able for accurate control in the range 21%–40%. An electrical blower system is shown to be capable of controlling the inspired-oxygen concentration with one standard deviation of 0.9% if the ventilation is less than 10 litres per minute. A simple oxygen mask of our design (authors' mask) is described, and shown to be capable of controlling the inspired-oxygen concentration with the same accuracy as the Venturi apparatus. This authors' mask should be very much cheaper than the Venturi apparatus.

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EXPERIMENTAL CLINIC FOR PREVENTING CHRONIC BRONCHITIS

BY

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> " It is shameful to the health services of Britain that this disease should be so prominent as a cause of sickness and death, and that comparatively little should have been done to remedy matters " (*B.M.J.*, 1963).

In the past 30 years the pattern of mortality from pulmonary tuberculosis, pneumonia, and lung cancer has changed. However, every year chronic bronchitis has killed more than any of the above diseases (Registrar-General, 1962), and has been a major cause of morbidity and misery.

Clinical experience indicates the importance of both chronic irritation, by air pollution and cigarette smoke, and recurrent or chronic infection in causing disability in the bronchitic. Confirmatory evidence of this has been obtained from patients' histories in epidemiological surveys (Higgins, 1959; Olsen and Gilson, 1960), from the study of sickness-absence records (Fairbairn and Reid, 1958), and pathological studies (Reid, 1958). Disability, once established, is usually permanent and progressive.

In the management of patients with chronic bronchitis all practicable measures to reduce respiratory irritation and infection are usually undertaken, but these measures are seldom applied until irreversible disease is well advanced.

In October, 1960, an experimental clinic was established at the Pound Lane Health Centre, Willesden. It aimed to attract those in the earliest stages of chronic bronchitis and to attempt to stop or slow down the progress of the condition by the application of measures usually reserved for patients with advanced disease. The clinic had the active support of a local hospital, a chest clinic, the public health service, and a number of general practitioners. This paper describes its work and a follow-up of patients attending during the first two years. Ultimately the value of such a clinic can be measured only by a careful follow-up of those attending over many years. In the meantime the acceptability of the clinic by patients, the extent to which they act on the advice given, and the changes in symptoms over a short period give some indication of its potential value.

Description of Clinic

The principal aims of the clinic included attempts to (1) reduce irritation of the respiratory tract by helping patients to stop smoking and teaching them practical steps to reduce the damage done by air pollution; (2) combat infection by the use of influenza vaccine and antibiotics; and (3) teach them to breathe better by daily exercises. At the same time general instruction and discussion on any matter relating to health were included.

For purposes of assessment the Medical Research Council (1960) Questionary on Respiratory Symptoms was completed on each patient and the forced expiratory volume ($F.E.V._1$) measured. No physical examination was undertaken and no attempt made to take over the management of the individual patient.

The clinic differed in two important respects from the accepted pattern of general-practitioner consultation or hospital out-patient attendance. Changing of habits was considered more important than dispensing of drugs, and patients were not necessarily ill or disabled. The clinic therefore had to be run at a time, at a place, and in a manner that would attract the patients for whom it was designed.

The most suitable time was found to be from 7 to 9 p.m. The clinic was held in a new local authority health centre. The facilities were excellent, but the absence of a porter, receptionist, or telephonist on duty in the evenings sometimes made the management of the clinic difficult.

It was decided to see the patients as a group, of 10 to 20, rather than individually. In this way each patient was actively involved for the whole two hours on each evening, and advantage could be taken of the group situation to stimulate discussion. This in turn helped to disguise the educative function of the clinic by creating a social atmosphere. With some objectives, such as stopping smoking, competition between individuals could be usefully aroused.

On the first evening all patients were given an introductory talk on chronic bronchitis, its symptoms, natural history, and what is known of its aetiology, and breathing exercises were started. A questionary on respiratory symptoms was completed and $F.E.V._1$ measured. Before leaving, the patients were given a bottle in which to bring a specimen of sputum on their next visit.

