STRATEGIES FOR CHANGING THE USE OF DIAGNOSTIC RADIOLOGY

REPORT SUBMITTED TO
THE KING EDWARD'S HOSPITAL FUND FOR LONDON

BY

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MARCH 1985

STRATEGIES FOR CHANGING THE USE OF DIAGNOSTIC RADIOLOGY

A multicentre trial of strategies for implementing the Royal College of Radiologists' guidelines on the use of pre-operative chest X-rays in hospitals in the United Kingdom.

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[An abridged version of this report will be available as a King's Fund project paper in the next few months. CCC 1.10.85].

March 1985

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ACKNOWLEDGEMENTS

This study was possible only with the assistance and co-operation of many colleagues and staff in academic departments and in the National Health Service.

I am particularly grateful to Professor Colin J Roberts who, throughout the study from conception to final analysis, offered invaluable advice and guidance.

The study was carried out under the auspices of the Royal College of Radiologists' Working Party on the Effective Use of Diagnostic Radiology whose members have provided continuous support and encouragement. In particular, I am most indebted to Professor K T Evans and Professor Rhys Davies for their advice and enthusiastic participation in the study. Dr J Laws, formerly President of the Royal College of Radiologists, played a major role in obtaining funding for the study and in enhancing its implementation.

In each of the study hospitals, consultant radiologists acted as local co-ordinators. Their contribution was vital to the success of the study. The local co-ordinators were as follows: Professor Rhys Davies and Dr J Roylance, Bristol; Professor K T Evans, Cardiff; Dr D Nolan, Oxford; Dr A E Hugh, Stoke on Trent; Dr G Green and Dr A L Power, Swansea. I am also grateful for the work carried out by members of the Utilization Review Committee: Professor K T Evans (Chairman), Dr A S Bligh, Mr D L Crosby, Dr J N Horton, Dr B W Lawrie and Dr J F Pearson.

The data co-ordinator in the research headquarters, Miss Catherine Anglim, had a difficult task in helping to ensure the flow of data during the study. She was ably assisted by clerical assistants in each of the study hospitals. I also appreciated the excellent contribution of Dr Keith Rogers to the computer programming and data analysis. Dr G Hartley (Manchester) and Dr M Charny (Cardiff) kindly provided additional control data.

Advice was received from many sources throughout the study. I am particularly grateful to Ms Matina Mitchell for her ideas on intervention strategies, to Mr John Stilwell and staff in the Economic Advisor's Office, DHSS, for advice on costing, and to Dr Stephen Gehlbach and colleagues in the Department of Epidemiology and Community Medicine, University of Wales College of Medicine for suggestions on study design and methods.

This study was generously supported by the King Edward VII Hospital Fund. My thanks go to Mr Geoffrey Cannon and Dr Iden Wickings of the King's Fund for their advice and interest in the project.

During the study, the secretarial work was carried out most diligently by Mrs Marilyn Morgan. I was also grateful for the excellent work of Miss Caroline Shaw in typing and preparing the final report. Ms Kirsteen Thomson gave useful advice and assistance with graphs.

Finally, I give thanks to the many NHS staff such as house officers, medical records officers, superintendent radiographers and theatre nursing officers, who all contributed in some way to the success of this project.

SUMMARY

Many patients have routine pre-operative chest X-rays despite evidence that the benefits do not justify the costs and risks. In order to promote more discriminating use, the Royal College of Radiologists Working Party on the Effective Use of Diagnostic Radiology formulated guidelines for the use of pre-operative chest X-rays in patients having elective non-cardiopulmonary surgery.

The aim of this study was to determine the effect of four strategies for implementing these guidelines in clinical practice: 1. utilization review committee, 2. feedback on use to consultants, 3. re-design of chest X-ray request form, and 4. concurrent review of chest X-ray requests by radiological staff. The main objective was to determine the effect of implementing each strategy in one hospital for a period of one year on the proportion of elective non-cardiopulmonary surgical patients having pre-operative chest X-rays.

A prospective trial was the method employed. Following approval of the guidelines by cogwheel divisions and implementation of the strategies, data was abstracted retrospectively from theatre registers, admission files, and radiology registers in four hospitals for a 2 month baseline period and a 12 month intervention period. Data was also collected in a control hospital which had no intervention strategy. During the fourth month of the intervention period, data on the adherence to guidelines was abstracted from the medical records of a stratified random sample of patients having pre-operative chest X-rays.

The results indicate that each strategy had an effect in reducing the use of pre-operative chest X-rays. The lowest level (8.5 chest X-rays per 100 elective operations) was achieved by the Utilization Review Committee as a result of displaying the guidelines in surgical wards. Information feedback produced a consistent and gradual reduction in use from 29.4 to 13.3 chest X-rays per 100 operations ($p < 0.001$). Introduction of the new chest X-ray request form was associated with an immediate and moderate reduction in use of 7.3 chest X-rays per 100 operations ($p < 0.001$), but this was not sustained following a change in house staff. Concurrent review of requests by radiological staff had an intermittent effect which was enhanced by feedback on use to the radiology department. The control hospital showed no significant change throughout the year of the study ($p > 0.05$). Approximately 75% of patients having pre-operative chest X-rays had clinical indications as stated in the Royal College of Radiologists' guidelines.

When the results are considered in conjunction with those from other studies, no firm conclusions can be reached about the single best strategy. But given the success of the utilization review committee radiologists might consider (i) seeking approval of guidelines by divisions, (ii) establishing review committees with the flexibility to implement a range of interventions, and (iii) monitoring chest X-ray requests from surgical firms. In the long term, change may be sustained if clinicians are more responsible and accountable for their use of resources.

CHAPTER 1.

INTRODUCTION : BACKGROUND TO THE STUDY

During the last twenty five years, substantial changes have taken place in the practice of medicine. Advances in scientific knowledge and innovations in medical technology have led to a vast array of tests available for clinical diagnosis. Developments such as multichannel autoanalysers and computerised tomography mean that the clinicians of today practise a style of diagnosis quite different from that of a previous generation. Greater reliance is now placed on the results of diagnostic tests than on findings in the history and physical examination , such that the number and range of tests used has increased exponentially, almost doubling every 10 years.

Diagnostic radiology has not escaped this trend; indeed, radiological workload has increased at a greater rate than the availability of facilities and manpower. This situation was partly responsible for the Royal College of Radiologists establishing in 1975 a Working Party on the Effective Use of Diagnostic Radiology. The main remit of the Working Party was to explore ways of limiting the unnecessary use of radiological procedures. It's first initiative was to conduct a major research project examining the use and value of pre-operative chest X-rays. This was followed by the formulation of clinical guidelines indicating which categories of patients should have these X-rays.

As this present study is concerned with the implementation of these pre-operative guidelines in clinical practice, recent trends in radiology and the development of the guidelines are important background.

1.1 TRENDS IN RADIOLOGY

In the United Kingdom, the National Radiological Protection Board is responsible for monitoring sources and levels of radiation, and has conducted national surveys of the work of radiology departments (Committee on Radiological Hazards to Patients, 1960; Kendall et al, 1980). In 1957, the total number of radiological examinations performed in the NHS was found to be 13 million (Committee on Radiological Hazards to Patients, 1960). When the survey was repeated in 1977 (Kendall et al, 1980), the number of examinations had increased by 64% to 21.3 million. This increase could not be explained by a change in the age structure and size of the population because examinations per head of population had increased by 2% per annum.

