudden alteration in the depth of anæsthesia that is sometimes noticed with cyclopropane. The patient may quickly become light and incommode the surgeon. When the anæsthesia is being deepened, if it be done too rapidly, he may as suddenly become anoxæmic, to the annoyance of the anæsthetist. Again, the sudden failure of the oxygen supply, if unnoticed for a few minutes, can produce an alarming greyish cyanosis. This means that a very constant, close supervision must be given to the patient throughout the operation, as, even with experience, these variations can occur so quickly. Cyclopropane is not an anæsthetic for the novice to handle. There is a much smaller margin of safety than with ether, and the anæsthetist must be quick to recognise the smallest alteration in the patient's respiratory rhythm, pulse rate, or colour. As I have mentioned when dealing with blood pressure, a slight increase in the pulse rate with a reduction in the systolic pressure would indicate that the patient needs more anæsthetic. But sometimes the surgeon is the first to notice that the patient is getting light, when the abdominal muscles tighten a little.

As far as post-operative sequelæ are concerned, cyclopropane compares favourably with the other inhalation anæsthetics. In this series only six patients showed any sign of post-operative respiratory trouble. Of these one had what seemed to be a pneumonia which did not resolve well. An X-ray was taken two months afterwards, when dulness was reported at one base without any fluid. This seems to have been a partial collapse of the lung. Another patient, on the third day after operation, developed a frank lobar pneumonia, which quickly responded to suphapyridine. This patient had been cyanosed during the greater part of the operation, despite the fact that an endotracheal tube had been passed. The cause of the

anoxia was never determined. The other four patients had varying degrees of post-operative cough, without much in the way of physical signs. All had abdominal operations, and all had slight colds before operation. One felt that the cause of the persistent post-operative cough in the majority of these cases was a reluctance on the part of the patient to clear the air passages of secretion on account of the pain caused in the wound. A few doses of a stimulating expectorant work wonders for these people.

Two patients developed auricular fibrillation after operation, but this cleared up with rest in bed.

The question of post-operative complications leads us to the consideration of deaths following cyclopropane anæsthesia. These I have divided into three categories. (1) Those who died on the table. (2) Those who died inside twenty-four hours after operation. (3) Those who died after twenty-four hours, before leaving the hospital or nursing-home.

Two patients died on the table. One of these was a woman of 50, who was brought for examination under anæsthesia. She had a complete paralysis of her left vocal cord, with a paresis of her right cord. She had a very poor myocardium, and had been given intensive courses of anti-syphilitic treatment. During induction, and before any operative interference, the patient suddenly collapsed, with cardiac and respiratory failure. A post-mortem examination revealed gross pathology in the liver, heart, kidneys, and spleen. This was apparently a case of primary cardiac failure due to cyclopropane, in a very bad-risk patient. The second death on the table was in an elderly woman of 62, who had a fractured neck of femur, for which a Smith-Petersen pin was being inserted. Shortly after the reduction of the fracture this patient became an ashen-grey colour, and remained so throughout the operation, which lasted forty minutes. Her condition did not improve despite the fact that her respirations were ample, and the oxygen content of the mixture was kept high. Just as the operation was being finished she died. It seems as if death in this case was due to an embolic infarct in the pulmonary artery, a not unusual complication of a fracture of the neck of the femur. The manipulations necessary for the reduction caused a clot to be dislodged, with fatal results, which could not in any way be blamed on the anæsthetic used.

Three patients died inside the first twenty-four hours after operation. The first of these was a young woman with a bad albuminuria of pregnancy. When she was brought to the table for a caæsarean section she was comatose, and never regained consciousness before she died, twelve hours later. The second was a healthy old man of 78, having a prostatectomy. His condition during operation was very good except for excessive hæmorrhage. A blood transfusion given shortly after operation improved him, but a further severe hæmorrhage late that evening caused his death. The last patient in this class was a man who was a very bad risk, and for whom a gastrectomy was done. He had been greatly dehydrated before operation, and his condition was always poor, even though an intravenous blood drip was started before the operation. The gastrectomy took three hours, and,

while he seemed fairly well later in the evening, he died twelve hours afterwards. In none of these three cases could the anæsthetic be blamed for the death.

Sixteen patients died before leaving the nursing home or hospital, at periods varying from two days to six weeks after operation. Half of these deaths were due to the fact that the condition for which the operation was performed was unrelieved. As might be expected, most of these were malignant conditions. One was a child of one year with an intussusception, where an extensive resection of gut was necessary. After seeming well the day following operation, he died on the second day. I have included in this group the young man mentioned above as having a thoracoplasty done even though he was very ill. He died on the fifth day. Three patients died due to cardiac trouble supervening after operation. One woman after a cholecystectomy took a sudden heart attack two days later, and died immediately. Another patient had a third dose of radium applied to her cervix, and died suddenly on the fifth day from coronary thrombosis. She had taken the two previous anæsthetics perfectly. The third patient did well for ten days before her heart suddenly gave out. In three of the cases nothing definite could be ascertained as to the cause of death. Two of these had extensive operations for cancer. One died on the third and the other on the fifth day after operation. The third was an elderly patient who had a cholecystectomy, but she died on the tenth day. Two other deaths remain to be described. One was in a patient of 45 who had a hysterectomy, and after doing quite well for seven days without any respiratory trouble, suddenly developed a broncho-pneumonia, and died on the tenth day. The other patient was also a hysterectomy, who developed an entero-coccal infection of her kidneys, and, after weathering a thrombo-phlebitis in both legs, died of a pulmonary infarct on the forty-second day. It will be seen that none of these late deaths could be attributed, either directly or indirectly, to the cyclo-propane, as in all cases the patients had recovered from the anæsthesia, and were in fairly good condition the day following the operation.

Little remains for me except to sum up our findings. It would seem that in cyclopropane we have an anæsthetic of almost equal potency with chloroform and ether, yet without many of their inherent disadvantages. Induction is quiet and pleasant for the patient, and, while relaxation may not be as good as that obtained with other inhalation or spinal anæsthetics, a sufficient degree can be obtained for most operative procedures, especially if the patient is intubated. The chief advantage of cyclopropane seems to lie in the relative absence of adverse post-operative complications. The distressing nausea and vomiting, the frequent respiratory troubles, and the slow excretion of the drug associated with ether anæsthesia, are all conspicuous by their absence. The administration of cyclo-propane demands constant, close supervision of the patient, and, especially in longer cases, continuous records of blood pressure and pulse rate. In the bad-risk patient, the patient with a poor myocardium, the bronchitic, the frail elderly woman, cyclopropane is seen to its greatest advantage. It is surprising to see how well these patients are the day following operation. In midwifery, cyclopropane has no rival; the imperfections of gas and air, the dangers of chloroform, and the

difficulty of administering ether, are all abolished by its use. In cyclopropane, then, we have a valuable anæsthetic agent, of high potency and low toxicity, of ready flexibility in its administration, and of relative freedom from unpleasant post-operative sequelæ.

In conclusion, I should like to pay a tribute to those surgeons whose patients I have anæsthetised with cyclopropane during the past seven years. I would like to thank them very sincerely for their patient longsuffering with me in those days before one became thoroughly acquainted with the new drug, when anæsthesia was far from perfect, and also for their valued help in my investigations, and for their kindly encouragement at all times.

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REVIEW

MEDICAL ASPECTS OF GROWING OLD. A. T. Todd, M.B.Edin., M.R.C.P.Lond. Bristol : John Wright & Sons. 162 pages. 15s.

IN his preface the author declares his threefold objective : "to assist the medical practitioner . . . . to help the elderly subject to make the most of his later life . . . . and for those not yet in later life for the correction of those many errors which may be made by them before extensive ravages have occurred." It may be said at once that he has succeeded as well as anyone may hope to succeed in the impossible task of writing for doctor and layman in the same text. A critical medical reader will find a good deal to criticise, as, for example, when he is told, "The full or irritated stomach appears to have some priority over activities, and it will not let us breathe freely, and unless we take things very quietly we find we are short of breath, and if we make ourselves work in spite of this shortness of breath, we soon experience pain about the heart which will soon radiate pangs down the arms—which is the beginning of angina pectoris or so-called effort syndrome."

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Electrical Convulsant Therapy

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Historical.

Meduna in 1934 introduced therapeutic convulsions for schizophrenic states on the assumption, later proved to be quite erroneous, that there was an antagonism between dementia præcox and epilepsy. Meduna used various convulsant agents before finally discovering the advantages of cardiazol. Although convulsant therapy was found to be disappointing for dementia præcox, the condition for which it was introduced, many observers began reporting good results in depressive states. Convulsant therapy by chemical means, however, had a good many disadvantages, the chief being the anxiety of the patient while awaiting his intravenous injection and before the onset of the fit. In many cases it was found impossible to persuade the patient to complete the course. In 1938 Cerletti and Bini finally perfected an electrical method of inducing convulsions which had the advantage that loss of consciousness was instantaneous, thereby ensuring complete amnesia for the whole event and consequently no apprehension on the part of the patient for subsequent convulsions.

Electrical convulsant therapy (E.C.T.) in mental disease has now been in fairly general use in the British Isles for the past three or four years, but it was not until October, 1943, that we were able to obtain an apparatus in Armagh. Since that date, up to December, 1944, we have treated sixty-nine patients, in whom we induced almost six hundred convulsions, and this paper is an attempt to assess the value of this addition to psychiatric treatment.

Technique.

Patients exhibiting any marked degree of cardio-vascular degeneration or any suspicion of pulmonary tuberculosis are excluded. Other contra-indications mentioned in the literature are such fairly obvious conditions as osteo-arthritis, spinal curvature, bone atrophy, thyrotoxicosis, malignancy, and thrombophlebitis. Age in itself does not appear to be a contra-indication, but the oldest patient in this series was 56. A cup of tea only is given on the morning of treatment, and the bladder is emptied just prior to treatment. The patient lies on an ordinary bed or couch with only a light covering blanket. Good electrical contact is ensured by swabbing the temples with spirit followed by saline, and the connecting pads of the head-band are liberally soaked with strong saline. The accurate working of the apparatus can first be tested by means of a "dummy patient" which has a fixed resistance, and when the head-band has been carefully adjusted the resistance of the actual patient is then noted. This resistance is no guide to the voltage required to produce a fit and is only of value in subsequent treatments, as a sharp rise in the patient's resistance usually indicates that contact is faulty somewhere. We always begin treatment by using a voltage of 130 and a time of .2 second (Cox-Cavendish Apparatus). If this fails to produce a fit, either the

voltage or time or both may be increased. Likewise a long delay before the actual fit develops will also call for an increase on the next occasion. Some patients never require an increase, whereas others have to be stepped up to the maximum of 150 volts and to .4 or .5 second; two of our patients eventually required .65 second. A rubber gag is inserted into the mouth (false teeth, of course, being removed, and also hairpins) before the shock button is pressed, but if the patient objects to this one can wait and insert it when the tonic stage begins. One assistant exerts pressure on the lower jaw to prevent dislocation, and two other assistants control the movements of the limbs but do not exert pressure on them. It is, I think, important not to obstruct the strong flexor movements of arms and legs. As soon as the clonic stage appears to be ending, the patient's head is turned over the side of the bed to allow saliva to dribble from the mouth, and as soon as regular breathing has restarted the patient is removed on a stretcher. In the average case we give treatment on alternate days, but in some very acute cases a daily shock for one or two weeks or even longer may be of considerable value. Unless a fit occurs no benefit whatever appears to result, and it may be advisable to repeat in half an hour or the following day. Sargant and Slater in an otherwise excellent account describe a much more elaborate technique in which the patient is largely immobilised, but I am not convinced of the necessity of this, and some of their reasoning is difficult to follow.

Complications.