The routine for subsequent sessions was to start with three-quarters of an hour of physiotherapy. The aims were to mobilize the chest and shoulders, to encourage abdominal breathing with emphasis on expiration, and to improve posture and teach relaxation. Breathing exercises to develop both lower costal and diaphragmatic breathing

were taught and were interspersed with general exercises until controlled breathing could be maintained during activities such as stair-climbing, lifting, walking, and even running. Postural drainage and a series of home exercises were also taught. The physiotherapy session became progressively more vigorous throughout the course in order to raise the exercise tolerance.

A 10-minute break for tea or beer was then followed by a talk, discussion, or film. An attempt was made to avoid didactic instruction and to encourage questions and discussion among patients. One of the talks was on the effects of chest infection; after this vaccination against influenza was offered. A session on air pollution included an explanation of what is being done locally to implement the Clean Air Act, advice on keeping bedroom windows shut during foggy weather, and on remaining at home, not even going to work, when fog is severe. Wick-type bottles containing a mixture of ammonia and ethyl alcohol were given to all those who said that their chest was affected by fog. They were instructed to remove the cap and pull up the wick until a very faint smell of ammonia could be detected in the room. This was to be maintained in their living-room or bedroom until the fog had gone. Another session was devoted to the nature of "phlegm," what it is, where it comes from, and why.

Those who came regularly to the course of six sessions were given 12 tablets of tetracycline on the last evening with detailed instructions on how to take them at the onset of a chest infection. They were told to see their own doctor if the infection had not been controlled before the tablets ran out, and, in any event, to replenish their supply of tetracycline for use in a subsequent attack.

There was a short session in most weeks devoted to encouraging patients to stop smoking. The known facts about smoking and bronchitis, lung cancer, and other diseases were explained by means of talks and films and by demonstrating pathological specimens. With the help of ex-smokers in the group it was then pointed out that many people have stopped smoking; and finally the various methods and aids to stopping were discussed. Further details of this technique of helping groups of smokers to stop have been described elsewhere (Wood, 1963).

The difficulty experienced in recruiting groups of 20 patients to start at one time led to modification of the programme in the second winter, to enable some new patients to be taken each week. This complicated the organization of the clinic, as the new patients were kept separate on their first visit before they joined the main group, which ran on a four-weekly cycle. It also made it more difficult for the physiotherapy class to develop progressively.

All patients who had attended a whole course were invited to return whenever they liked, and at least each autumn, for one evening, when they could be reminded of their exercises and previous teaching, be vaccinated against influenza, have their "smog" bottle topped up, and any other problems discussed. This was also intended to provide a means of follow-up.

Recruitment of Patients

Early cases of chronic bronchitis are seldom in touch with any doctor and their recruitment to the clinic proved difficult. That a large number of suitable subjects for the clinic exist was demonstrated by a concurrent survey of respiratory symptoms among 177 workers in one factory in the district: 30% of males and 21% of females had symptoms of bronchitis. During the first two winters 165 men attended the clinic. Of these, 56 were referred by general practitioners, 54 by industrial medical officers, 17 from a mass *x*-ray unit, 12 from a chest clinic, and the remainder from a variety of sources. Many general practitioners found difficulty in recalling the names of patients who had *early* symptoms. This was especially so in the autumn, when their patients had not been seen since the previous winter. The few industrial medical officers in the area were better able to select early cases from their records, but many of those referred lived far away and did not attend.

Latterly a more promising method of recruitment from a static mass *x*-ray unit was started. The sending of patients with a chronic cough or a severe chest cold for *x*-ray is perhaps one of the best-established and most commonly used screening techniques. When a patient living in the area of the clinic was referred for *x*-ray examination because of these symptoms and was found to have a normal picture, a letter suggesting referral to the clinic was enclosed with the report sent to his doctor. This meant that referring doctors could enlist patients who came to hear the results of their *x*-ray examinations at the time when they were a little apprehensive and more open to medical advice.

Irrespective of the source of referral, the patient's general practitioner was always consulted, initially often by telephone and subsequently by letter, so that the aims and methods of the clinic could be explained.

During the second winter six women attended, but they have not been included in the analysis. The age of the patients attending the clinic varied from 19 to 68, but the majority were between 45 and 65.

Most of the patients said that they had had at least one chest illness, usually called bronchitis, which had kept them off work in the past three years. All except 30 said that they already had either persistent cough or phlegm. Most of those without had had recurrent chest illnesses, some with a predominantly asthmatic component. A few had been referred with only minor chest symptoms because they were smokers (Table I).