Information on radiological workload has also been obtained from statistics on the amount of radiographic film used in the NHS. The use of film increased by an average of 6% per annum from 1966 to 1978 (Wrighton and Oliver, 1980). In 1951, 16.5 million square feet of film were consumed; by 1971 the consumption had risen to 42.5 million square feet (Bull, 1974). This was equivalent to a doubling of consumption every 12 years.

Statistics on radiographic workload collected by the Department of Health and Social Security (DHSS) have also shown substantial changes in recent years (Raison, 1976; Wrighton and Oliver, 1980; Wrighton, 1982). From 1968 to 1980, workload in radiology departments increased by approximately 5% per annum to a total of 306.5 million units in

England in 1980 (Wrighton, 1982). (One unit of workload is equivalent to 1 minute of radiographer's time (DHSS and Welsh Office, 1973). This rise in workload has been due to an increase in the complexity of examinations in addition to the greater numbers of examinations performed. From 1957 to 1977 workload per examination increased threefold to a mean of 14.3 units per examination (Wrighton and Oliver, 1980). However, from 1967 to 1977 the rise in Class III (more complex) examinations was only slightly greater than the increase in Class I (simpler) examinations (Abrams, 1979).

This change in the nature and complexity of diagnostic radiology can be attributed to the impact of new medical technology (Evans, 1981; Steiner, 1982). Major advances have included the introduction of image intensifiers and television contributing to increased diagnostic accuracy in a number of fields, particularly cardiology. Computerised tomography (CT scanning) has had a considerable impact on diagnosis particularly of diseases of the nervous system (although CT scanning may soon be replaced by nuclear magnetic resonance). Diagnostic ultrasound has virtually replaced conventional radiography in obstetrics and is being used more widely for other purposes such as the detection of gall stones. Radio-isotope imaging is proving useful in the assessment of functional abnormalities in many organs, particularly those of the cardiac, respiratory and renal systems.

Such is the variety of imaging techniques now used in radiology departments that any definition of the specialty based on X-rays is misleading (Evans, 1981). As Seaman (1973) has stated, "any signal which is differentially handled by various structures within the body and can be displayed so as to convey information about these structures is properly within the range of diagnostic radiology".

These innovations have had a substantial impact on radiological workload because many are complex and consume a considerable proportion of radiologists' and radiographers' time. However, the great majority of examinations performed in the NHS are still those employing conventional radiology. For example, in the 1977 survey conducted by the National Radiological Protection Board (Kendall et al, 1980), chest X-rays comprised 33% and limb extremities 30% of all examinations. By contrast CT scans comprised only 0.3% of examinations.

These changes in radiological workload have been accompanied by increases in the costs of the service over and above those due to inflation. In 1968/69 the cost of radiological capital equipment in the NHS was £3.6 million; by 1980/81 this figure had risen to £20.1 million (excluding expenditure on CT scanning) (Wrighton, 1982). The equivalent 1968/69 figure for the 1980/81 expenditure was £5 million. Thus, capital expenditure had increased by almost 40% in real terms over a 12 year period. Revenue costs increased at a similar rate to reach £63 million in England in 1977/78 (Wrighton and Oliver, 1980). Total expenditure on radiological services during that year was £83 million, accounting for 1.3% of centrally funded NHS costs.

An increasing radiological workload has been accompanied by a shortfall in radiological manpower. Almost 20 years ago, the British Medical Journal (Editorial, 1966) drew attention to the problem with a leading article entitled "Shortage of Radiologists". Inadequate recruitment in the United Kingdom and in the United States was attributed mainly to the shortage of academic departments of radiology and to the lack of instruction of medical undergraduates. However, from the mid 1960's the number of consultant radiologists in NHS hospitals increased substantially and by 1978, 740 whole-time equivalents were in post (Wrighton and Oliver, 1980). But the rate of increase was considerably lower than the rise in units of workload (Raison, 1976). In 1978, consultants and senior registrars in England and Wales were each handling approximately 20,000 examinations during the year. According to Wrighton and Oliver (1980), this level of workload was not managed easily; a workload of 15,000 examinations per year was a more reasonable target. These figures would suggest that consultant radiologists in 1978 were probably undermanned by about 25%. Indeed, the DHSS has for several years encouraged health authorities to continue expanding their establishment of radiological posts in both training and consultant grades.

Many solutions, other than expansion of radiological posts, have been put forward for resolving the imbalance between workload and manpower. It has been suggested that non-contrast X-rays could be reported by consultants who made the requests, (Bull, 1976) or by general practioners employed as clinical assistants (Editorial, British Journal of Radiology, 1975). Radiologists might control workload by vetoing certain requests (Bull, 1976) or by regularly visiting wards and providing a consultancy service to clinical colleagues (Bull, 1976; Shuman and Heilman, 1979). Brindle (1978) in Kings Lynn has reduced workload by creating a waiting list for radiological examinations. This in turn has led to a reduction in demand.

The Education Board of the Royal College of Radiologists has suggested radical changes in the teaching of diagnostic radiology to medical undergraduates which would encourage a more discriminating use of X-rays. The Board recommended "that the undergraduate should understand the values, limitations, hazards and to a certain extent financial implications of high cost technology in clinical management" and ".....emphasis should be given to the role of diagnostic radiology in clinical management strategy rather than to the acquisition of interpretative skills". (Education Board to the Council of the Royal College of Radiologists, 1981).

This major imbalance between workload and manpower was one of the main reasons for the establishment by the Royal College of Radiologists of a Working Party on the Effective Use of Diagnostic Radiology. The minutes of its first meeting held in August, 1975 stated that "radiologists are very concerned about the increasingly expensive and often inefficient use that is being made of diagnostic facilities. Correction of the situation would lead to greater efficiency in patient management, reduction in radiation exposure and a reduction in the cost of the service, thereby possibly obviating the need for future expansion to meet growing demands".

Indeed, the establishment of the College Working Party reflected a growing awareness among many radiologists of a need for greater discrimination in the use of diagnostic radiology. This was manifest in the British medical press in several articles written by prominent radiologists (Editorial, British Medical Journal, 1977; Evans, 1977; Goldberg, 1977; Sherwood, 1978). Similar attitudes were emerging among radiologists in the United States. In 1971 the American College of Radiology created an Efficacy Studies Committee to make recommendations to the College and its membership on the effective use of radiology in medical diagnosis (Loop and Lusted, 1978). In the American medical press, reasons for the "overutilization" of X-rays were explored, and a more discriminating approach was advised (Hall, 1976; Abrams, 1979). This perspective on the need for a more rational approach to radiological investigation was, and is, a view shared by many radiologists throughout the world and has been exemplified in a recent WHO publication, "A Rational Approach to Radiodiagnostic Investigations" (Report of a WHO Scientific Group, 1983).