Many complications including fractures of the femur and crush fractures of the vertebræ have been described. The latter were only diagnosed radiologically and only appeared to give rise to some pain in the back. In our series there were two cases of dislocated jaw. Treatment was discontinued in one case because it seemed to produce an undue amount of circulatory shock, and in another case because there was an undue delay in the restarting of respiration.

Results.

Excluding the two patients in whom treatment was stopped after the first or second convulsion, the remainder—sixty-seven patients—could be divided into the following groups: Melancholia (thirty-four cases), paraphrenia (chronic delusional insanity with hallucinations) (nine cases), dementia præcox (ten cases), recent mania (one case), and a miscellaneous group (thirteen cases) consisting mainly of patients exhibiting recurring attacks of excitement with impulsiveness and destructiveness or episodes of refusal of food. Many of this group were partially demented or feeble-minded patients to whom the treatment was given in the hope that it would lessen excitability or destructiveness or promote appetite, and all were old-standing cases.

To take the last group first, there was no recovery in this group. In a number of cases periodic refusal of food or destructiveness was definitely cut short and the nursing anxieties considerably lessened. There was no evidence though that this treatment will have any effect in reducing the frequency of such periodic episodes.

Only one case of recent mania in a single woman of twenty-seven years was

treated. This patient ultimately made a good recovery in four and a half months, but I had the impressioon that she would probably have recovered more quickly without the treatment. Extremely little has been published about the effect of E.C.T. in mania; the results, however, so far published appear much less favourable than in melancholia. Recent mania as a rule responds very quickly to ordinary psychiatric treatment, but with further experience of E.C.T. a field of usefulness may be uncovered, especially in the prevention of delirious states. I shall refer to this later.

In the paraphrenic group only one of the nine patients treated appeared to benefit, but it is unlikely that she will ever recover sufficiently to be discharged.

In the dementia præcox group all the ten patients treated were well established cases, and in none of them did there appear anything but very temporary benefit. Some writers have recorded good results in very early cases of dementia præcox, but in some of these I have a suspicion that the condition may actually have been a melancholic psychosis with confusion, which is often very difficult to differentiate from dementia præcox. However, in such cases there is no harm in giving the patient the benefit of the doubt, as the treatment appears to be harmless. It is wise, though, in dementia præcox cases especially, to take extra nursing precautions, as some patients become extremely impulsive during the treatment.

When we come to depressive conditions, however, I am glad to be able to present a slightly different picture. Of the thirty-four patients treated, twenty-six have already recovered and are doing well at home, and one, although completely recovered, is learning forestry on our farm prior to discharge to take up similar work. One patient is definitely improved both mentally and physically, and is allowed parole, but a residue of depression is still in evidence. Two female patients are still under weekly "maintenance" doses, to which I shall refer later. Only four cases therefore out of the thirty-four treated appeared to gain no benefit. Two of these cases were re-admissions whose first mental symptoms dated back a number of years. The third case, although apparently recovering completely from each series of convulsions, repeatedly relapsed into a semi-stuporose condition. We are now giving her a long rest before trying her again. The fourth case was a hypomanic male patient who was admitted in his fourth attack of melancholia. He recovered quickly under E.C.T., but soon relapsed, and we are now allowing recovery to proceed by natural means.

I think it would be helpful to give brief histories of some of these cases. The following three cases, with some others, were all in the hospital a considerable time before we obtained our apparatus.

C. F. Adm. 22/8/42. Aged 48. Married. Acutely depressed on admission. Suicidal. For a few months after admission patient showed some improvement, but this was not maintained, and for the whole of 1943 she was depressed, suicidal, and under special observation. E.C.T. commenced 4/1/44. Nine convulsions given. No apparent improvement at end of course, but three weeks later marked improvement set in, and she was discharged "recovered" on 1/4/44.

M. McA. Adm. 13/4/42. Female. Aged 40. Single. Weaver. Dull and

depressed on admission. Poorly nourished. Vacant expression. Answers in monosyllables if at all. Difficult with food. Spoon-feeding often required and sometimes tube-feeding. Remained as above until May, 1944. E.C.T. commenced 30/5/44. Brighter after third convulsion. After fifth convulsion rational and cheerful. Anxious to write home. Eight convulsions given in first course. Discharge arranged for July, when patient relapsed. Five more convulsions given in July, after which patient was again much improved, but improvement only lasted one week. Allowed to rest until October. Three further convulsions given early in October, following which patient appeared fully recovered, and treatment discontinued. Remained well, and discharged 22/12/44. Continues to do well. Sixteen convulsions given in all three courses.

D. R. Adm. 13/6/38. Aged 39. Single. Farm labourer. Depressed and worrying. Sleepless and agitated. In October, 1938, he began to mutter incoherently to himself and became completely inaccessible. Remained in this condition without any variation until July, 1944. E.C.T. commenced 6/7/44. Spoke a few rational sentences after fourth convulsion. After fifth convulsion spoke rationally and freely. Received six convulsions in all. Remained rational and cheerful and full of interest in everything. Complete amnesia for the whole of his period in hospital. Never heard of the war. Annoyed and amused at losing six years of his life. Discharged 6/9/44. Visited hospital 10/2/45. Has remained well and working continuously since discharge.

The following eight cases were recent admissions and are typical examples of our experience. In the first case we did not use E.C.T. for some months after admission, as we were then to some extent feeling our way.

M. C. Adm. 4/12/43. Aged 53. Married. Embroiderer. Depressed. Agitated. Delusions of syphilitic infection. Took food badly. Lost weight. No improvement when E.C.T. commenced in May, 1944. After second convulsion much brighter. Began to smile. After fourth convulsion said he "felt a different man." Seven convulsions in all given. Improvement maintained, and discharged "recovered" 10/6/44. Has continued to do well. When E.C.T. treatment was decided upon this patient's physical condition was beginning to cause anxiety. He was steadily losing weight, continually restless, acutely depressed, picking at his skin, etc. This condition was completely transformed within one week.

E. McG. Adm. 7/4/44. Aged 20. Married. Depressed. Weeping. Delusions that she is frightening other people. Symptoms present for two months following premature birth of twins—with considerable hæmorrhage. E.C.T. commenced 29/5/44. Marked improvement after fourth convulsion. Eight convulsions given. Improvement fully maintained. Allowed out on parole. Discharged "recovered" 30/6/44. Has continued to do well.

G. C. Adm. 31/7/44. Aged 55. Married. Card Loom Worker. Depressed. Full of worries. No interest in work. "Would rather be dead." E.C.T. commenced 11/8/44. Four convulsions given. Stated after fourth convulsion that he was too sore to stand any more. Very much brighter. Week later stated he was "one hundred per cent. better." Improvement fully maintained, and

discharged "recovered" 18/10/44. Has continued to do well. This was a depressive illness which ordinarily speaking might have been expected to last six to eight months. Recovery was actually complete in just a month from admission, but patient was in no hurry to go home, and remained another seven weeks.

M. K. Adm. 8/9/44. Aged 38. Married. Depressed. Weeping. Unable to look after children. Symptoms present for nine months following illness of youngest child, when patient lost sleep for about a month. E.C.T. commenced 9/9/44. Six convulsions given. Improvement immediate, and no weeping after fourth convulsion. Patient continued to improve steadily following cessation of treatment. Allowed parole outside grounds. Became steadily more self-confident, and was discharged "recovered" 30/11/44.

T. K. Adm. 7/6/44. Aged 31. Single. Farm Labourer. Depressed and extremely confused on admission. Absolute sleeplessness in spite of sedation. Toxic and delirious symptoms of great gravity began to develop, and in view of the hopeless outlook with the usual methods of treatment it was decided to try E.C.T. E.C.T. commenced 10/6/44. Five convulsions given. The toxic and delirious symptoms disappeared after first convulsion and never re-appeared. A week following cessation of treatment he developed a pneumonic consolidation at one base, and this was extremely slow in clearing up, but eventually he made a good recovery, and was discharged 13/10/44. Has continued to do well.

R. P. Adm. 14/4/44. Aged 56. Married. Depressed. Delusion that the devil is in her ear. Restless and agitated and continually picking at ear to get the devil out. Caused considerable septic inflammation of outer meatus. E.C.T. commenced 20/5/44. Eight convulsions given. Depression and agitation disappeared completely after sixth convulsion. Discharged 1/7/44. Has remained well.

B. M. Adm. 1/9/44. Aged 32. Single. Housekeeper. Depressed. Said "she was going off her head." Sleepless. Unable to do her work for previous six weeks. E.C.T. commenced 12/9/44. Four convulsions given. Treatment stopped on account of excellent response. Patient apparently completely recovered. Maintained improvement, and discharged 6/10/44. Visited hospital subsequently and said "she felt better than she had been for years."

A. B. Adm. 14/12/44. Aged 54. Fitter. Emaciated. Very depressed. Refusing food at home. Delusions of bowels being stopped. E.C.T. commenced 15/12/44. Seven convulsions given. Began to eat and sleep well after first convulsion. No depression or delusions in evidence after fifth convulsion. Put on weight rapidly. Remained well, and discharged 3/2/45. This man made a complete recovery from a very acute melancholic illness in under eight weeks. Prior to E.C.T. one would have been well satisfied to have obtained this result in eight months.

Taking sixteen recent admissions exhibiting depression, where the treatment was instituted comparatively early, the average length of stay in hospital was $2\frac{7}{8}$ months—shortest period one month, longest five months. The average number of convulsions given to these patients was ten. In comparing this with an analysis of a similar series of recovered melancholic cases which I carried out some years

ago, I am satisfied that E.C.T. considerably more than halves the length of stay in hospital. Apart from definite melancholia, cases which one might label 'anxiety neurosis' would seem to do equally well. Case M. K., whom I saw in the first instance at Lurgan Out-Patient Clinic, was a typical case exhibiting weeping and anxiety. Anxiety hysteria, often confused with anxiety neurosis, is of course an entirely different affection. It should rarely require this treatment, nor does shock therapy appear to be particularly successful in hysterical states.

In view of the success of E.C.T. in a case of delirious melancholia, T. K., I wondered what effect it would have in that equally rare but more intractable condition known as delirious mania. This condition frequently resists all treatment, the patient sinking into a delirious and semi-comatose condition with usually a terminal broncho-pneumonia. On 7th February, 1945, a female patient, M. J. McC., aged 63, was admitted in a very exhausted, maniacal condition. Her condition remained stationary for about ten days, but on 17th February it was evident that the excitement had passed into a delirium—with continuous incoherent chattering, obliviousness of surroundings, extreme restlessness, red dry tongue, some bronchitis and pyrexia. On account of the extremely poor outlook with the usual methods of treatment, I decided to try E.C.T. Convulsions were given daily for five days, beginning on the 17th. Following the first convulsion there was a definite lessening of delirium, and following the second, the patient rested and slept naturally throughout the following day and night. She now coughed up the bronchial secretion which previously had gurgled up and down in the bronchial tubes. Improvement has been fully maintained, and there has been no return of delirious symptoms, although the patient still remains in a condition of mania.

Our practice has been to give one or two additional convulsions after all the depression has apparently disappeared. A return of depression is similarly dealt with. To continue unduly with this treatment—after depression has completely gone—would seem to run the risk of inducing elation or confusion. In some cases patients appear completely self-confident as soon as the course is finished. In others, although there is no depression, a variable time is required before the patient completely regains self-confidence. Temporary loss of memory during the treatment is sometimes puzzling to the patient, but is of no account. A feature of the treatment is the marked increase in appetite which it induces. Patients who were spoon- or tube-fed can scarcely be satisfied, and the weight literally jumps up.

Prognosis in melancholia was of course always relatively good, but with E.C.T. the period of hospitalization is greatly reduced. The treatment, moreover, promises practically to eliminate those triple bogies of melancholia—suicidal attempts, gradual loss of weight ending up in exhaustion and circulatory collapse, or the appearance of intense depression with restlessness, sleeplessness, and confusion, ending up in melancholic delirium. In addition, the distressing symptoms of the actual mental depression are removed almost overnight and natural sleep almost immediately restored.