TABLE I.—*Chest Illnesses and Symptoms of* 165 *Patients*

	Yes	No	Unknown
One or more chest illnesses in past 3 years	131	28	6
Cough — Mornings only	31	36	6
Cough — Throughout day	92		
Sputum — Mornings only	25	39	6
Sputum — Throughout day	95		
Nasal catarrh — Winter only	17	73	33
Nasal catarrh — Throughout year	42		

Of the 128 patients who attended the clinic at least twice, 91 returned specimens of early morning sputum—all that could be brought up in the first hour after rising: 34 produced more than 5 ml. of sputum and 20 produced mucopurulent or purulent sputum.

Despite the attempt to concentrate on early cases who were not disabled, there were 18 men who said that they sometimes had to stop for breath while walking at their own pace on the level. In the 148 in whom it was measured, the $F.E.V._1$ was below 1 litre in 29, between 1 and 2 litres in 38, and over 2 litres in 81.

A quarter of those referred to the clinic were non- or ex-smokers. Of the smokers, 84 smoked ready-made and 29 hand-rolled cigarettes, 8 smoked a pipe or a combination of pipe and cigarettes. The majority were moderate smokers (Table II).

TABLE II.—*Smoking Habits of* 165 *Patients*

Non-smokers		10
Ex-smokers		29
Smokers of	1–4 g./day	8
	5–14 ,,	64
	15–24 ,,	27
	25+ ,,	22
Unknown		5

Results

An individual appointment was made with those who had attended the clinic more than once to obtain more complete information about progress than could be collected at a group session. Out of the 113 attending regularly (four or more times) 109 were seen; out of the 15 attending two or three times 10 were seen. The time between completing the course and follow-up interview varied considerably. For 30 who had been to the clinic during the first winter the interval was over one year; for 80 who attended during the second winter the interval was 4 to 30 weeks; and for nine attending the last clinic the follow-up data were obtained at an interval of less than four weeks. The data presented below are based on the 109 regular attenders seen.

Acceptability of Clinic

The demonstration of the fact that a preventive clinic of this nature can be run is important. One measure of its acceptability by those subjects for whom it is intended is given by the attendance figures. Many had only been advised to come and see what it was like; on the first attendance it was explained that to obtain any benefit they would have to attend regularly for a minimum of four more sessions. Thirty-seven patients came once only. Of the 128 who attended a second time, only 15 failed to attend four sessions. The lapse rate was slightly greater among the younger patients and among those who smoked heavily. A large majority of patients attending regularly thought that they had benefited. They also said that they would like to return for the "refresher" session at the beginning of each winter; this may be regarded as confirmatory evidence of their approval, beyond the dictates of good manners. When asked to specify in what way they had benefited most of the replies were vague. Nearly all felt that their breathing had improved; and they attributed this to the exercises. A few replied more convincingly, such as "going over the railway bridge is easier." Others attributed the benefit to inoculation against influenza, to the tetracycline tablets, or to help with giving up smoking.

Advice Followed

Specific advice was given on doing breathing exercises at home, taking tetracycline at the onset of a chest cold, using a "smog" bottle on foggy nights, and stopping smoking. The extent to which this advice was acted on is described below.

Breathing Exercises.—At follow-up 31 (28%) out of 109 patients said that they were regularly—though not necessarily daily—setting time aside to do their exercises, and a further 57 (52%) said they were doing them during their normal activities.

Tetracycline.—Of the 106 who had been given tetracycline tablets, 46 reported having the type of episodes for which they had been instructed to take them. Of these, 37 (80%) took them on one or more occasions, a further two took other appropriate measures on their doctors' advice, and seven failed to take them. Only 19 of the 37 who had used their tablets renewed them on the first occasion, and six of these failed to do so subsequently.

"Smog" Bottle.—During the two winters in question there were so few occasions in which the bottles might have been used that no assessment, either of the extent to which they had been used or of their efficacy, was possible.

Smoking.—The amounts which patients said they had smoked, at the time of the initial interview and at the time of the follow-up interview, are compared in Table III. Of the 77 smokers, 28 (36%) had stopped smoking, 24 (31%) had decreased, 24 (31%) were smoking the same, and 1 (1%) had increased. One ex-smoker had started again.