1.2 DEVELOPMENT OF GUIDELINES ON USE OF PRE-OPERATIVE CHEST X-RAYS

In order to promote the more rational use of diagnostic radiology the College Working Party considered an important step to be the formulation of guidelines for the use of radiological examinations. Ideally, such guidelines might be based on the results of research on the effectiveness, safety and cost of the examinations. However, as there was a paucity of such research, the Working Party decided to carry out a series of national multicentre studies to evaluate some commonly used radiological examinations: pre-operative chest X-rays in elective surgery; skull X-rays in head injured patients; lumbar X-rays in the investigation of back pain; X-rays of injured extremities; and straight X-rays in the investigation of acute abdominal pain.

The first multicentre study, conducted under the auspices of the Working Party, investigated the use of pre-operative chest X-rays. Over a period of almost five months, utilization was examined in 10,619 patients undergoing non-acute non-cardiopulmonary surgery in eight hospitals in England, Wales and Scotland. The results of the study showed a wide variation in utilization both between centres (11.5% to 54.2%, of patients X-rayed) and between specialties. This variation could not be explained on clinical grounds. Furthermore, pre-operative chest X-rays did not seem to influence the decision to operate nor the choice of anaesthetic; nor was there any evidence that the pre-operative chest X-ray was of much value as a baseline against which subsequent X-rays might be judged (National Study by the Royal College of Radiologists, 1979).

A few years prior to the multicentre study, the value of routine pre-operative chest X-rays had been questioned in two leading articles in the medical press (Editorial, British Medical Journal, 1975; Editorial, Lancet, 1975). Both articles reviewed a recently published study by Sagel et al (1974) on the value of routine chest X-rays in patients admitted to a hospital in the USA. In concluding their reviews, neither editorial advocated the use of routine pre-operative chest X-rays and the British Medical Journal went as far as to suggest that it should "... not require too muuch persuasion for most surgeons and anaesthetists to accept the recommendation that routine chest radiographs should no longer be done on patients under the age of 20 or even 30 years".

The idea of reducing the use of pre-operative chest X-rays was, however, unacceptable to many clinicians. The College Working Party was made fully aware of such attitudes at a seminar on the use of diagnostic radiology convened by the DHSS at Harrogate in 1978. Some clinicians believed that the clinical risk of not carrying out an X-ray was unacceptable and that everything possible should be done to reduce the risk of surgery, irrespective of cost. Others thought that limiting the use of the procedure was morally unjustified and would open the floodgates to medical litigation. Clinicians, especially those in surgery, obstetrics and gynaecology, and anaesthesia felt that their clinical freedom would be threatened. Despite the publication of another editorial in The Lancet doubting the value of pre-operative chest X-rays (Editorial, Lancet, 1979) it appeared at that time that there was little likelihood of more effective use of the procedure being achieved in the forseeable future.

Indeed, the Working Party's perspective on the use of pre-operative chest X-rays as expressed in the report of the multicentre study (National Study by the Royal College of Radiologists, 1979) was at variance with the views of a sister College in the United States. During the 1970s some professional groups in North America were advocating a more limited use of routine chest X-rays in hospital (Martin, 1981) but the American College of Radiology did not issue guidelines for the use of routine chest X-ray examinations until 1982 (Council of the American College of Radiology, 1982). Even then, they recommended simply that "routine chest radiographs not be required solely because of hospital admission" and made no specific recommendation on the use of pre-operative chest X-rays.

It emerged subsequently that the view of the American College was that "pre-anaesthesia recommendations ... should be set by a panel of anaesthetists and surgeons as well as radiologists. This subject is somewhat more sensitive than the others because it affects other physicians, such as opthalmologists, who perform surgery. For such physicians, the pre-operative roentgenogram is a form of insurance should pulmonary complications from surgery arise" (Merz, 1983). Since then, however, a government agency in the United States, the Centre for Devices and Radiological Health, has issued a draft guideline prepared by a panel of experts (Radiological Health Sciences Education Project, 1984). This guideline states that "pre-operative chest radiography not be required as a routine for operating room admission". But the expert panel felt unable to give positive guidance in the form of a list of acceptable indications for requesting pre-operative chest X-rays.

Given prevailing attitudes in the United Kingdom and elsewhere, the College Working Party realised that the introduction of a change in practice consequent upon the findings of the multicentre study would take time and would have to be handled carefully. Thus, when publishing the results of the study in 1979 (National Study by the Royal College of Radiologists, 1979) the Working Party described only non-specific "possible" guidelines for the use of pre-operative chest X-rays. The guidelines stated that:

"a) it is unnecessary to have a radiologist's report on any pre-operative chest X-ray unless one has been specifically requested.

b) the use of pre-operative chest X-rays as a baseline for post-operative management at present levels of utilization is not justified. In any event the 90% level of utilization needed to effect this would prove very difficult to achieve in practice.

c) it is advisable on financial and ethical grounds that the pre-operative chest X-ray service should in future be used:

1) selectively only in circumstances where the clinical history or signs place the patient at very high risk of post-operative pulmonary complication and where it is considered the investigation will provide important additional information, and

2) routinely, perhaps only in population groups where the prevalence of undiagnosed chest disease is likely to be high (e.g. immigrants)".

They also issued a cautious policy statement: "... temporary norms of utilization would probably be best derived from the low rather than the high figures taken from participating centres and we would recommend that utilization for non acute non-cardiopulmonary surgery should run at no more than 12%". The purpose of this statement and the "possible" guideline was simply to influence the prevailing climate of opinion.

The method employed in the multicentre study probably had some effect on the opinions of clinicians and others working in the participating hospitals. Under the guidance of the Working Party, the design of the study was developed collaboratively between staff in the departments of Diagnostic Radiology and Epidemiology and Community Medicine at the University of Wales College of Medicine in Cardiff. Following successful piloting of the method, the co-operation of radiologists was obtained in each of the proposed study centres. The study was then discussed with local clinicians and if their support was forthcoming, approval was sought from cogwheel divisions. Co-operation was also obtained from radiographers, hospital administrators and medical records officers. A senior radiologist was designated the local co-ordinator and a part-time research assistant appointed in each hospital. This method of investigation thus required the co-operation of many health service staff. Such widespread participation may in itself have had an important effect in changing attitudes towards a more discriminating approach in the use of the procedure.

Reinforcement of the message contained in the policy statement and "possible" guidelines took place over a period of two years following the publication of the results of the study (National Study by the Royal College of Radiologists, 1979). The results were presented by members of the College Working Party at scientific meetings and discussed with clinical colleagues in local hospitals. During this period the Working Party became aware that radiologists in a few hospitals were collaborating with local clinicians in attempting to implement the ideas contained in the general policy statement. However, progress seemed slow and it was doubted whether the sporadic changes in attitude that were occurring during this period would have ever gained sufficient momentum to bring about the national change in attitude that was desired. (Personal communication, Working Party on Effective Use of Diagnostic Radiology).

In 1981 an opportunity arose to determine if the policy statement and "possible" guideline were having an impact on utilization. In South Wales there had been considerable interest in the study on pre-operative chest radiology conducted by the College Working Party; the policy statement had been disseminated among local radiologists by word of mouth at scientific and divisional meetings and by distribution of reprints of the paper describing the results of the multicentre study (National Study by the Royal College of Radiologists, 1979). The Working Party decided to monitor the use of pre-operative chest X-rays at two hospitals in South Wales to determine if these local initiatives were having any effect on practice. Also, they decided to seek evidence of desirable or undesirable clinical outcomes consequent upon any change in practice.