Relapses following the cessation of a course of treatment are not uncommon, as in the case of M. McA., who required three courses. Between the second and third

courses we allowed her to remain depressed and confused for three months. In the last course three convulsions only were sufficient to restore her to complete normality, and she never subsequently showed any tendency to relapse. In two cases, still in hospital, a weekly 'maintenance' dose keeps them cheerful, rational and well occupied; without this both would relapse in the course of another week or so into a depressed, confused, resistive condition, giving considerable difficulty with food. Until, of course, the tendency to relapse disappears, if at all, it will be impossible to discharge them. Further experience should throw a good deal of light on the problems presented by such patients, and I anticipate that in the light of this experience we should be able to use this treatment with much greater finesse.

I might perhaps summarise my experience to date of this form of treatment.

E.C.T. does not appear to give any further hope in those sad cases sometimes known as the *malignant* psychoses—dementia præcox and paraphrenia. In manic states there is not much definite evidence of its value; one case would suggest that it may be very useful in delirious mania. In depressive states at all ages, and in all degrees of severity, from simple anxiety to melancholic delirium, it would appear to be one of the most important additions to treatment in the long and tortuous history of psychiatry.

REFERENCE.

SARGANT AND SLATER: *Physical Methods of Treatment in Psychiatry.*

REVIEW

THE QUARTERLY REVIEW OF PÆDIATRICS. THE QUARTERLY REVIEW OF PSYCHIATRY AND NEUROLOGY. THE QUARTERLY REVIEW OF UROLOGY.

THE Washington Institute of Medicine announces three important additions to its already imposing list of Quarterly Reviews. The first of this—Quarterly Review of Pædiatrics, which will appear under the direction of a strong editorial board representative of many medical schools in the United States and Canada, with Dr. Irving J. Wolman of the Children's Hospital, Philadelphia, as editor in chief. Its prime function is to make it feasible for the busy physician to keep abreast of the most recent progress in all branches of pædiatrics with a minimum of time and effort. Abstracts are prepared by trained bibliographers, most of whom are physicians, and explanatory or critical comments are added where necessary. The Quarterly Review of Psychiatry and Neurology will perform a similar task in its special subjects under the editorship of Professor Winifred Overholser of the George Washington University School of Medicine. The table of contents of the first issue ranges over very wide fields in psychiatry and neurology. The Quarterly Review of Urology has Dr. Hugh J. Jewett as editor in chief, and the members of his Board "are charged with the responsibility of selecting from every dependable source all contributions which in their judgment are of fundamental importance and unusual merit, to which they may add their own comments."

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REVIEW

THE QUARTERLY REVIEW OF PÆDIATRICS. THE QUARTERLY REVIEW OF PSYCHIATRY AND NEUROLOGY. THE QUARTERLY REVIEW OF UROLOGY.

THE Washington Institute of Medicine announces three important additions to its already imposing list of Quarterly Reviews. The first of this—Quarterly Review of Pædiatrics, which will appear under the direction of a strong editorial board representative of many medical schools in the United States and Canada, with Dr. Irving J. Wolman of the Children's Hospital, Philadelphia, as editor in chief. Its prime function is to make it feasible for the busy physician to keep abreast of the most recent progress in all branches of pædiatrics with a minimum of time and effort. Abstracts are prepared by trained bibliographers, most of whom are physicians, and explanatory or critical comments are added where necessary. The Quarterly Review of Psychiatry and Neurology will perform a similar task in its special subjects under the editorship of Professor Winifred Overholser of the George Washington University School of Medicine. The table of contents of the first issue ranges over very wide fields in psychiatry and neurology. The Quarterly Review of Urology has Dr. Hugh J. Jewett as editor in chief, and the members of his Board "are charged with the responsibility of selecting from every dependable source all contributions which in their judgment are of fundamental importance and unusual merit, to which they may add their own comments."

Currents and Eddies in Practice

By ALEX. PATTON, B.A., M.D., D.P.H.

When one passed as a student from Arts to Medicine, and back again to Arts—as some of us did—Professor Boas with his Shakespearean recollection of the witches would refer to our "fitful re-appearances." In making one of these, I invite you to come down from the bright circle where you have sojourned at the last few meetings, and have a peep at the pit—even though in the modern theatre there may be neither pit nor circle. In a weak moment I have been tempted to give you this paper, partly to jot down a few experiences and ideas, however circumscribed, before they become out of date or merely academic. I would also take the opportunity to pay a humble tribute to the memory of our teachers—men of much charm and considerable distinction—who were wont to forgather here and adorn these front seats. You missed them one by one—to me the loss appears as of all together at one fell swoop. Furthermore, in two destructive wars we have lost much of the flower of two generations, and thus handicapped remain to face the opening of a new era.

> "For, some we lov'd, the loveliest and the best
> That from his vintage rolling Time has prest,
> Have drunk their cup a round or two before,
> And one by one crept silently to rest."

Neither the turbid waters of society nor the more limpid rivulets of the art and science of medicine move in quite so steady a stream as once we visualised. Strong currents, eddies, even whirlpools have upset the even tenor of the passage. Something of this may appear as we proceed. It has been my privilege to practise in the ambit of three great cities—Belfast, Liverpool, and Manchester. Usually I preferred to observe their communal life from the near and middle distance—a dozen miles out on the green belt. As a city Liverpool seemed most attractive—its clean, tidy streets, convenient shopping centre, pre-war imports of fruit, social and intellectual snobbery at a proper discount, its cosmopolitan welcome and broad humanity, the Playhouse, the ferries and splendid docks. Manchester, of course, had its love of art and literature and its polite manners—I found its great obstetric hospital St. Mary's the most helpful and obliging. In trade, Mancunian in foreign parts has been almost synonomous with English. But I do not envy its planners, faced with the gaunt ruins of the first Industrial Revolution. Neither of these great centres has a hinterland to compare with yours—the approach to Belfast Lough on a summer morning being excelled in Europe, in the view of many travellers, only by the islands guarding Stockholm or by the Golden Horn. *Vis-a-vis* your other virtues, language fails! The blot on your landscape is infant mortality—in other parts of the United Kingdom they apologise for a figure of 50, and I see dear old Holywood has now got down to 43. Many of these infants are born prematurely, and our present knowledge properly applied could save most of them. Although it has other drawbacks, institutional maternity is of benefit in this respect. No longer do we hear the sagas and folk songs of the "handy women"—gone with the wind.

Again I hear the familiar dialect. "What age are you?" does not have to be translated as "How old are you?"; and one may freely imbibe the gorgeous colouring of sea, sky, and countryside scarcely noticed by the residenters. During well nigh twenty years in the other island, the *Ulster Medical Journal* and the *Belfast Telegraph* kept me informed, but in these last years of austerity their sparse and attenuated efforts, together with black-out and censorship, served only to accelerate the onset of nostalgia. Although the car suffered least from bureaucracy in transit —no permit required—the stringent tones of fuel and power on this side—"Sorry, no petrol!"—could hardly damp one's admiration for a progressive Northern Ireland Ministry of Agriculture which arranged for an unrestricted supply of milk —pasteurised, too—and an allowance of fresh fish, a delicacy almost recalled from a previous existence. Unfortunately, however, as in England, there is some failure to tackle bovine T.B., and the two per cent. of "beasties" which transmit the disease seem to elude the authority. The British Ministry of Food deserved many compliments, but their pasteurised milk, owing to short staff and carelessness, was frequently stale and dirty; nor were any bouquets forthcoming for the distribution of fish, which still causes needless hardship to many toiling housewives. I take off my beaver to these spartan women of Lancs, who, next to the Merchant Navy, endured and toiled perhaps more than any other Britishers: the same who for the most part never had an anæsthetic nor even an analgesic to relieve the purple patches of their reproductive married lives, besides having to fight for justice—many of them—in securing their rights in National Health Insurance. Whatever else social security fails to do, it will at least bring automatic benefit to motherhood.

Men rather than women showed the effects of war-time neurosis, convinced that every illness was due to conditions of work. This meant more fatigue for the already overburdened panel doctor, though the morbidity was not necessarily shown in statistics available to the Ministry of Health. And much of it was due to the neglect by politicians and managements of the Medical Research Council's findings a quarter of a century ago in regard to working conditions. Pigeon-holed and forgotten! In practice many practitioners had nine-tenths of their insurance patients ill each winter, whereas you in Northern Ireland seem to see a much smaller proportion. The general effect in such practices is frustration for doctor and patient alike. As Dr. Crichton Miller says: "National Health Insurance has made domiciliary medicine give way to a crowded surgery. The personal approach has been crowded out by the technical imperative, and re-adjustment must be made." It is a recognised fact that many practices could not be carried on but for the immense assistance—sometimes even abuse—of the voluntary hospitals, and the great good-will of the consultants attached to them. This applied to many private patients also—I have known practitioners whose only notes on their private cases (apart from accounts) were those they had received in the course of years from consultants, hospital and private.

Who ever supposed that the ideal setting for medical work is the lust for speed and hustle that has invaded surgeries, consulting-rooms, and hospitals alike—even in peaceful Ulster? The careful and unhurried tradition of McQuitty, Robert

Campbell, and Killen of the Benn, produced as good results, but now the poor patient is *rushed* from pillar to post, not seldom failing to gain satisfaction, and, his fears and worries unresolved, enters a puzzling world of conflicts and repressions. In the words of Osler, "The philosophies of one age have become the absurdities of the next." There seems to be no remedy in sight save a large accession to our ranks. Compare the leisured ease of the municipal office, the Exchange, or even the majesty of Law. Even when the junior arrives at 9.30, the great man saunters along in time for morning coffee, and business is well in hand by early afternoon. Incidentally, I thought work began an hour earlier in England in keeping with the boat time-table Livepool 6.30, Belfast 7.30. One had to see two or three serious cases soon after 8 to be at surgery in time to encourage the early birds at 8.45, whereas professional routine in Ireland was not in evidence before 10. There was little room for ill-feeling between general practitioners, or between these and consultants, unless in the very few instances where the latter were not genuine—a condition which is now being remedied. In some districts, however, there is need for much greater co-operation between general practitioners and the full-time Health Officers, both of whom pursue their own course at times gloriously unaware of their imperfections. Not all M.O.H.'s were as honest as the new Superintendent of Belfast who, when asked whether Belfast people are healthy, admitted that he had little means of knowing. They have only statistics of deaths and a few infections to guide them. In Britain Council officers have long since given up the pretence of being preventive rather than curative; in fact, a great deal of the preventive work is already done in advanced areas by the general practitioner and the industrial adviser, in the more backward areas men wake up every few years and write to the Journals in amazement at what has happened to the women and children, etc. Health visitors working overtime; parallel lines failing to meet; but also much very fine work. *Vita brevis, ars longa.*

Between the wars I met a goodly number of Queen's graduates, many doing good work, some enjoying life with a hobby or a speciality, others slogging along in unpleasant surroundings, hardly knowing the country ten miles from their doorstep, yet others in the guise of itinerant craftsmen. What a tribute to the fraternity that, be the scene ever so benighted, no district but had its medical attendant, you would find a Scot, an Irishman, above all a Queensman, ministering to those poor English of the North and Midlands. Wales was more impenetrable, but Wales can be forgiven anything for its choral singing—the human voice *in excelsis*. Golfers I noticed were among the survivors, even if they had to tee up in a rubbish heap. They avoided the English figure of expectation of life (about 55 for doctors), approaching the Irish figure of 65.