TABLE III.—*Changes in Smoking Habits of* 109 *Patients*

Initial Interview	Follow-up Interview						
	Non-	Ex-	Smokers (g./day)				Total
			1–4	5–14	15–24	25+	
Non-smokers	**8**	—	—	—	—	—	8
Ex-smokers	—	**23**	—	1	—	—	24
Smokers 1–4 g./day	—	3	**3**	—	—	—	6
Smokers 5–14 ,,	—	13	10	**16**	—	1	40
Smokers 15–24 ,,	—	8	1	8	**3**	—	20
Smokers 25+ ,,	—	**4**	1	2	2	**2**	11
Total	8	51	15	27	5	3	109

Influenza Vaccination.—Approximately 40 patients, a high proportion of those attending before Christmas each year, were given 1 ml. of anti-influenza vaccine ("flubron"). No attempt was made to assess the value of this measure by itself.

Changes in Symptoms

The interval between first attendance and follow-up was varied and often short. Also some patients were referred in the winter after a chest illness and were followed-up in early summer. The following changes in symptoms are presented primarily to illustrate the method by which more prolonged follow-up will be undertaken.

Cough and Phlegm.—Standard questions concerning the frequency of cough and phlegm were asked on first attendance and at follow-up. The answers were graded as: none; only in the first hour after rising; and throughout the day. Cough improved in 42 out of 109 subjects, remained the same in 52, and was worse in 15. Phlegm improved in 34, remained the same in 62, and 13 were worse. Improvement in cough and phlegm occurred more often among those who stopped smoking than in those who decreased or made no change (Table IV).

TABLE IV.—*Changes in Cough and Phlegm of* 107* *Patients Related to Changes in Smoking*

Smoking Habit:	Smokers at First Attendance			Non- and Ex-Smokers at First Attendance
	Stopped	Decreased	No Change	
No. of patients	28	24	24	31
Cough improved	18 (64%)	10 (42%)	6 (25%)	8 (26%)
Phlegm improved	16 (57%)	5 (21%)	7 (29%)	6 (19%)

* The two patients who reported an increase in smoking have been omitted

Forced Expiratory Volume.—For 89 patients two F.E.V. readings can be compared. The mean $F.E.V._1$ on first attendance was 1.98 litres, and after a mean interval of six months it was 1.95 litres. Changes varied widely from patient to patient. In some there was striking improvement, but in the majority the changes were insignificant. It is not reasonable to calculate a mean rate of fall over such a short time for comparison with other normal or bronchitic groups.

The above results reflect the mean response of the group. The following case reports illustrate the range of response in individuals.

Case Reports

Case 1.—A man aged 36 was referred by the industrial medical officer at his place of work. For the past two years he had had a persistent cough and brought up phlegm both in the early morning and throughout the day. Though he often attended the medical department he had not missed any time from work. He was smoking 15 cigarettes a day. Three months after attending the clinic he was not smoking, he had lost his cough and phlegm, and his $F.E.V._{\cdot 1}$ had risen by 20% to 3.9 litres. He was feeling very much better, and had restarted energetic sport after a lapse of eight years.

Case 2.—A man was referred by a hospital physician on account of persistent cough and phlegm and increasing breathlessness. He had recently reduced his smoking to 15 cigarettes a day. He stopped smoking while attending the clinic and was still not smoking when seen at follow-up 15 months later. His cough and phlegm were reduced though still present in the early morning. He was doing exercises regularly and said that he felt better despite a slight fall in his $F.E.V._{\cdot 1}$ to 0.75 litre.

Case 3.—A man aged 56 was referred by his general practitioner three months after a negative chest *x*-ray examination. He had a dry cough and complained of shortness of breath. He had stopped smoking 30 cigarettes a day five months earlier. He was unable to keep up with others in the physiotherapy class, and when seen two months later his cough was worse and his $F.E.V._{\cdot 1}$ had fallen over 25% to 1.3 litres. He was referred to his practitioner for a further *x*-ray examination, and a carcinoma of the lung was discovered.