Under the auspices of the Working Party, the author and colleagues in the University of Wales College of Medicine conducted such a study. The results (Roberts et al, 1983) showed that a highly significant reduction in the use of pre-operative chest X-rays had occurred in both hospitals during the study period ($p < 0.001$). In one hospital (which had participated in the multicentre study) the rate decreased each year from 1977, the year of the original study. In the other hospital (which had not participated in the multicentre study) the use declined abruptly in 1979, the year of publication of the results (National Study by the Royal College of Radiologists, 1979) to a level which was maintained in 1980. In the hospital participating in the multicentre study utilization fell by 42% and was observed across all specialties. In the other hospital utilization in ENT surgery increased by 61% and in ophthalmology by 190%, the latter being largely attributable to a newly appointed consultant who replaced a retiring colleague. However the decrease in utilization in the remaining specialties (40% in general surgery, 41% in orthopaedics and 69% in gynaecology) brought about a 27% reduction overall in that hospital during the study period. In neither hospital was there evidence of a significant change in clinical outcome in terms of an increase in surgical mortality or in post-operative morbidity (using the proxy measure of post-operative length of stay).

This study (Roberts et al, 1983) was an important milestone in the pursuit of the objective of defining acceptable national guidelines. It suggested that a more discriminating approach in the use of pre-operative chest X-rays was considered reasonable by many of the clinicians in the study hospitals and that a reduction in the use of pre-operative chest X-rays had no undesirable effect on patient care and outcome. This evidence gave the Working Party the confidence to firm up it's preliminary guidelines into a specific recommendation about how pre-operative chest radiology should be used. These guidelines were accepted and ratified by the Board of the Royal College of Radiologists in 1983. The guidelines stated that routine pre-operative chest radiology was no longer justified and that pre-operative chest X-rays should be considered only in patients with acute respiratory symptoms or possible metastases, and for those who had chronic cardiorespiratory disease or who were recent immigrants from tuberculous endemic countries. The latter two categories of patient only required a chest X-ray if they were not X-rayed within the previous 12 months. Appendix I contains the full text of the guidelines.

The difficulty now facing the Working Party was the selection of a strategy to introduce and sustain the implementation of the guidelines in clinical practice. The survey in the two hospitals in South Wales (Roberts et al, 1983) had shown a considerable reduction in the use of pre-operative chest X-rays, but the level of utilization was still well above the recommended level of 12%. In both hospitals over 30% of elective non-cardiopulmonary surgical patients were still having pre-operative chest X-rays. Furthermore, any impact that the multicentre study and its publication had on utilization had probably diminished. Given this difficulty in not knowing how best to proceed with implementation of the guidelines, the author and colleagues in the University of Wales College of Medicine, under the auspices of the College Working Party, sought financial support to mount a trial in five hospitals in the UK of alternative strategies for implementing the guidelines. The King Edward VII Hospital Fund generously agreed to support this study which began in January, 1983.

CHAPTER 2.

LITERATURE REVIEW

This study is concerned with changing the use of a diagnostic procedure. Before conducting the study and attempting to implement change, a comprehensive review had to be made of published evidence on the use and value of the procedure. Were the costs, risks and benefits such that it was reasonable to change utilization?

In addition to reviewing the frequency of use, yield of clinical abnormalities and effect on patient management of pre-operative chest X-rays, useful information was also obtained from studies of routine non-pre-operative chest X-rays (for example, chest X-rays performed on patients admitted to hospital and in mass population surveys). Information from these sources was then used to make an assessment of the costs, risks and benefits of pre-operative chest radiology.

2.1 PRE-OPERATIVE CHEST X-RAYS

2.1.1 Frequency of use

The National Study by the Royal College of Radiologists (1979) is the most comprehensive survey to date of the frequency of use of pre-operative chest X-rays in the United Kingdom. As stated in Chapter 1, the use of pre-operative chest X-rays was examined in eight hospitals on 10,619 patients undergoing non-acute non-cardiopulmonary surgery. On average, 29.7% of patients had a pre-operative chest X-ray, but this varied widely between hospitals from 11.5% to 54.2% of patients. The greater part of the variation between hospitals could not be explained by differences in the age of patients, in the proportion undergoing major surgery or in the mix of specialties. The use of pre-operative chest X-rays varied three and a half fold between the specialties ranging from 13.1% of patients in gynaecology to 46.8% of patients in general surgery. This variation could not be explained by differences in the age of patients nor in the proportion undergoing major surgery within the specialties.

The use of pre-operative chest X-rays had not been studied prior to the National Study by the Royal College of Radiologists (1979). During the 1950s and 1960s utilization was probably high, not least because of the greater incidence of tuberculosis. The prevailing medical opinion was that individuals should be screened wherever possible for the detection of this disease. Commenting on a study of 1000 pre-operative chest X-rays carried out in a district general hospital in 1954 (Loder, 1955), the author stated in a later paper (Loder, 1978) that the clinical policy in the hospital in the early 1950s was to request a chest X-ray for every patient admitted for a surgical operation. This was probably the case in most hospitals at that time.

In other western countries pre-operative chest X-rays are used frequently. In the United States, although no surveys of use have been conducted recently, there is little doubt that pre-operative chest X-rays are "commonly performed" (Robbins and Mushlin, 1979). In Australia, a survey of the use of diagnostic services on patients admitted in 1977 to a teaching hospital for routine surgery found that over 85% of patients had a pre-operative chest X-ray (Catchlove et al, 1979). Likewise, in New Zealand in the mid 1970s, 83% of patients admitted to a major teaching hospital for elective surgery on varicose veins and inguinal hernia received pre-operative chest X-rays (Delahunt and Turnbull, 1980).

2.1.2 Yield of clinical abnormalities

The main rationale put forward for performing pre-operative chest X-rays is to detect cardiac or respiratory abnormalities which place patients at increased risk of death or serious complications during or after surgery (Loder 1955, 1978; Kerr, 1974; Sane et al, 1977). In patients with clinical symptoms and signs, the chest X-ray might confirm the presence of an abnormality and identify the extent of the abnormality; in patients with no clinical symptoms or signs, the chest X-ray might detect unsuspected abnormalities. Identifying a cardio-respiratory abnormality allows an operation to be delayed or administration of an anaesthetic to be altered in order to decrease the risk.

Another rationale put forward for performing routine pre-operative chest X-rays is to produce pre-operative "baselines" for comparison with chest X-rays performed because of post-operative complications (Kerr, 1974; Evison, 1976; Loder, 1978; Milne, 1980; Seymour et al, 1982). These "baseline" X-rays might assist in the detection and interpretation of abnormalities in the post-operative chest X-rays.