On the specialist or expert level your Society has had good *liaison,* but one has sometimes felt that many less famous *alumni* have experienced colourful episodes which are being lost, i.e. for the amount of talent you export not so much is gained in return. To mention amongst a great number only three—now unhappily passed on—Macargur Scott, the seamen's friend; Billy Browne, chief citizen of a progres-

sive Borough; Arthur H. Joy, who, after a career in the Royal Navy, looked after disabled ex-servicemen. Others, however, remain, such as M.O.H.'s in important positions as Surrey and Huddersfield; a bright graduate whose mission in life has been to direct patients to the right consultant; and a host of eminent police surgeons called in to assist in the diagnosis of road accidents. It might be no bad thing to have a thoroughgoing exchange of teachers and students, as is mooted in other educational spheres, not only within the British home countries, but with the Dominions, U.S.A., Scandinavia, etc. That would eliminate the alleged time-lag, give us a richer "flair for orchestration," and render less harmful the untimely intrusion of the oboes and the bassoons—blissfully oblivious of what is going on in the world. To most doctors who are in touch with social conditions it is evident that the physicians of the past accepted as their standards service and self-discipline, and would not countenance the lower social and moral values of the market place to-day for all their glittering display of wealth and power. If it were not for our pagan code, the struggling voluntary hospitals could have their immediate difficulties met by a voluntary levy on all profits of the last six years over a reasonable margin. Too often the leaders in industry and wealth—merely by want of thought—beg the question by urging high taxation as a reason for ignoring their responsibility to the less fortunate. Shades of St. John of Jerusalem! But as far as hospitals are concerned, you have still in Ulster a larger body of kind benefactors, although the tendency to spread the cost over rates and taxes gains ground. *L'état, c'est moi!*

At our meetings on the other side, in the smaller towns and societies, we used to read papers to one another to stimulate discussion; two or three times in a season a junior specialist would oblige on his special subject. Often these would be on the staff of a teaching hospital, while at the same time visiting a municipal type in a smaller town, and as subsidiary work they functioned as a useful buffer to interpret the evergreen query "Can I be X-rayed, doctor?" The valuable labour of the vast majority was everywhere appreciated; it was one or two seniors who appeared to be in some danger of losing their souls to big business, insurance companies, or the State. At rare intervals a brighter star would visit us—from a London hospital, Birmingham, Leeds, or more local—Sir Robert Jones, who, with his band of followers, including your townsman Professor T. P. McMurray, raised the Liverpool School of Orthopædics to an unrivalled position; Sir Robert Kelly, almost as well known in Wales or Manxland as he was loved at home; in medicine, amongst a learned and able group, Prof. Henry Cohen, whose re-assurance to a patient was of an inspiring quality. Liverpool excelled in architecture, orthopædics, and psychiatry; Manchester's high lights were pædiatrics and radium therapy. The surgeons reached a sound technique—much better, as one would expect, than in areas where the cottage hospital type of practice was in vogue, and this matter, I take it, is one of the headaches for the Regional Hospital Service of the future. If one failing was open to criticism, it was that a few surgeons seemed to under-estimate the need for psychology in the consultant as distinct from the operative end of their work, particularly in these days when a super-imposed anxiety so often complicates the most obvious surgical condition. Much of this anxiety in middle-

class patients was of course caused by the patient having arranged no provident or insurance scheme to cover the cost of illness of this nature.

The County of Lancaster—where I think the only large town I missed was Oldham—bore a certain resemblance to Ulster in a sturdy independence of character, but this was sapped in the inter-war period by the operation of several causes, one being the failure of National Health Insurance and Workmen's Compensation to encourage light work as a means of early rehabilitation, another the inflationary methods of house building which made a demoralising hole in the low average wage of the time. The town of 40,000 inhabitants where I worked in the slump years had almost as good a record as any—from 1918 to 1938 it built 2,500 houses by private enterprise and 2,092 by the Local Authority. On returning to this side I have been surprised to find so little new building, but perhaps the population has been more stationary, and no doubt some of the century-old shacks are cosier and cheaper than the more modern structures, though there are not nearly enough of them. Some of the smaller districts are better up to their duty than the larger. A few medicos drift into Parliament at intervals, and in Britain there is a sprinkling on County and Borough Councils, but it is strange that there is hardly one on large Councils like Down or Antrim—representing each nearly a quarter million souls, and at a time when health matters will need expert attention. But maybe you are content to leave local government to the permanent officials!

Two other matters may be touched on. A little-discussed point in the employment of assistants in general practice is the effect on freedom of choice for the patient. We know practices where the assistant or apprentice had a greater reputation than the principal; and I knew an assistant who tied himself down for a period of years to do three-fourths of the work for one-fourth of the income. There are other financial anomalies which have not received sufficient study. With regard to health centres, the incubus of Local Authority control has burked consideration, although many doctors are already at the stage of making plans. Even in rural areas, something in the nature of the clinics operating in some American States, without any financial embarrassment, and rendering good service, has not been given much attention here. A few advantages may be noted:—

(1) Better equipment for diagnosis and treatment;

(2) Relief of congestion in hospital out-patients;

(3) Open all day—no need to ask "when will doctor be in?" or "what time does doctor shut?"

(4) Healthy team work and group practice—what Lord Moran, I think, has styled a return to the courtesies of student days;

(5) The encouragement of local specialisation;

(6) Labour saving for doctors' wives.

This type of public practice, we are told, may run alongside private work.

Currents and eddies lead to change, and in a changing world the end result may be decay as readily as growth. Most of us, however, are incurable optimists. seeking not licence, but a little freedom.

Knowledge comes, but wisdom lingers.

"Knowledge is proud that he has learnt so much.
Wisdom is humble that she knows no more."

REVIEW

AVIATION NEURO-PSYCHIATRY. By R. N. Ironside, M.B. (Aberd.), F.R.C.P. (Lond.) and I. R. C. Batchelor, M.B. (Edin.). Edinburgh: E. & S. Livingstone Ltd. 1945.

It is often urged, in view of the changed conditions in modern warfare, that the three fighting services of this country should have one common Medical Corps. One feels that this book is a tacit acknowledgment of the very complicated and specialised medical problems which may arise in any one of the Forces, and of the corresponding need for a separate administration of each service. The authors rightly state: "The psychiatrist or neurologist who has to deal with flying personnel will quickly find that he requires not only a knowledge of the medical aspects of his subject, but also a grasp of the environmental conditions in which aircrew work, and the demands made on the individual by the various categories of aircrew duties. This experience can only be gained at first hand."

The opening chapters deal chiefly with the difficult problem of the selection of personnel for flying duties. A useful scheme of examination is set out and the relative value of selecting candidates by performance and by personal examination discussed. Few will disagree with the view expressed that the candidate's will to serve and the strength of his motive in this respect may often be given priority over certain minor physical disabilities to which he may be subject. But, stress is laid on the necessity of finding out how strong is the motivation and the need for discounting sentimental reasons, revengeful feelings, a desire to test oneself, or for self-experiment, emulation or friends' example, etc.

The work is not intended as a textbook on psychiatry and neurology, so diagnosis is lightly touched upon, it being assumed that the reader has already some neuro-psychiatric experience. The subject of prognosis is given more detail and the principal aspects under which it may be assessed classified. The instructions given as to the care of personnel after flying accidents are well conceived, especially the dictum that leave should not be granted as a routine award, and that no member of aircrew should be allowed to go on leave after a flying accident before he has returned without symptoms to full duties.

The book can be confidently recommended to medical men having to deal with flying personnel, whether in the Royal Air Force or in the Civil Services, and is a welcome contribution on the subject. The authors have had a difficult task in deciding how much space to devote to the description of abnormal states, and how much to allow for administrative service details, and they have succeeded admirably. It is possible, however, that in subsequent editions they may find it advisable to enlarge the former section and include more detail of the affective, hysterical and other common disorders which predominate in this type of practice. R. S. A.

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Deposition at the Adjourned Inquest on the Death of Four Firewatchers

Submitted by HENRY BARCROFT, M.A., M.D.
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THE room had four windows, which could be opened, and a wall ventilator; on the night of the tragedy the windows were shut. The question was, suppose the gas stove was burning, could the men have died from suffocation due to insufficient ventilation? To answer this question the following test was devised. Two extra stoves, similar pattern to that already there, were to be installed in the firewatchers' room. Two individuals were to enter the room in the morning; close the door and windows, as they were on the night of the accident, and light all three stoves. If no signs of suffocation occurred after eight hours it could reasonably be concluded that suffocation could be ruled out as the cause of death. It might be objected that the test was not quite fair, because five people were in the room on the night of 2nd December, and only two were to be in on the day of the test. The objection, however, would not be valid, because the two extra stoves would use up as much air in a given time as thirty men. The conditions of the test would therefore be much more rigorous than those obtaining at the time of the accident.

It is necessary to say a few words about the tests to be performed by the individuals in the room, tests to see if there was any tendency towards suffocation. To understand these we must consider a little more closely the meaning of the word suffocation in this connection. It would cover three possibilities: (a) oxygen starvation, due to the oxygen in the room being used up—mainly by the three stoves; (b) carbon-dioxide poisoning, due to accumulation of this gas which would be produced by the burning stoves, and, to a smaller extent, exhaled by the subjects. Strictly speaking, these two—oxygen starvation and carbon-dioxide poisoning—would be covered by the term suffocation. But there would be another possible cause of disaster, (c) carbon-monoxide poisoning. This gas, which is deadly poisonous, forms about 18 per cent. of Belfast coal gas. When gas is burned in a modern pattern stove, in good order, all the carbon monoxide is destroyed in the burning process. Still the possibility of incomplete combustion, of carbon-monoxide poisoning, could not be overlooked. During the test eight hours in the room with the three stoves on, the individuals would busy themselves with tests to see if conditions were tending towards oxygen starvation, carbon-dioxide and/or carbon-monoxide poisoning.

1. In the first place a couple of mice would be taken into the room and examined regularly. Mice and canaries collapse much more quickly than men in the presence of carbon monoxide. They are used to test whether the atmosphere in mines is dangerously contaminated with carbon monoxide. If the mice collapsed in the room then it would prove that the atmosphere was becoming dangerous to men.

2. If there was any danger of oxygen starvation, or of carbon-dioxide or mon-

oxide poisoning, it would grow very gradually, and the individuals would be able to detect in themselves the early signs of poisoning.

Oxygen starvation has been studied extensively, for instance by climbers. When gradual it causes headache, nausea, dizziness, mental confusion, dimness of vision and weakness of hearing, palpitations, muscular weakness, increased pulse and breathing rate, vomiting, and blueness of the face and hands.

Carbon-dioxide poisoning causes increase in the rate of breathing, a bounding pulse, mental confusion, and a sensation of choking.

Carbon-monoxide poisoning really amounts to much the same thing as oxygen starvation, because carbon monoxide prevents the blood from carrying the oxygen from the lungs to the tissues. Hence the symptoms of carbon-monoxide poisoning are those of oxygen starvation (with the difference that the face does not go blue).

The individuals therefore would note at regular intervals their own feelings, normal or abnormal, their pulse, and their breathing rates.

3. As the small room was to be heated by three stoves it might become very hot, and this might of itself cause some discomfort. It would be advisable to check this regularly by measurements of room temperature.

4. At regular intervals during the eight hours in the room the air would be analysed to see how much poorer it was getting in oxygen and how much fouler in carbon dioxide. At the end of the eight hours samples of the air would be drawn off into tubes and, by the kindness of Mr. Hyslop, Engineer and Manager of the Belfast Corporation Gas Works, they would be analysed by another independent analyst. This would be a check.

5. Gas meters were installed so that the gas consumed (a) by the permanent stove and (b) by all three stoves would be checked at regular intervals. The data would be useful to calculate how quickly the room was being ventilated with fresh air.

The test, along the above lines, was carried out on Wednesday, 6th January, 1943. Of the two individuals concerned, one was Mr. Robbins, Assistant Manager of Belfast Gas Works, who supervised the stoves and meters; the other had charge of the medical and chemical aspects.

The room was closed up and the stoves lighted at 9.55 a.m. It will be convenient to refer to Table I for the results.

We now come to the inferences drawn from these tests. These are :—

(i) *Mice.*—No signs of abnormality at any time, in the room or after. No suggestion of carbon monoxide.