Discussion

The most encouraging aspect of the work of the clinic was the interest shown by those who attended regularly. It became apparent that many with established bronchitis understand the progressive nature of their disease and are distressed about it and well aware of the uselessness of imbibing bottles of cough medicine. The presence at the clinic of a few established cases, together with pathological specimens taken from advanced cases, helped to emphasize the progressive nature of the disease to those in the early stages. However, too many established cases would probably deter the younger and earlier patients from coming.

The referral of suitable patients to the clinic was the most difficult problem to tackle. At the stage before irreversible changes have taken place and when remedial action is likely to be of most use few subjects regard themselves as "patients" and most of them are not attending any doctor regularly. It is for this reason that recruitment of patients after a chest *x*-ray examination is the most promising method. Every year thousands of people are *x*-rayed after an acute chest illness or on account of persistent cough, and all too often if no abnormality is detected they are reassured that "there is nothing to worry about." Chronic bronchitis in the early stages produces no *x*-ray changes. Subjects with a chronic cough or recurrent chest illnesses in whom an *x*-ray examination has excluded tuberculosis or carcinoma are a large and important group eminently suitable for the type of preventive programme described.

The physiotherapy class was the most popular item of the programme, and one of its values was that it kept up attendances so that less popular features, such as anti-smoking sessions, had greater opportunity than they would have had on their own. The physiotherapy class also had other values, despite the fact that significant changes in F.E.V. were not shown in the group. Many patients undertook more vigorous exercise than they believed themselves capable of, and this improved their confidence. Others claimed that learning to control their breathing made it easier to go up stairs or up a hill. This claim is independent of any change in F.E.V. and more akin to learning the technique of a mountaineer in tackling heights slowly and steadily rather than rushing at them.

The provision of beer as well as tea in the interval served the dual purpose of quenching thirst and showing that though smoking was discouraged we were not against all pleasures. It also contributed to the informal atmosphere in which the subsequent discussions were held.

The short-term results of the clinic indicate that a number of beneficial changes occurred in the group as a whole. Approximately one-third of all the smokers had stopped smoking. This proportion compares unfavourably with the success of an anti-smoking clinic run in the district, where approximately two-thirds of the regular attenders stop (K. P. Ball, personal communication, 1962). However, it must be remembered that those who agree to attend an anti-smoking clinic have at least partially accepted its aims, while those attending a clinic for the prevention of bronchitis have no prior commitment. Among our patients, 80% were continuing breathing exercises, though only 28% were doing them thoroughly. The use of antibiotics early in the onset of a chest illness was made initially by 80%, but less than half of these renewed their supply for use in subsequent attacks.

At the autumn "refresher" classes it is possible to re-emphasize the previous instruction by means of discussion with those who have followed the advice given and derived benefit. These people are apt to be more persuasive and helpful than the staff of the clinic alone.

The case histories given show that the improvement in some patients could be measured objectively; in others the improvement, though not necessarily unreal, could not be demonstrated, and in yet others, in whom the disease was advanced or complicated, no improvement occurred. If more patients were referred and greater attention was paid to selection, with experience the proportion deriving benefit would be likely to increase.

Some, but not all, of the programme of the clinic could be carried out on an individual rather than a group basis. It is, however, doubtful if it would be as effective a means of changing opinion and habit as group activities. Also, by means of a group clinic more patients can be seen for an effective time in a given period.

Group clinics are one of the means of prevention that should be extended. The clinic described was made possible initially by a research grant from the North-West Metropolitan Regional Hospital Board, which paid the salary of the part-time social scientist (S. H. M.) and covered the expenses of the physiotherapist, secretarial assistance, and miscellaneous charges such as the hire of films. The doctor (C. H. W.) was loaned by the university, and later a nurse by the chest clinic. The premises were loaned by the local authority and drugs were supplied by the hospital. After the first two winters further help was given by the Willesden Chest Clinic, which in future will staff and finance the clinic.

Who should provide other clinics? General practitioners are likely to be the first to come into contact with early cases of chronic bronchitis, but, except in a few practices, do not have the facilities for handling groups of patients. Hospitals have the facilities but no opportunity of finding early cases. Many chest clinics, however, set up by local authorities to fulfil their legal obligation to provide preventive and aftercare tuberculosis services have both the access

to early cases and the facilities for providing group treatment. They could therefore most appropriately undertake this work and provide a national network of clinics for the prevention of chronic bronchitis. Clinics might also be established wherever there are groups of people exposed to special risks of respiratory disease, such as in certain industries.