The rationale for performing pre-operative chest X-rays would appear to be clinically logical, but whether pre-operative chest radiology is beneficial depends on the effect of such a policy in reducing operative mortality, increasing life expectancy and reducing post-operative morbidity (Neuhauser, 1978). Determining the effect of pre-operative chest radiology on these outcome measures would require a very large controlled trial of hundreds of thousands of patients followed up for many years. Because of the organisational and financial constraints in carrying out such a trial most studies attempting to determine the benefits of routine pre-operative chest radiology have had to be content with more limited measures of outcome such as the yield of important abnormalities or the effect of the procedure on subsequent management of the patient.

The yield of abnormalities was surveyed in 667 consecutive patients having pre-operative chest X-rays prior to elective non-cardiopulmonary surgery in a large hospital in Wales (Rees et al, 1976). The abnormalities discovered were allocated, as in the subsequent National Study by the Royal College of Radiologists (1979), into "significant" and "non-significant" categories according to their "relevance to general anaesthesia and surgery". Significant abnormalities included those affecting the heart (e.g. cardiomegaly), the aorta and pulmonary artery, the lung fields (e.g. metastases), the pleura, the skeleton (e.g. cervical spondylosis) and the mediastinum. One hundred and twenty six significant and 173 non-significant abnormalities were found. Of the significant findings, 54% were due to cardiomegaly and 19% to chronic respiratory disease. A similar survey of 1,000 consecutive pre-operative chest X-rays carried out in a district general hospital in 1954 (Loder, 1955) and repeated in 1977 (Loder 1978) found that approximately 10% of radiographs had abnormalities. The most common abnormalities were "heart enlarged and/or aortic unfolding", "tuberculosis: calcified foci or glands" and "collapse and/or infection of lung". The survey by Catchlove et al (1979) in Australia found a similar incidence of abnormalities (in 14% of pre-operative chest X-rays).

The yield of abnormalities varies according to the age of patients. Rees et al (1976) found no significant abnormality in patients under 30 years old. In patients aged 30 years or older the yield of abnormalities rose progressively with age, mostly due to an increasing prevalence of cardiomegaly. In a similar study of patients age 65 years and over (Seymour et al, 1982), 40.3% had an abnormality which was regarded as clinically significant according to the criteria developed by Rees et al (1976). Cardiomegaly was the commonest abnormality, occurring in 18% of men and 26% of women. In a survey of patients over 70 years of age presenting for elective surgery in a hospital in Sweden, 37% of patients who had no clinical indications for a pre-operative chest X-ray were found to have abnormalities. Half of these abnormalities were cardiomegaly (Tornebrandt and Fletcher, 1982).

Other studies have shown almost no yield in patients under 30 years of age (Loder, 1978; Catchlove et al, 1979), but the numbers of subjects in the study populations have been small. In the United States, larger surveys of pre-operative chest X-rays performed on children (Sane et al, 1977; Farnsworth et al 1980; Wood and Hoekelman 1981) have shown some variation in the yield of significant abnormalities from 0.3% (Farnsworth et al, 1980) to 4.7% of children (Sane et al, 1977). This variation may have been due to differences in the definition of "significance", in the interpretation of X-rays, in the social class of the population, and in the seasons in which the surveys were performed. For example, in the study with the highest abnormality rate (Sane et al, 1979), most abnormalities were due to pneumonia, This survey was carried out during winter and spring.

2.1.3 Validity and reliability of yield

The extent to which the yield of abnormalities detected on routine chest X-rays reflects the true level of abnormalities (the validity) cannot be measured accurately because of difficulties in determining the true level of abnormalities. However, comparisons of routine readings by an individual with those of an expert panel provide some useful information on the diagnostic value of the procedure.

In the 1940's, with the advent of mass miniature radiography for the detection of tuberculosis and of coal miners' pneumoconiosis, considerable interest was expressed in the validity of these surveys. Garland (1959) reviewed the studies of diagnostic accuracy in interpreting routine chest X-rays and found that at least 25% of positive films (standard size and minature) were missed on one reading. In addition to these false negative results, approximately 2% of normal X-rays were designated positive (false positive results). Depending on the proportion of affected individuals in the population, false positives and false negatives might on occasions have counterbalanced each other so that the overall yield of abnormalities was correct. But within this yield individuals would have been misclassified as positive or negative.

Reliability (repeatability) in the detection of abnormalities was also assessed (Garland, 1959). When interpretations of the same chest X-rays by two experienced physicians were compared, disagreement occurred in about 30% of cases (inter-observer variation). In repeat viewings of the same film a single reader would show disagreement between about 20% of the compared readings (intra-observer variation).

These early studies of diagnostic accuracy in the interpretation of chest X-rays (Garland 1959) were concerned mainly with chest X-rays taken during surveys for tuberculosis and pneumoconiosis. More recently, Herman et al (1975) determined levels of accuracy in interpreting chest X-rays selected randomly from a hospital file. On average a single reader missed 25% of "significant" or "potentially significant" abnormalities detected by an expert panel. Among the five readers in the study, this error rate ranged from 16% to 34% of abnormalities missed. False negative errors were three times more common than false positive errors suggesting that overall there was an under-reporting of abnormalities in the hospital. The results of this and earlier studies indicate that there is considerable error in the interpretation of chest X-rays and disagreements between observers. This might not only explain some of the differences in yield from routine pre-operative chest X-ray examinations, but would also tend to diminish the value of routine chest X-rays in detecting important clinical abnormalities.

Variations in yield may also be due to differences in radiographic technique particularly in the use of the lateral view. Sagel et al (1974) judged the value of the lateral projection in over 10,000 chest X-rays performed in one hospital. In 11% of X-rays performed as a "routine screen" the lateral projection confirmed or clarified possible abnormalities detected on the postero anterior view. However, 0.6% of patients had an abnormality which was observed only on the lateral projection; this detection rate was higher in patients aged 40 years or older (0.9%). On the basis of these results, the authors advocated lateral views in screening examinations of patients 40 years of age or older.

In another large study carried out in a Veterans Administration hospital in the United States, Eisenberg et al (1980) determined the optimum number of radiographic projections needed to assess applicants for compensation for chest disease or injury related to military service. The results showed that in 978 out of 987 chest examinations (99%), the final radiographic assessment could have been made from a single postero-anterior view. In eight of the nine cases in which an abnormality was not detected using the postero-anterior view, the findings were considered to be clinically insignificant. The one potentially serious lesion missed (a possible pulmonary nodule) was also missed using the lateral projection and was only detected on oblique views. The results of these studies (Sagel et al 1974, Eisenberg et al 1980) would suggest that the yield of abnormalities observed on routine chest X-ray screening is not affected to any great degree by performing a lateral projection in addition to the postero anterior view.

2.1.4 Effect on patient management

Although surveys of yield have indicated the level and nature of abnormalities found on routine pre-operative chest X-rays, they have not provided adequate evidence of the value of the procedure. The true "significance" of the abnormalities was not known; many of the abnormalities may not have had an untoward effect on the outcome of surgery. Indeed, Rees et al (1976) questioned their own decision to attribute cardiomegaly as a "significant" abnormality. In noting a higher prevalence with age they wondered whether this observation "gives some support to Simon's suggestion (Simon, 1975) that the diameter of the thorax shrinks with advancing age and hence questions the extent to which asymptomatic cardiomegaly should be regarded as an abnormal finding". Yet cardiomegaly accounted for 68 out of the 126 significant findings in their study. Such doubts about "significance" have led many researchers to examine, in addition to the yield of abnormalities, the effect of the pre-operative chest X-ray on subsequent management of the patient.