(ii) *Men.* Subject A.—No subjective symptoms whatever suggesting oxygen starvation, carbon-dioxide or carbon-monoxide poisoning. Pulse did not rise progressively, breathing did not increase in rate. Subject B.—No subjective symptoms, or pulse or breathing changes suggestive of oxygen starvation, carbon-dioxide or carbon-monoxide poisoning.

(iii) *Chemical Analysis of Air.* (a) Oxygen. The oxygen fell from the normal 21 per cent. to 19.2 per cent. As regards the diminution in the pressure of the subjects' oxygen supply, this can be altogether disregarded. The diminution in the oxygen pressure would be about the same as that one thousand feet above sea level,

say at the top of Cavehill. (b) Carbon-dioxide at the end of the eight hours was 1.4 per cent, a high but harmless figure. The atmosphere in which workmen work daily in breweries and aerated water factories sometimes contains 2 per cent. or more.

The tests on the mice and men and air have but a single meaning : i.e., they indicate that the air in the room remained harmless. It did not suffocate in spite of three stoves on, in spite of the fact that the two extra stoves would use up air as fast as about thirty men, in spite of the fact that all four windows were shut.

We conclude therefore that had the stove been alight throughout the night of 2nd December suffocation could not have been the cause of death. The results of out test are entirely in keeping with the fact that no ill-effects were observed on the nights previous to the accident when the firewatchers slept with the stove on.

But we can push our argument a stage further. We shall show that if the room had been closed and if one stove had been turned on but not lighted, there would soon have been a very distinct danger of coal-gas poisoning.

Referring to the test results of 6th January (Table I), it will be seen that during the eight hours 440 cubic feet of gas were burned by the three stoves. When gas is burned it produces, on the average, half its own volume of carbon dioxide. That is, the stoves emitted $440 \times \frac{1}{2} = 220$ c.ft. carbon dioxide in eight hours. (The amount produced by the subjects in the same time was so small in comparison that it can be neglected). Now, the air in the room contained an average of 1.1 per cent. carbon dioxide (see Table I). We can calculate how much air the 220 c.ft. was 1.1 per cent. of.

1.1 c.ft. of carbon dioxide are in 100 c.ft. of air

1 ,, ,, ,, $\frac{100}{1.1}$,, ,,

220 ,, ,, ,, $\frac{100 \times 220}{1.1} = 20{,}000$ c.ft. air

But, you may say, the room had a cubic capacity of three thousand c.ft., which is far less. True. The reason that the carbon dioxide from the stoves was contained in such a large volume of air was that fresh air was entering and foul air leaving the room the whole time (one change every 1 hour 20 minutes). We know then that the stream of 220 c.ft. of carbon dioxide mixed with a total of 20,000 c.ft. of air, more or less.

Let us suppose one stove is on but unlighted. How much coal gas would enter the room in eight hours? Referring to Table I, we see that the permanent stove consumed 24.5 c.ft. gas in the first hour. After this the consumption fell. This was because the stove has a thermostatic device which cuts down the gas when it is properly warmed up. We may then take 25 c.ft. per hour as the rate at which gas would issue from the unlighted stove. It would pass $25 \times 8 = 200$ c.ft. in eight hours. This would contain eighteen per cent. carbon monoxide, that is $\frac{200 \times 18}{100} = 36$ c.ft.

When the 36 c.ft carbon monoxide was mixing with the 20,000 c.ft. of air the

mixture would contain $\frac{36 \times 100}{20,000} = 0.18$, say, to the nearest place of decimals, 0.2 per cent carbon monoxide, less or more.

What effect would 0.2 per cent. carbon monoxide have on human beings?

AUTHORITY.	STATEMENT.
Sollman. *Manual of Pharmacology.*	0.2—0.4 per cent. is generally fatal.
British Encyclopædia of Medical Practice.	0.07 per cent. will cause unconsciousness.
Leschke, *Clinical Toxicology.*	0.1 per cent. produces unconsciousness and acts fatally in a few hours.
Hefter. *German Pharmacology.*	0.2—0.35 per cent. probably fatal.
Haldane, J. (1895). *Journal of Physiology.* 18/431.	Breathed 0.21 per cent. for 71 minutes, the results are given in full below :—

After 16 min. Pulse 91. No symptoms.
,, 20 ,, 17 per cent. of the blood saturated.
,, 34 ,, Very slight feeling of fulness and throbbing in the head.
,, 37 ,, Fulness and throbbing more distinct. Saturation 39 per cent.
,, 43 ,, Feeling decidedly "abnormal." Slight increase in breathing and marked throbbing.
,, 54 ,, Feeling very decidedly abnormal. Vision seems not so good. Slight feeling of giddiness.
,, 59 ,, Increased breathing more distinct. Beginning to look pale and yellowish and "as if ill."
,, 61 ,, Saturation 44.5 per cent.
,, 63 ,, Feel worse shortly after making any movement in my chair.
,, 65 ,, Marked increase in breathing and slight confusion of mind.
,, 71 ,, Saturation 49 per cent. Stopped experiment. Vision dim. Limbs weak. Had some difficulty in getting up or walking without assistance; movements very uncertain.

From these observations, Your Worship, we conclude that if, on the morning of 6th January one stove had been turned on but not lighted, the air would have been sufficiently poisoned with carbon monoxide to cause very serious effects in a few hours. We conclude that the tragedy on the night of 2nd December could have been caused by coal-gas poisoning.

In answer to a question from His Worship regarding the likelihood of similar ventilation conditions on the night of the accident and on the day of the test, the witness replied that the Air Officer Commanding, Northern Ireland, had kindly permitted the release of the following weather information.

DATE	WIND DIRECTION	MEAN SPEED	MIN. TEMPERATURE
2nd Dec., 1942 (night)	Calm or light northerly		30.05°F
6th Jan., 1943 (day)	North-east	15 m.p.h.	44.0°F.

The weather data were obtained a short distance from the city and in the open, and conditions in a built-up area some way removed would differ. On both occasions the weather was quiet generally, and there was no reason to think that the ventilating conditions would have been very different.

TABLE I

Time After beginning of Test in Hours	Condition of Mice	Condition of Subject A			Condition of Subject B			Room Temp. °F.	Air Analysis*		Gas Consumption c.ft. per hr.	
			Pulse	Resp.		Pulse	Resp.		$\%O_2$	$\%CO_2$	1 Stove	3 Stoves
0	All Well	No Headache or Palpitations	102	21	No Headache or Palpitations	86	18	51	—	—	0	0
1	„ „	Normal	93	21	Normal	84	19	59	—	—	24.5	75
1¼	—	—	—	—	—	—	—	—	19.9	0.5	—	—
2	„ „	Normal	82	20	Normal	77	—	66	—	—	23.0	50
2¼	—	—	—	—	—	—	—	—	19.9	0.9	—	—
3	„ „	Normal	78	20	Normal	76	16	68	—	—	17.4	55
3¼	—	—	—	—	—	—	—	—	19.5	0.9	—	—
4	„ „	Normal	83	19	Normal	74	20	71	—	—	22.8	50
4¼	—	—	—	—	—	—	—	—	—	1.4	—	—
5	„ „	Normal	89	20	Stuffy	82	20	72	—	—	18.1	60
6	„ „	Normal	91	19	Normal	84	20	73	—	—	19.0	50
6½	—	—	—	—	—	—	—	—	20.1	1.4	—	—
7	„ „	Normal	93	20	Normal	88	19	74	—	—	19.0	50
7¼	—	—	—	—	—	—	—	—	19.1	1.7	—	—
8	„ „	Normal	87	20	Normal	77	19	75	—	—	18.0	50
8¼	—	—	—	—	—	—	—	—	19.2†	1.4†	—	—
								Average	19.6	1.1	Total	440

*Analysis of fresh room air gave oxygen (O_2) 21%, carbon dioxide (CO_2) 0.2%.

†Gas Works Analyst obtained 18.3% oxygen and 1.5% carbon dioxide in his samples.

Inhaled and Swallowed Foreign Bodies

By KENNEDY HUNTER, M.B., F.R.C.S., D.L.O.
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IN reviewing the early medical literature, one is impressed with the relative scarcity of references to foreign bodies in the air passages; practically all the earlier cases were œsophageal. This must be due to failure of recognition. This assumption seems reasonable, when one reflects that thoracic percussion was discovered by Auenbrugger in 1753, but was not accepted generally until 1839, when Skoda further investigated this method of diagnosis; and Laënnec's discovery of auscultation of the chest in 1816.

Another important factor, particularly in the diagnosis of laryngeal foreign bodies in adults, was the development of mirror laryngoscopy. This was first attempted in 1829, but was not satisfactory till after 1854.

The very early accounts of the removal of foreign bodies from the air passages are of doubtful authenticity. Muys in 1690 reported in his "Practical Surgery" a case of a child of seven who died from suffocation three weeks after aspirating a bean.

In 1759, Louis read his "Memoir on Bronchotomy" before the Royal Academy of Surgery at Paris. He collected all the then known cases of foreign body, twenty-eight in number, and presented all that had been learned concerning the subject up to that time. An elaborate study of the subject was published by Samuel Gross in 1854 entitled "Treatise on Foreign Bodies in the Air Passages."

Certain of the physical signs and the important observations which were made during the early part of the nineteenth century are still fundamentally sound. With the development of X-rays, the diagnosis of foreign bodies has become, in great part, a problem for the radiologist.

It was Mr. Goodall of Dublin in 1844 who directed attention to the part played by the carina in influencing the passage of foreign bodies in their descent to the bronchi.

The significance and mechanism underlying the production of obstructive emphysema was described by Lescure in 1843.

Early in the nineteenth century, Allan Burns noticed the tendency for foreign bodies under certain conditions to play up and down the trachea, and later Cooper described a flapping noise which is heard over the cricoid cartilage by placing the ear over that structure, and is produced by the foreign body striking against the rima of the glottis.

In Gross's time, the treatment for foreign bodies in the air passages was, first—emetics and sternutatories to promote the expulsion of the foreign body, and, second—bleeding, expectorants, purgatives, and counter-irritation to prevent the effects induced by the presence of the foreign substance.

The danger of the foreign body being coughed up and impacted in the larynx

was recognised. The opinion was generally held that the only real safety for a person harbouring a foreign body in the air passages consisted in bronchotomy. Theophilus Bonetus recommended bronchotomy in 1850 in the case of a boy who had inhaled a piece of bone. He was over-ruled by the medical attendant, and the child died.

The first recorded case of this operation for relief from a foreign body was detailed by Verduc in his "Surgical Pathology" published in 1717. A fragment of bone was extracted through the free incision in the trachea. The removal of a bone from the right bronchus by Killian in 1897 marked the beginning of a new era in the treatment of foreign bodies in the air passages. Since then, contributions by Coolidge, Jackson, and others have aided in the perfection of a successful plan for treatment which has reduced the mortality rate from foreign bodies in the air passages from a frightfully high level to a rate not exceeding one to two per cent.

Some form of carelessness is responsible for most foreign-body accidents. Hasty eating, careless cooking, the holding of foreign bodies in the mouth by adults as well as children.

The majority of œsophageal foreign bodies in adults occur in those wearing an upper denture. This inhibits sensation, as the hard palate is more sensitive than the tongue. Objects which would not otherwise stick, may be arrested by stenosis of the œsophagus, simple or malignant.

In prophylaxis, the habit of holding objects in the mouth should be deprecated. Children are liable to follow the bad example set by their elders. Small objects such as safety pins, buttons, beads, and coins, should not be left within a baby's reach. No child under three should be allowed to eat nuts unless ground down.

Digital efforts at removal of foreign bodies frequently force them lower down. Dentists should exercise extreme care whilst extracting teeth under general anæsthesia. Careful mastication would reduce the number of swallowed bones. Loose dentures, especially partial ones, should not be worn.