However, a more active part in advising some patients individually and selecting others for further treatment is required of all who come into contact with those in the early stages of disease.

Summary

Chronic bronchitis is a major cause of sickness absence, misery, and death in this country. Chronic irritation by air pollution and cigarette smoke, and chronic or recurrent infection, contribute both to its development and to its progression.

An experimental group clinic designed to help patients with early symptoms has been run for two winters.

Difficulties in the recruitment of suitable patients are described. It is suggested that those attending mass *x*-ray units on account of a persistent cough or recent chest illness, and who have negative films, are a major source of potential bronchitics eminently suitable for preventive treatment.

The programme included instruction in breathing exercises, vaccination against influenza, the provision of antibiotics to be taken at the outset of a chest infection, the provision of a "smog" bottle, an attempt to stop patients smoking, and general health education.

A short-term follow-up of 109 patients indicates that the clinic is fulfilling a need and that many patients are following the advice given: 28% say they are setting time aside to do their breathing exercises, and a further 52% are doing them during their normal activities. Of those having chest infections, 80% followed the antibiotic regime suggested, though many failed to replenish their supply. Of 77 smokers, 28 (36%) stopped smoking, 24 (31%) decreased, 24 (31%) continued as before, and 1 (1%) increased.

The short time-interval between attendance and follow-up and the seasonal differences render changes in symptoms of doubtful significance, but cough and the production of phlegm decreased, particularly in those who stopped smoking.

It is suggested that other clinics on the lines of the one described should be started. Chest clinics are the most appropriate organizations to provide a service on a national scale, but an active part in selecting suitable patients must be played by all who come into contact with those in the early stages of disease.

We are grateful to Mr. Sohikish, of the Camden Rehabilitation Unit, who ran the physiotherapy session with enthusiasm throughout; to the late Dr. S. Leff, M.O.H. of Willesden; to Miss Parbery, S.R.N., of the Willesden Chest Clinic, who helped with the running of the clinic; and to our secretaries. We wish to thank Dr. H. Joules, of the Central Middlesex Hospital, Professor R. S. F. Schilling, of the London School of Hygiene and Tropical Medicine, and Dr. C. H. C. Toussaint, of the Willesden Chest Clinic, for the encouragement and help that they have given; and the North-West Metropolitan Regional Hospital Board, who made a research grant. We would also like to thank Pfizer and Co. for supplying flubron for use during the first winter and for the repeated loan of their film "Chronic Bronchitis," and the British Temperance Society, from whom the film "Time Pulls the Trigger" was repeatedly borrowed.

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UNUSUAL NEUROLOGICAL AND CARDIOVASCULAR COMPLICATIONS OF RESPIRATORY FAILURE

BY

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It is known that respiratory failure is often attended by neurological and cardiovascular complications. Most of the neurological complications—for example, drowsiness, depressed tendon reflexes, extensor plantar responses, and coma—are thought to result from hypercapnia with or without hypoxia. They have been well reviewed by Westlake, Simpson, and Kaye (1955) and by Sieker and Hickam (1956).

Similarly, the majority of cardiovascular complications, such as acute congestive cardiac failure and atrial fibrillation, are well known and have been described and discussed by many authors—for example, Harvey and Ferrer (1960).

This paper deals mainly with additional neurological and cardiovascular complications which are not so well documented, but which we have observed in a number of patients.

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The Series.—We have made a prospective study of all patients admitted in respiratory failure, with or without cor pulmonale, to the Central Middlesex Hospital during the winter of 1961–2. Many of them had previously been seen at the hospital or at the Willesden Chest Clinic. Neurosurgical complications or cardiovascular complications, or both, were observed in 17 patients.

Methods

On admission a history of previous respiratory illness and disability and of the present episode was taken. In the examination particular attention was paid to the clinical assessment of hypoxia and hypercapnia, and to the respiratory and cardiovascular systems. Investigations always included a chest *x*-ray examination and an initial estimation of the mixed venous P_{CO_2} using the rebreathing method of Campbell and Howell (1960). The latter investigation was repeated within the first hour of treatment and then