(1) Effect of detecting abnormalities

In 1955, Loder found that 29 out of 1,000 patients receiving a pre-operative chest X-ray had their surgery postponed (although he does not indicate whether the results of the chest X-rays led to the postponements). In six patients unsuspected active tuberculosis was identified - a diagnosis which would justify a postponement of most elective surgical procedures. More recently the National Study by the Royal College of Radiologists (1979) examined the subsequent events in patients who had received pre-operative chest X-rays. The chest X-ray report did not seem to have much influence on the decision to operate in that 96.2% of patients with a normal report and 92.0% of patients with a significant radiological abnormality proceeded to operation. Likewise the decision to use inhalational anaesthesia did not appear to be influenced by the report. In those having a routine pre-operative chest X-ray 96.7% of patients with normal reports and 96.1% with significantly abnormal reports underwent inhalational anaesthesia. Furthermore, 25.7% of those having a pre-operative chest X-ray proceeded to operation without the radiological report being available. In one quarter of these reports a significant radiological abnormality was observed.

Catchlove et al (1979) also found that the pre-operative chest X-ray had little influence on subsequent management. The chest X-ray results in 79 pre-operative patients did not lead to postponement or cancellation of any operation. In Wellington, New Zealand, the unreported abnormalities detected on the pre-operative chest X-rays of 803 patients undergoing elective surgery were all considered to be of a minor nature and had no effect on subsequent management of the patients (Delahunt and Turnbull, 1980).

In another survey of 1,530 patients, surgery was postponed in only two cases; one child scheduled for cystoscopy had a possible lung infiltration and an elderly woman had intestitial pulmonary oedema (Petterson and Janower, 1977). Seymour et al (1982), in their study of 258 elderly patients undergoing surgery, found that the results of the pre-operative chest X-ray affected surgical management in 10 patients. In five patients radiological lesions suggestive of neoplasia were discovered, and the surgical procedure was modified accordingly. The other five patients had their operations cancelled. Three of these patients had secondary carcinoma, one had tuberculosis and the fifth had dysphagia secondary to left atrial enlargement. It is not clear, however, how many of the pre-operative chest X-rays were "routine" and how many were performed on patients with cardio-respiratory or other symptoms warranting chest X-rays.

The influence of the pre-operative chest X-ray on the subsequent management of children are not consistent in the two studies of this age group. Farnsworth et al (1980) found in a survey of 350 children admitted for elective surgery that the results of pre-operative chest X-rays never led to the cancellation of an operation, nor to a change in the pre-operative diagnosis. On the other hand, Sane et al (1977) in a study of 1,500 consecutive patients under 19 years of age found that 3.8% of patients had surgery postponed or cancelled or the anaesthetic technique altered as a result of the X-ray findings.

(2) <u>Effect of baseline chest X-rays</u>

The value of the pre-operative chest X-ray as a baseline against which to compare subsequent post-operative radiological changes has also been examined (National Study by the Royal College of Radiologists 1979; Farnsworth et al, 1980; Seymour et al, 1982). In their study of elderly patients, Seymour et al (1982) found that over one third of patients were judged by the surgical team to require a post-operative chest X-ray for diagnostic reasons. The authors stated that discerning old lesions from new on the post-operative chest film would have been more difficult if baseline pre-operative chest X-rays had not been available. But they produced no evidence to substantiate this claim. On the other hand, in one of the studies on the use of pre-operative chest radiology in children (Farnsworth et al 1980), only 11 out of 350 children had a post-operative chest X-ray. The authors considered that the pre-operative chest X-ray was not helpful in the interpretation of any of the post-operative chest X-rays.

Differences in projection, posture and lung inflation between X-rays taken pre- and post-opertively also limit the value of the pre-operative chest X-ray as a baseline procedure. In a comparison of pre- and post-operative chest X-rays of 22 patients undergoing elective open-heart surgery, Harris (1980) found several differences due to positioning. He recommended that if pre-operative chest X-rays are to be of value as a baseline procedure, they should be taken at lung values and in postures comparable with those occuring post-operatively.

In the National Study by the Royal College of Radiologists (1979),43% of patients who developed a post-operative pulmonary complication had not had a pre-operative chest X-ray. Of those with serious medical conditions involving the chest and/or heart recorded pre-operatively, only one half had a pre-operative chest X-ray. Although these results did not indicate the true value of a pre-operative chest X-ray as a baseline procedure, the inconsistencies in practice suggested that many doctors who ordered pre-operative chest X-rays did not subscribe to the view that it is a necessary baseline procedure. Or if they did subscribe to this view, they did not act upon this belief in any rational or systematic way.

In summary, the results of surveys of pre-operative chest radiology suggest that such X-rays are used frequently, but inconsistently, in surgical practice. The yield of unsuspected clinical abnormalities is minimal and there is probably considerable error in the detection of abnormalties. The effect on patient management in terms of delaying surgery or avoiding general anaesthesia would appear to be negligible. The pre-operative chest X-ray is probably of little value as a baseline procedure.

2.2 ROUTINE NON PRE-OPERATIVE CHEST X-RAYS

The yield of abnormalities on chest X-rays performed routinely on populations other than those proceeding to surgery provides additional information on the abnormalities which may be detected in individuals who do not have overt cardio-respiratory disease. Routine chest X-rays are performed frequently on patients admitted to hospital and were until recently carried out on many women attending antenatal clinics. Chest X-rays may also be administered routinely to selected groups in the population, such as individuals having pre-employment medical examinations or routine health examinations. Mass chest X-ray surveys of unselected populations have been performed in many countries.

2.2.1 Admission to hospital

In a prospective study of the yield from over 2,000 chest X-rays performed routinely on patients admitted to a hospital in the United States, Sagel et al (1974) found that 16.5% had a "serious" abnormality. The proportion of patients with a serious abnormality increased with age and, in keeping with the results of studies on pre-operative chest X-rays, the majority of abnormalities were cardiomegaly and chronic obstructive airways disease. However, on retrospective analysis of the patients' medical records, 73% of patients were found to have a history and/or physical findings compatible with a cardio-respiratory condition. Thus the pre-operative chest X-rays were not strictly "routine". Indeed, only 4% of the chest X-rays performed revealed new diagnostic information.

In a similar study conducted more recently in a general medical unit in California (Hubbell et al, 1985), routine admission chest X-rays revealed new findings in 7% of patients. However, treatment was changed in only 4% of patients, and in only one of these 12 patients would appropriate treatment probably have been omitted if a chest film had not been obtained. The patient's outcome was not improved by the treatment instituted.

Sewell et al (1981) examined the usefulness of screening investigations performed in the management of elderly acutely ill medical patients. They found that, when chest X-rays were performed for specific clinical indications, 86% had abnormalities whereas, of those performed routinely as screening tests, only 21% had abnormalities. In only one of six patients with a clinical abnormality did the new finding (blunting of a costo-phrenic angle) contribute to a change in management. In a similar study of admission chest X-rays performed on patients aged 60 years and over, Denham et al (1984) found that only 5% of patients had findings which affected their subsequent management. However, a retrospective review of the case notes of these patients indicated that they had clinical findings warranting chest X-rays. These results led the authors to recommend that routine chest X-ray screening of elderly patients admitted to hospital was not justified.