The reaction of the bronchial mucous membrane to the presence of a foreign body depends on its nature and size. A small metallic foreign body may lie dormant in a bronchus for a considerable time. A vegetable substance such as a nut will quickly set up a violent reaction and will prove fatal, if not expelled or removed.

A careful history is most important in all foreign-body cases. There is practically always a symptomless interval between the initial symptoms and the onset of the later symptoms due to secondary changes in the lung.

A foreign body in the larynx will produce hoarseness, wheezing respiration, and cough; if large enough to produce obstruction, there will be dyspnœa with indrawing of the suprasternal notch, supra-clavicular fossæ, intercostal spaces and epigastrium. Cyanosis will only be present if the obstruction is sudden, otherwise the face will be pale and anxious.

A foreign body in the trachea may produce very few signs. A wheezing respiration may be heard with the stethoscope. A movable foreign body may produce a slapping noise by hitting the larynx on inspiration and falling down on expiration.

It may end in sudden asphyxia by becoming impacted between the cords with a violent expiration, such as a cough, or by holding a child upside down in an effort to expel it.

The physical signs of bronchial foreign body will depend on the amount of obstruction.

Jackson describes four definite types :—

Type I. *By-pass or partial bronchial obstruction.*—Here the air can pass to and fro with some degree of obstruction. Limitation of expansion of the affected lung may be found. There may be slight dullness or diminished breath sounds. Rales are present. An asthmatoid wheeze may be audible at the open mouth.

Type II. *Expiratory check-valve obstruction.*—Here air can enter the affected lung, but its exit is impeded so that emphysema is produced. Expansion is limited, and on percussion a tympanitic note is elicited. Breath sounds are diminished or absent. No rales are heard on the affected side, but may be present on the normal side. The heart is displaced somewhat to the opposite side. This type of obstruction is most often met with in the presence of a vegetable foreign body.

Type III. *Inspiratory check-valve obstruction.*—Here air can be forced out, but cannot enter. This quickly leads to atelectasis.

Type IV. *Complete bronchial obstruction.*—Air cannot enter or leave the lung. The air present is soon absorbed. Secretions rapidly accumulate and atelectasis results. Percussion is impaired, expansion is limited, and breath sounds are absent. The heart is displaced to the affected side.

Jackson lays great stress on the asthmatoid wheeze in bronchial foreign bodies. It is heard by placing the ear at the patient's open mouth during a prolonged forced expiration. He remarks that "all is not asthma that wheezes."

After a careful clinical examination, radiographic examinaton is done. In a non-opaque foreign body, screening is very useful. The expansion of each lung is carefully watched and the movement of the mediastinal structures is noted. Comparison of films taken at the end of inspiration and the end of expiration may localise a non-opaque foreign body.

The right bronchus is more frequently involved than the left, because of its greater diameter, its lesser angle of deviation from the tracheal axis, and the situation of the carina to the left of the middle line of the trachea.

There are no constant physical signs associated with uncomplicated impaction of a foreign body in the œsophagus. Here again, the history is important but often misleading. The patient usually points to a definite spot. If a bone is impacted just below the upper sphincter, the most common site, there may be a point of tenderness low down on one side of the neck.

On being confronted with a patient who claims to have swallowed a fish bone, a careful examination of the pharynx should first be made. Fish bones frequently stick in a crypt of the tonsil, and only a very small point may be visible on the surface, so good illumination is essential. The laryngo-pharynx should next be examined with a mirror. I have seen many fish bones stuck in the dorsum of the

tongue. An eggshell may lie in a pyriform fossa for a long time if it corresponds to the shape of the fossa.

In a doubtful case of impacted non-opaque foreign body in the œsophagus, an X-ray barium swallow may help, but it is usually not conclusive.

My general plan is to see the patient again in twelve to eighteen hours. If there is still any doubt, I do an œsophagoscopy. The danger of an œsophagoscopy in an otherwise normal patient, if done carefully, by one who knows the technique, should be negligible. Foreign bodies in the trachea, bronchi, and œsophagus, if not expelled or removed, ultimately prove fatal. There is much less chance of a vegetable foreign body, such as a nut, being expelled from the bronchus. Jackson quotes 112 cases in which no bronchoscopy was done; in three the nut was spontaneously expelled (less than 3 per cent.); in 109 of the cases the patient died (over 97 per cent.).

The danger from bronchoscopy lies in the use of oversized instruments and in repeating bronchoscopies in children at too frequent intervals or in prolonging the procedure unduly. Jackson's guide to duration is as follows :—

In children under one year, endoscopy should be limited to twenty minutes and should not be repeated sooner than a week unless urgently indicated. A child of five will bear forty to sixty minutes and an adult a longer time. Intermittent illness calls for postponement unless urgently indicated.

Complications of bronchoscopy.—Surgical shock is avoided by a careful technique and an eye on the clock. Local reaction may vary from a slight hoarseness for a few days to subglotic œdema. The latter is only seen in infants under three years of age with loose, subglottic aureolar tissue that swells quickly. The treatment is early tracheatomy.

Complications of œsophagoscopy.—Faulty technique may cause injuries to the larynx, especially the crico-arytenoid joint. The most dangerous complication is perforation of the œsophageal wall with mediastinitis; occasionally it may become localised and may be evacuated surgically. It is usually very virulent and spreading infection, with death in forty-eight to seventy-two hours. It is possible that penicillin may considerably lower the mortality in this very dangerous but fortunately rare complication.

Foreign bodies may remain in the œsophagus for a long time. Weaver of Detroit reported a case in the Archives of Oto-Laryngology (July, 1943) of a chicken bone in the œsophagus for fifty-six days. I shall refer later to a case of similar duration.

The equipment required for successful peroral endoscopy is extensive, and many failures are due to inadequate equipment.

The bronchi and œsophagus will not safely allow dilitation beyond their normal calibre, therefore it is necessary to have tubes of the sizes to fit these passages at various ages and at various depths in the bronchial tree. All the standard instruments should be at hand in every case. It may be necessary to procure additional instruments for an unusual case. Two essentials are a suction apparatus

and a reliable electric battery with spare cells. All instruments, including lamps, should be tested immediately before use.

Preparation of patient for endoscopy.—Artificial dentures should be removed. Whether local or general anæsthesia is to be used, the patient should receive no food for five hours before operation, except in the case of an emergency. A general examination of heart and chest should always be made. I have heard of an aortic aneurysm being opened by an œsophagoscope with disastrous and very messy results.

Dehydration and acidosis should be treated first, except in acute dyspnœic cases. Every patient should be examined by indirect mirror laryngoscopy as a preliminary to peroral endoscopy. In most cases, radiographic examination is essential. Babies and very young infants should receive no anæsthetic. The older child should have a general anæsthetic except in the presence of acute dyspnœa.

Bronchoscopy in adults is done under local anæsthesia with cocaine. Œsophagoscopy in adults is usually done under local anæsthesia, but special cases, such as a very large œsophageal foreign body, are better done under general anæsthesia. An hour before operation, a full dose of morphia and atropine is given. The pharynx is sprayed with two per cent. cocaine, and then the superior laryngeal nerves are blocked by placing swabs soaked in ten per cent. cocaine, in the pyriform fossæ; the nerves are immediately under the mucous membrane of the medial wall of the pyriform fossæ. In addition, the epiglottis, pharynx, gums, and lips are painted with cocaine. This is all that is required for œsophagoscopy. If bronchoscopy is contemplated, a swab is placed between the vocal cords and this is followed by an injection of cocaine down the lumen of the trachea, the patient being postured to allow the cocaine to run down the right or left bronchus or both, if required.

The position of the patient on the table is most important. The head and shoulders should extend beyond the end of the table, the edge of which supports the thorax at the level of the scapulæ. The head is held by an assistant so that the cervical spine is flexed and the head extended at the atlanto-occipital joint. The œsophagoscope is passed down one side of the tongue till the epiglottis is seen. It is passed behind this and then made to enter the pyriform fossa on that side. Slight perssure is brought to bear in the direction of the opposite side, and if the patient is conscious, voluntary swallowing efforts help to overcome the contraction of the upper œsophageal sphincter. Once it has passed this, it usually passes easily if the head is moved so that the scope is directed towards the centre of the lumen.

In doing a bronchoscopy, after the epiglottis has been passed, the scope is directed forwards between the cords into the trachea. At the lower end of the trachea, the carina or septum between the two bronchi is identified as a vertical spur. The head is moved to the side away from the bronchus to be examined. The main bronchial orifices are then examined seriatim.

The following are illustrative cases of œsophageal and bronchial foreign bodies :—

1. J. M., male, aged 59. Swallowed meat bone four days previously. Dysphagia,

level of supra-sternal notch. Œsophagoscopy. Local anæsthesia: meat bone found impacted just below upper sphincter. Disimpacted and removed. (Fig. 1).

2. S. A., male, aged 52. Swallowed piece of dental plate. Sensation of sticking above cricoid. X-ray: foreign body level of first thoracic vertebra. Œsophagoscopy. Local anæsthesia. Foreign body removed. (Fig. 2).

3. J. B., male, aged 29. Swallowed upper denture previous day. X-ray: denture upper end œsophagus. Œsophagoscopy. General anæsthesia. Foreign body removed with great difficulty.

4. H. W., female, aged 62. Swallowed meat bone six weeks previously. Examined at another hospital—nil found. Complained of dysphagia. Paralysis right vocal cord. X-ray: three shadows in position of œsophagus at level of first thoracic vertebra. Œsophagoscopy eight weeks after accident, general anæsthesia. Three pieces of bone impacted in wall of œsophagus. Disimpacted and removed. Recovery uneventful.

5. M. G., female, aged 65. Swallowed pigeon bone. Dysphagia level of cricoid. X-ray barium swallow: suspicious shadow. Œsophagoscopy. General anæsthesia. Pigeon's rib with "flag" of skin attached found impacted across lumen of œsophagus. Disimpacted and removed.

6. S. B., male, aged 60. Swallowed meat bone two days previously. Swallowing impossible. Pain in chest. Œsophagoscopy. Local anæsthesia. Bone removed. (Fig. 3).

7. J. H., male, aged 27. Swallowed chicken bone. X-rayed and told no foreign body present. Four days later, complained pain radiating through to back. Slight pyrexia. Œosphagoscopy. Local anæsthesia. Chicken bone removed. Post-operative treatment: rectal drip and sulphonilamide powder by mouth. Recovery uneventful.

8. T. C., male, aged 62. Swallowed meat bone. X-ray: foreign body level of aortic arch. Œsophagoscopy. Local anæsthesia. Bone removed.

9. R. McK., male, aged 16. Swallowed penny. X-ray: coin upper end œsophagus. Œsophagoscopy. General anæsthesia. Coin removed. (Fig. 4).

10. S. McC., female, aged 20. Swallowed half-crown. Complained pain in chest. X-ray: coin in œsophagus. Œsophagoscopy. Local anæsthesia. Coin removed.

11. E. W., male, aged 46. Tooth extracted under gas and oxygen. Tooth slipped from forceps and disappeared. X-ray: tooth in right bronchus. Bronchoscopy. Local anæsthesia. Tooth removed. (Fig. 5).

12. L. McG., female, aged 14. Inhaled piece of grass two weeks previously. Complained of cough. Unilateral bronchitis. X-ray: opacity right lower lobe. Bronchoscopy. Local anæsthesia. Muco-pus seen in secondary branch of right lower bronchus. Suction tube passed down bronchus. No foreign body seen. X-ray ten days later, chest clear.

13. H. B., male, aged 3. Inhaled pea-nut. Child distressed and suffered from attacks of dyspnœa. Temperature 100. Pulse 140. Nil found on clinical or X-ray examination. Bronchoscopy. Avertin anæsthesia—unsatisfactory. Small nut in trachea. On removing nut, it broke up and fragments passed down into left

bronchus. One small fragment could not be removed because child became distressed. Next day, some stridor due to prolonged manipulation. Physician reported poor air-entry left base. Temperature subsided with sulphonamide therapy. Five days later, bronchoscopy repeated under general anæsthesia. No foreign body seen. Mucous membrane inferior branch left bronchus injected. Lipiodol injected. Chest X-rayed. No bronchial block. Recovery uninterrupted.