In earlier years, one of the main reasons for carrying out routine chest X-rays on admission to hospital was to detect active tuberculosis. In the mid 1970s, Feingold (1977) examined the tuberculosis detection rate in 39,000 consecutive admissions to a hospital in Atlanta, most of whom had a routine chest X-ray on admission. Only two unknown cases of tuberculosis were detected (yield 0.05 per 1000) but both of these patients had respiratory symptoms and one was febrile. Thus, no cases of tuberculosis were discovered in patients in whom the diagnosis was not suspected on clinical grounds. Other studies of chest X-rays performed on patients admitted to hospital (Goldstein and Miller 1980; Fink et al 1981) have shown a high yield of abnormalities but they did not distinguish between patients who did and did not have cardiorespiratory symptoms and signs.

Radiography is often performed routinely on patients admitted to psychiatric wards with the main purpose of excluding unsuspected physical disease that might be responsible for psychiatric symptoms. Hughes and Barraclough (1980) examined the use of chest X-rays in 746 patients admitted to acute psychiatric beds in Southampton. They found that 231 had had a chest X-ray and that 9% of these had "significant" abnormalities requiring further investigation. However, none of the chest X-rays disclosed an abnormality which should not have been suspected clinically. In another survey of psychiatric in-patients in a hospital in the United States, Liston et al (1979) found that in patients where there was a suspicion of a cardio-respiratory abnormality, 18% had a significant finding on chest X-ray. But, of the 102 patients who had no suspected abnormality, none had a significant finding on routine chest X-ray.

In psychiatric practice, chest X-rays may also be used routinely prior to electro-convulsive therapy (ECT). (Such chest X-rays might be considered as routine "pre-operative" chest X-rays in that they are taken prior to patients having a general anaesthetic). In a retrospective study of 367 consecutive patients having electro-convulsive therapy at a hospital in Portsmouth (Abramczuk and Rose, 1979) 91% had a pre ECT chest X-ray. Of these, 147 had an abnormal physical examination but no unsuspected findings were detected on the chest X-ray. Of the 258 patients who had a normal physical examination, a major abnormality on chest X-ray was detected in only one patient. They concluded that routine chest X-ray screening prior to ECT was not justified and recommended that more emphasis should be given to the conduct of a proper physical examination.

2.2.2 Antenatal Care

The value of routine antenatal chest X-rays was questioned in the early 1970s. A retrospective survey of 1,239 patients attending an antenatal clinic in Nebraska in 1970 disclosed that 1,030 patients had a chest X-ray and of these 17 had an abnormal physical finding (Mattox, 1973). In only one patient was the abnormality (haemangioma of the rib cage) unsuspected. The author concluded that the $20,000 spent to identify one benign lesion was not justified and that chest X-rays should only be considered in the presence of a positive history or physical examination. This extremely low yield was confirmed subsequently in other studies in the United States. In reviewing 12,109 consecutive deliveries at the Mayo Clinic between 1966 and 1975, Bonebrake et al (1978) found that 97% of mothers had had routine antenatal chest X-rays; only 74 patients had an abnormality. In each case, findings in the history or physical examination would have suggested the presence of the abnormality.

In antenatal clinics serving poor black populations in the United States, the yield of abnormalities on chest X-ray is still extremely low. Hadlock et al (1979) found that of 5,422 pregnant women having chest X-rays, only three unsuspected abnormalities were detected. These cases included two patients with active pulmonary tuberculosis, but they were immigrants from countries with a high incidence of tuberculosis where an abnormality might have been suspected on these grounds alone. The authors concluded that the low case detection rate probably reflected the general decline in incidence of pulmonary tuberculosis. They suggested that routine chest X-rays were no longer indicated as part of antenatal care. Awareness of the poor yield from routine chest X-rays during pregnancy and some concern about the radiation risks to the foetus have resulted in the discontinuation of this procedure.

2.2.3 Occupational Health

Chest X-rays have been performed routinely as part of pre-employment medical examinations and routinely on employees in certain industries.

One of the largest surveys of the yield of chest X-rays in pre-employment examinations was carried out at the Eastman Kodak company in Rochester, New York (Ashenburg, 1982). Chest X-rays on 3,266 applicants for a position in the company yielded only 52 (1.6%) abnormalities. Of these, 25 (0.7%) had a radiological finding that was considered relevant in terms of clinical follow-up, appropriate job placement or deferment of employment. Eighty percent of the applicants were under the age of 35 and in comparison with other studies the yield might be considered quite high, but individuals with a positive history or clinical examination were not excluded from the study. It was concluded that routine pre-employment chest X-rays were not necessary but should be based on a history of occupational exposure to substances that might have an adverse effect on pulmonary function or cause pulmonary disease.

This recommendation by Eastman Kodak was not compatible with that made a few years earlier by a specialist committee of the American Occupational Medical Association (Lincoln et al, 1979). Although not citing evidence, this committee thought that "determining the presence of existing lung disease at the time of employment is a justifiable concern. Even when completely normal a baseline X-ray for future reference may be justified". But, the committee did have reservations about the use of routine chest X-ray examinations during employment and recommended that:

"(i) Chest X-rays for the detection of tuberculosis are not justified unless individuals are in a high risk group;

(ii) Chest X-rays are not cost effective in the detection of lung cancer and;

(iii) Chest X-rays to detect asbestosis and other chronic lung diseases are only useful in those exposed to risk factors."

2.2.4 Health Examinations

Routine medical examinations on "healthy" individuals may include a chest X-ray. Screening programmes comprising a general medical examination have produced useful information on the expected yield from routine chest X-rays and also on their effect in preventing mortality and morbidity.

The only study which has examined specifically the value of the chest X-ray during routine health examinations was conducted on children and adolescents attending a paediatric screening clinic in an area of New York city with a higher than average incidence of tuberculosis (Brill et al, 1973). One thousand consecutive healthy children aged from one month to 18 years attending the clinic in 1972 were X-rayed. Six percent were found to have abnormal findings. However, 4% had minor skeletal abnormalities and only one child was found to have an abnormality which was possibly significant. This child had bilateral interstitial infiltrates which persisted unchanged for a period of 6 months. The authors concluded that chest radiography was not indicated as a screening procedure in healthy children. For the detection of tuberculosis, they recommended initial skin testing and subsequent chest X-ray for those with a positive reaction. They also recommended that on the basis of their findings, routine pre-operative chest X-rays should not be considered in children under 18 years of age.

There have been two properly controlled trials of routine health examinations; one was performed in general practice in South East London (South East London Screening Study Group, 1977); the other was performed in the Kaiser-Permanente Health Programme in California (Dales et al, 1979). In both these trials the individuals in the screening groups were given a routine chest X-ray. Although the trials did not examine the specific effects of the chest X-ray in reducing mortality or morbidity, benefits of the screening examination overall were compared between the groups. The South East London Study lasted for 9 years and there was no statistical difference between the screened and control groups in mortality, certified absence from work through illness, admission to hospital, or in visits to their general practitioner. The results of the Kaiser-Permanente study were reported after 11 years of follow up. There was no difference between the two groups in total mortality, self reported disability, the use of out-patient facilities or admission to hospital. But, particularly in the 45 to 54 year age group, mortality was significantly less from complications of hypertension and from colo-rectal carcinoma. It was unlikely that the routine chest X-ray contributed to improved management of these conditions.