14. G. P. male, aged four. History of "swallowing" small metal cylinder. Complained epigastric pain. Seen by house surgeon and allowed home. Told to report if further symptoms developed. Brought back to hospital five days later. Vomiting previous night and complained of abdominal pain. Admitted to hospital. Very distressed. Respirations 34. Pulse 120. Temperature 101. Diminished expansion left side, breath sounds absent left base. X-ray : foreign body in left bronchus. Bronchoscopy. No anæsthesia. Metal pencil-top removed from left bronchus. Recovery uneventful.

15. W. McW., male, aged nine. History of "swallowing" end of silver pencil six days before. Coughed at the time, but no symptoms since. X-ray : foreign body in right bronchus. Dullness and poor air-entry right base. Bronchoscopy. General anæsthesia. Foreign body removed from right bronchus. Recovery uneventful.

REVIEW

TEXTBOOK OF PUBLIC HEALTH. By W. M. Frazer, O.B.E., M.D., Ch.B., D.P.H., and C. O. Stallybrass, M.D. (State Medicine), Ch.B., D.P.H., M.R.C.P., L.R.C.P., Order of St. Sava. Eleventh Edition. Edinburgh : E. & S. Livingstone Ltd. 1946. Pp. 571; figs. 78. Price 25s. net.

This book, representing largely the combined experience of the Public Health Department of Liverpool, covers the whole field of Public Health, and is an excellent manual for graduates studying for the Certificate and the Diploma in Public Health under the General Medical Council's new rules. The undergraduate will find the book too full of information for him to assimilate for his M.B. examination, but as a book of reference he will find it invaluable.

The introductory chapter is specially good, giving an account of the evolution of Preventive Medicine and showing its relationship to Social Medicine, a subject to which at present much attention is being devoted. A fine balance is maintained between the two aspects of the subject—personal and environmental.

Included in the book is a chapter on genetics, which, though succinct, gives an excellent exposition of this difficult subject, including a clear account of blood groups.

As one would expect from the authors and their colleagues, the work is written with first-hand knowledge of the many subjects discussed, is very readable, and is well illustrated.

W. J. W.

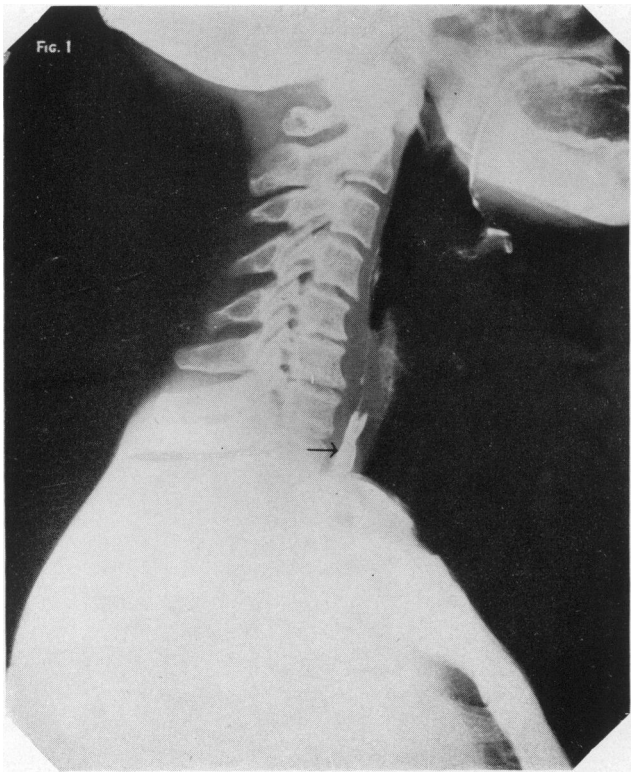
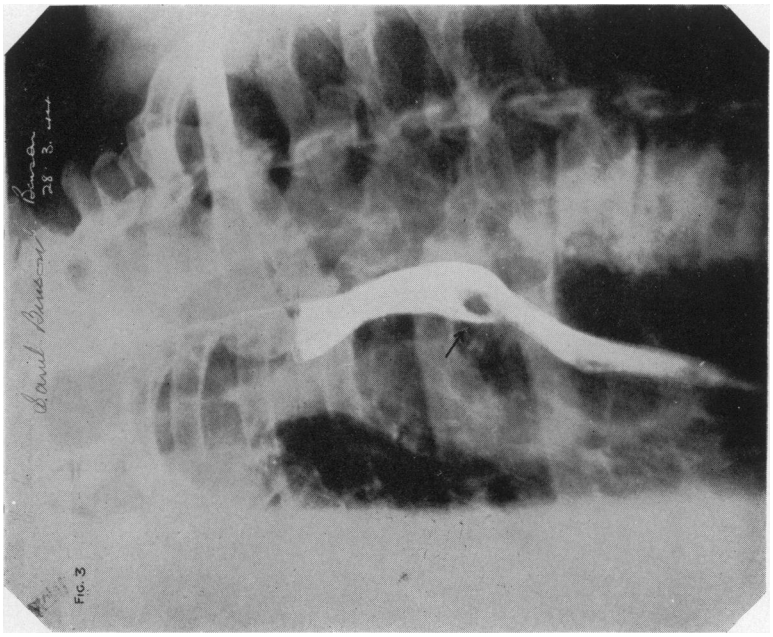


Fig. 1.



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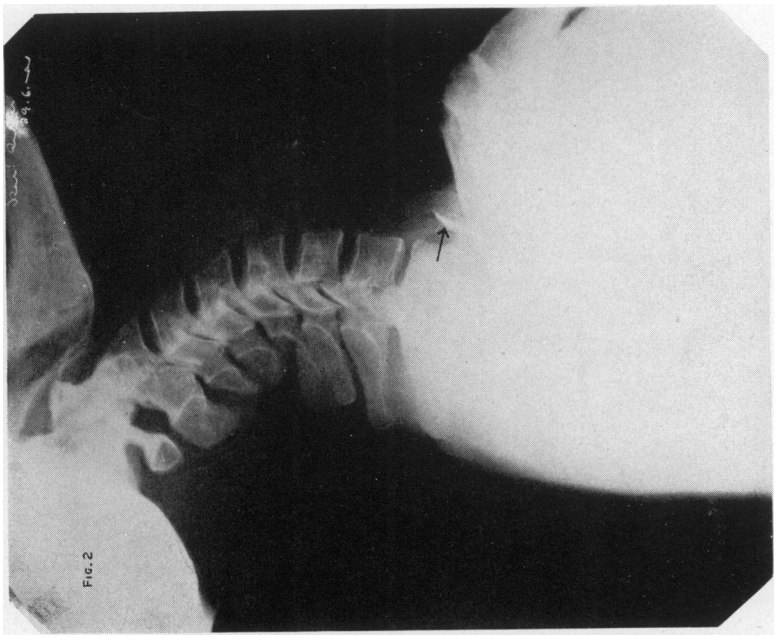

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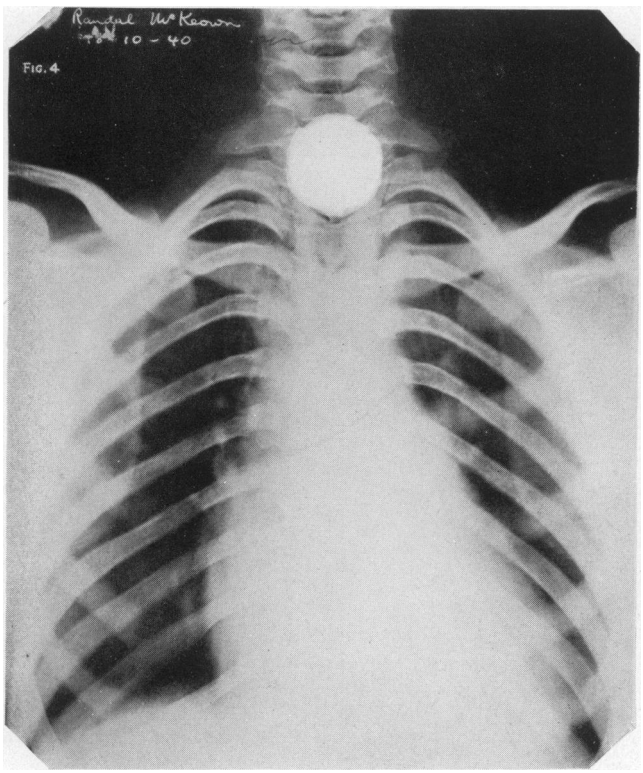

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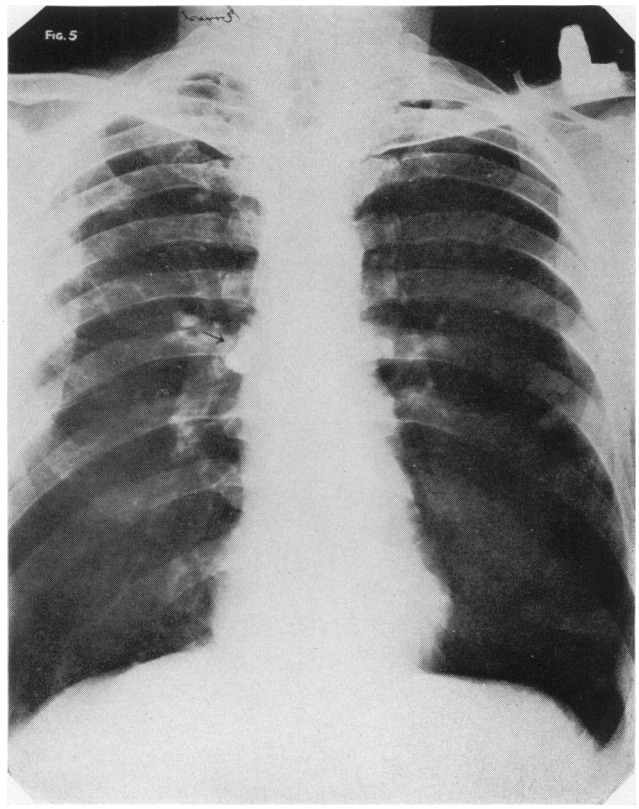

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TASMANIAN HEALTH SERVICES

TASMANIA, the heart-shaped island State two hundred miles below south-east Australia, is the second oldest state in the Commonwealth. History is graven into stone buildings that date back to the days of first settlement in 1803. The past lives on in cobbled streets, in ruins, and in old white farmhouses and inns.

But though Tasmania wears an air of antiquity gracefully, her Government and administration, particularly by her social services, are in line with modern practices. The Public Health Administration took another step forward recently when it launched a campaign to end tuberculosis within the State. The directors of the campaign realise that this will take years to achieve, but with every scientific, technical, and publicity aid they are confident of success.

The first task is to have an X-ray of every man, woman, and child in the State—a total over a quarter of a million. Ten thousand people were X-rayed at Hobart, the capital, in two weeks. There are stationary units there and at Burnie on the north coast; and mass radiography will be done by mobile units through every part of the State. The examinations are voluntary, and employers have co-operated with the public health authorities by sending their staffs to the clinics in groups of twelve every thirty minutes. Within ten days of the examination each person is sent one of two notices. The first advises that the X-ray was satisfactory, and asks that another be undertaken in twelve months. The second notice is sent to those in whom any abnormality has been detected. It advises an appointment time for a more detailed examination. If, after this, tuberculosis is detected, the sufferer is sent immediately to a local clinic or doctor for advice and treatment.

Sanatoria are to be built round the State so that those who have to enter the hospital will be able to go to one close to home. In every maternity hospital, every mother is X-rayed on admission. If there are any signs of the disease, the child is examined soon after birth, and close watch is kept on its growth.

It's an all-out war against disease. Tasmanians grow up in a bracing climate that is unsurpassed in the world. Their island is rich in beauty and natural charm. They intend that the people who have inherited one of the world's beauty spots will also possess health, the most priceless gift.

REVIEWS

DISEASES OF THE NERVOUS SYSTEM. By F. M. R. Walshe. Fourth Edition. Edinburgh: E. & S. Livingstone Ltd. 1945.

At one time neurology was considered by many to be a dull subject which offered little opportunity for successful treatment. Those who fought shy of the intricacies of diagnosis comforted themselves with the reflection that it did not matter much what was the site and character of the lesion as there was probably no treatment anyway. The appearance of a fourth edition (in five years) of Dr. Walshe's book on Nervous Diseases for Students and Practitioners

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Sanatoria are to be built round the State so that those who have to enter the hospital will be able to go to one close to home. In every maternity hospital, every mother is X-rayed on admission. If there are any signs of the disease, the child is examined soon after birth, and close watch is kept on its growth.

It's an all-out war against disease. Tasmanians grow up in a bracing climate that is unsurpassed in the world. Their island is rich in beauty and natural charm. They intend that the people who have inherited one of the world's beauty spots will also possess health, the most priceless gift.

REVIEWS

DISEASES OF THE NERVOUS SYSTEM. By F. M. R. Walshe. Fourth Edition. Edinburgh: E. & S. Livingstone Ltd. 1945.

At one time neurology was considered by many to be a dull subject which offered little opportunity for successful treatment. Those who fought shy of the intricacies of diagnosis comforted themselves with the reflection that it did not matter much what was the site and character of the lesion as there was probably no treatment anyway. The appearance of a fourth edition (in five years) of Dr. Walshe's book on Nervous Diseases for Students and Practitioners

is a good index on modern interest in the subject and it is also a fitting testimony to the well-considered authoritative and pleasing style of the author.

The general plan is the same as in previous editions. Part I contains chapters on etiological and anatomical factors in diagnosis. Part II is devoted to details of the more common diseases. Outstanding among these are the development of the speech function and aphasia, epilepsy and cervical rib. But it is difficult to discriminate. The last-named subject, together with the sections on peripheral nerve lesions, Herpes Zoster, sciatica, and protrusion of the intervertebral disc, have been recast, but so discreet has been the choice of new material and so refined is its presentation that the whole book (including illustrations) dies not exceed 350 pages. Here and there throughout Dr. Walshe does not hesitate to express his own personal opinion, albeit this is sometimes scathing, and those familiar with his teaching and views will delight in such passages as the following: "The easy opportunities which the nose and its accessory sinuses present to the determined seeker after irrelevant bacteria need not be emphasized. It should be borne in mind that with the increasing range of diagnostic procedures, biochemical, bacteriological, radiological and the like, few indeed of us even when we enjoy complete health could hope to escape without the discovery of some imperfection were we so unwise as to submit ourselves to inquisition on these lines. That the subject of an anxiety neurosis has teeth that show signs of wear and tear, nasal catarrh or large tonsils is not necessarily evidence that these blemishes stand in any relation to his symptoms, and to assume that they must do so is a travesty of reasoning that should not have survived the discipline of a scientific education." The only criticism indeed that one might level against this work is that too little space is devoted to the "psychoneuroses." Anxiety states, hysterical reactions and other kindred ailments are at least as common in practice as the other nervous diseases which are described in some detail. Dr. Walshe refers to the concept of psychosomatic illness, and says: "We know that psychological factors may set in train disturbances of bodily function, that in their turn may issue in structural lesions and symptoms arising therefrom." Clearly he is still sceptic, but it might be an advantage to include here more discussion on the relative importance of psychosematic relationships in such conditions as chronic rheumatism. The scheme given for examination of the nervous system would also be improved by introducing more detailed directions for assessing the mental and emotional state of patients. R. S. A.

THE PROBLEM OF LUPUS VULGARIS. By Robert Aitken, M.D., F.R.C.P.E., F.R.S.E. Edinburgh: E. & S. Livingstone Ltd. Price 15s.

This book of sixty-six pages, by the well-known Edinburgh dermatologist, is a valuable contribution to the diagnosis and treatment of lupus vulgaris, and is based, not only upon a sound knowledge of the disease, but also upon many years of practical experience in its treatment.

The first chapter deals with the ætiology, diagnosis, and clinical features of the disease, while the second is devoted to the various forms of treatment—local and general. The third chapter, however, is the most important, and describes the modern treatment with the Finsen-Lomholt carbon-arc lamp and general irradiation of the skin with the open carbon-arc lamp. The lamps themselves, their best method of use, and the technique of treatment are all described in detail. Aitken compares the effects and results of this treatment with those obtained by means of the mercury vapour lamp; the results which he describes make a very strong case in favour of the carbon-arc lamp.

Chapter 4 describes the tuberculin treatment of the disease, but this has now fallen into disuse since the advent of modern carbon-arc and intensive vitamin therapy. The fifth and concluding chapter summarises the problem, and mentions the interest taken by Sir Norman Walker in organising the treatment of lupus in Scotland. Aitken advocates the formation of treatment centres attached to medical schools or teaching hospitals, where the necessary specialised treatment can be given, and stresses the importance of encouraging lupus patients to attend these centres.

The book contains thirty-one illustrations, including fourteen in full colour, and can be recommended to all those interested in the treatment of this chronic, though curable, form of tuberculosis of the skin. I. H. McC.

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This little book is intended primarily for first-aiders. It gives a clear account of the physiology of respiration, with a timely reminder that in this function the circulation plays as important a part as the lungs. All the methods of artificial respiration are described, including the author's rocking method. The book is full of interest for the experienced first-aider, but presents too many choices of method to do other than confuse the novice. It should be read by all who attempt to teach first-aid. The delicate literary tribute to the diaphragm, and the excellent illustrations, make the book pleasant to read and easy to understand. R. W. M. S.

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Of late years, text-books on tuberculosis have increasingly stressed the social, economic, and statistical aspects of the disease: and this book, written by one who is a Medical Officer of Health and a Fellow of the Royal Statistical Society, is no exception to the above generalisation. "Social medicine," states the author (p. 486), "in all its aspects, has, perhaps, greater scope for its functions in the management of tuberculosis than in that of any other disease."

It is essential that, in future, the student should be taught to regard the patient suffering from pulmonary tuberculosis as part of a great national problem, and not as an isolated case, demonstrating certain classical physical signs in the chest, but, in the present state of our knowledge, these signs cannot be jettisoned. To these signs Dr. Underwood devotes only five pages out of five hundred; and, in his preface, he "makes no apology for reducing to a minimum observations on the physical diagnosis of chest conditions, which are more easily studied from standard works on the subject."

In our great teaching hospitals, it is scarcely feasible at the moment entirely to abandon the stethoscope, as recent discussions have suggested, and to rely on X-ray diagnosis in chest diseases. The two methods of examination should be complementary.

Dr. Underwood has reproduced many excellent radiographs of pulmonary tuberculosis, accompanied by diagrams. It might be suggested that these diagrams should be accompanied by the signs illustrating the presence of abnormal types of breathing and of adventitia, so that students might correlate physical signs with X-ray appearances.

The chapter on allergy and immunity devotes overmuch space to a description of the various tuberculin tests. The author does not come to a definite conclusion on the subject, but quotes the American view that "these two phenomena develop at approximately the same time, on parallel lines, after a first injection, but that they are really independent."

One might question some of the author's statements on the clinical side. For example (p. 84), it is stated: "Hæmoptysis in a female may be merely a method of casting out blood at the menstrual period—a type of vicarious menstruation." Surely the correct explanation is that the amenorrhœa is due to the general debility and anæmia caused by pulmonary tuberculosis, and that the hæmoptysis is coincidental but definitely tubercular in origin.

Again (p. 296), it is stated: "The diagnosis should be established by demonstration of the tubercle bacillus in the cerebro-spinal fluid. Sugar is absent": whereas one's experience is that tubercle bacilli are not always found, and glucose is reduced in the cerebro-spinal fluid in tubercular meningitis. In future editions, the chapter on Administrative Measures might, with advantage, include a synopsis of the Public Health (Tuberculosis) Act (Northern Ireland) 1945, with its power to require "contacts" to be medically examined, and the power given to a court of summary jurisdiction to remove a person infected with pulmonary tuberculosis to hospital (Part iii, clauses 15 and 16).

The chapters on Domiciliary Management, Disinfection, Post-Sanatorium Regime, and the Tuberculosis Dispensary are clear and lucid, and will be of value not only to the practitioner but also to the tuberculosis visitor.

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One noteworthy feature of the book is that the articles are admirably balanced, and their length is usually proportional to the importance of the subject discussed; and the thirty contributors have achieved a praiseworthy equality in clear and well-expressed prose. The print is pleasant and the format is attractive. There is certainly no better text-book on treatment in the English language.

LEPROSY. By Sir Leonard Rogers, K.C.S.I., C.I.E., M.D., F.R.C.P., F.R.C.S., I.M.S. (Retired), and Ernest Muir, C.I.E., M.D., F.R.C.S. (Edin.). Third Edition. Pp. 280. Illustrated. Bristol: John Wright & Sons Ltd. 1946. 25s.

THE third edition of the excellent text-book on leprosy was called for at the present time, mainly on account of the destruction of a large part of the second edition during the bombing of Bristol. The necessity for a new edition at the present juncture appears to be unfortunate, since we are on the threshold of treatment by various new drugs and anti-biotics. After the lapse of a comparatively short time, one hopes that there may be striking advances to report in the realm of the treatment of leprosy with such new substances as asiaticoside, diasone, promin, penicillin, and streptomycin. Treatment with promin and streptomycin has given favourable and hopeful results in certain varieties of tuberculosis, and the close resemblance between the myco-bacteria of tuberculosis and leprosy suggests that similar beneficial effects may be obtained in "the most cruel disease that flesh is heir to," viz., leprosy. Trials with new drugs and anti-biotics are briefly mentioned in the text. The preliminary results are encouraging, but obviously it is still too early to speak with conviction either about efficiency or dosage. The advances made in our knowledge of leprosy during the war years, though small, are included in several of the sections, particularly those dealing with diagnosis and treatment. In these days of vastly improved travelling facilities and mixing of peoples from all parts of the earth's surface, the danger of transmission of leprosy (and many other dread diseases) is inevitably increased, and now when many thousands of servicemen are returning from tropical countries where leprosy is endemic, it behoves all doctors (and not only those engaged in anti-leprosy work) to acquire fundamental and accurate knowledge of the disease. This can be done painlessly and even pleasantly in a few hours by reading this well-constructed and clearly written book, which runs only to 266 pages of text and which includes eighty-eight excellent photographs.

The six sections deal in turn with the history of the diesase (from the "mists of antiquity" to the present day) and its distribution, epidemiology and communicability, prophylaxis, ætiology, clinical description, and treatment. The lepromin test, which, although not diagnostic, helps to distinguish lepromatous from neural cases, is described, together with Lowe and Dharmendra's technique for the preparation of the antigen and method of performing the test. The authors rightly stress the great importance of good general treatment, and there is an adequate account of the special treatment by hydnocarpus (chaulmoogra) oil and its esters. In an appendix, details of two methods recommended for the preparation of the esters are given. The book is well produced and clearly printed on good quality paper, and the photographs are first-class. Many of the illustrations are new and have not appeared in the previous editions.

There are very few doctors and medical students who would not enjoy and derive much benefit from reading this concise account of one of the world's most dreadful and dreaded diseases. It can be highly recommended, even if we hope never to see a real live case of leprosy. Both authors have had vast experience of the disease from all aspects, and present its baffling problems in a most interesting and readable way.

J. C. D.