In North America recommendations have been made that routine annual physical examinations should be replaced by periodic health examinations which vary in content according to the age of the patient (Breslow and Somers, 1977; Canadian Task Force on the Periodic Health Examination, 1979) . In describing the details of such periodic health examinations, the Canadian Task Force (1979) did not include routine chest X-rays in the list of effective procedures for the health protection of adults. In the "Lifetime Health Monitoring Programme" developed by Breslow and Somers (1977) they emphasised that routine chest X-rays were not justified. Based on the lack of yield from their own study the Kaiser-Permanente Medical Group in San Francisco has discontinued the practice of performing annual chest X-ray examinations on their entire population (Dales et al, 1979). In 1980 the Advisory Board of the Harvard Medical School Health Letter evaluated and rated various diagnostic tests that might be used during periodic health examinations (Editorial, Harvard Health Letter, 1980). The chest X-ray was rated the least useful of 15 procedures.

In the NHS, routine health examinations are performed only rarely in general practice, although in recent months some private health organisations have been offering them on a fee for service basis.

There has been some minor support for the periodic health examination in the British medical press and, interestingly, one recommendation (Bayliss, 1981) included a list of tests that might be performed (for example, a baseline electro-cardiogram and baseline mammograms in women between the ages of 35 and 40 years). But no mention was made of the chest X-ray. The consensus of opinion would thus appear to be that the chest X-ray is not of value in routine health examinations.

2.2.5 Mass population surveys

Chest X-ray screening of the general population has been carried out in many countries since the early 1940's. The purpose of these surveys has been to detect unsuspected active cases of tuberculosis and to a lesser extent cases of lung cancer. The results of these surveys not only provide further evidence as to the likely yield of routine pre-operative chest X-ray screening but also whether pre-operative chest X-ray screening might be justified as an adjunct to population screening.

Since the 1920's, tuberculosis mortality and notifications have been falling steadily in the United Kingdom, apart from a brief period during World War II. When mass miniature radiography (MMR) was first introduced, the yield of cases of active tuberculosis was considerable. For example, in Wales in 1944, 5.7% of those screened were found to have active tuberculosis (Cochrane and Fletcher, 1968). By 1966 the yield had dropped to 0.06% and mass miniature radiography was accounting for less than 20% of all notified cases. In Scotland where a particularly successful MMR campaign in 1957-58 identified more than 12,000 new cases of tuberculosis, the detection rate fell to only 1.1 case per 10,000 screened in 1969 (Carstairs and Howie, 1972).

The 1972 report of the MMR service in England and Wales showed a similar casefinding rate but noted a higher rate in immigrants where 0.34% of those screened were found to have tuberculosis requiring treatment or close supervision (Registrar General's Quarterly Returns 1974). The decreasing yield from MMR, the continued decline in the incidence of tuberculosis, and the increasing cost of detecting cases led to a phasing out of MMR units in the United Kingdom.

Lung cancer has remained a major cause of death in developed countries for many years and for this reason chest X-ray screening was put forward as a possible means of reducing this mortality. In a large study in the United Kingdom, 25,000 people were screened twice per year using chest fluorograms. One hundred and one new cases (0.4% of the study population) were detected. However the 5 year survival of these cases was not significantly greater than the survival of cases detected in a controlled group who were not given screening (Brett, 1969). The reasons for the failure to improve survival were probably because many lung cancer patients had other diseases that precluded chest surgery and because metastatic spread may have occured before an abnormality was detected on chest X-ray. Population screening for lung cancer has thus not been thought worthy of implementation in the United Kingdom.

In most other western countries, mass chest X-ray screening has also been discontinued. In the United States, the Bureau of Radiological Health of the Department of Health, Education and Welfare issued a policy statement in 1972 stating that "community chest X-ray survey among the general population should not be used as a screening procedure for the detection of TB, other pulmonary disorders, and heart disease" (Radiological Health Bureau, 1973).

In summary, the results of research over the last 20 years would suggest that the chest X-ray is not useful as a routine screening procedure in many situations, namely on admission to hospital, in antenatal care, in occupational health, as part of a periodic health examination, and in mass population surveys, thus providing further circumstantial evidence of the limited value of chest X-rays as routine pre-operative procedures.

2.3 COSTS, RISKS AND BENEFITS OF PRE-OPERATIVE CHEST X-RAYS

2.3.1 Costs

In the National Health Service the Standard Accounting System does not require the costs of individual diagnostic tests to be specified. Consequently, a standard method of attributing costs to chest X-rays and other diagnostic procedures has not been developed. Costs of diagnostic tests have been estimated in ad-hoc studies of patient and disease costing where estimates have been made of the cost to the NHS of treating a patient with a specific disease.

In a trial of patient costing in Manchester (Babson, 1973), the cost of an X-ray was based upon the number of work units assigned to the X-ray. Unit values for each X-ray are published by the DHSS (1973) and are used as a means of estimating workload in radiology departments. The average unit cost in a department can be calculated by dividing the total annual expenditure of the department by the annual number of work units. A chest X-ray has been assigned a unit value of six (DHSS 1973); the cost of a chest X-ray is therefore six times the cost per unit. In a patient costing survey at Northwick Park Hospital in 1971/72, Perry (1974) estimated that the cost per unit was 21 pence. The cost of a chest X-ray was therefore £1.26p.

In a study in South Wales examining the costs of alternative methods of treating varicose veins, Piachaud and Weddell (1972 a and b) used a different method for estimating radiology costs. They noted the number of X-ray films required for each radiological investigation and using the known cost of an X-ray film, calculated the total cost of films used for each procedure. From standard hospital costing returns the ratio of the total cost of all X-ray films to the total departmental cost was obtained and it was assumed that this ratio was constant irrespective of the type of investigation performed. Using this ratio the cost of an individual radiological investigation was estimated as follows: cost of investigation = cost of films for investigation x total departmental cost divided by total film cost. Using this formula and data from Northwick Park Hospital, Mason et al (1973) calculated that a chest X-ray would cost between £1.50 and £3.00 in 1971/72.

Stilwell (1984) has recently developed a more detailed system for estimating the costs of X-rays in a hospital in the West Midlands. This system includes estimates of not only revenue expenditure but also the costs of capital. The cost of a chest X-ray in 1983 was estimated to be £4.24p broken down as follows: medical salaries 28p, radiographer and non-medical salaries £1.16p, film 93p, chemicals (minus silver recovered) 36p, medical administration 11p, hospital overheads 87p, capital 40p, other 12p. On applying this method in the University Hospital of Wales the author estimated that a chest X-ray cost £5.04p in 1983. The difference between the costs in the University Hospital of Wales and the hospital in the West Midlands could be attributed almost entirely to the higher capital costs in the former.

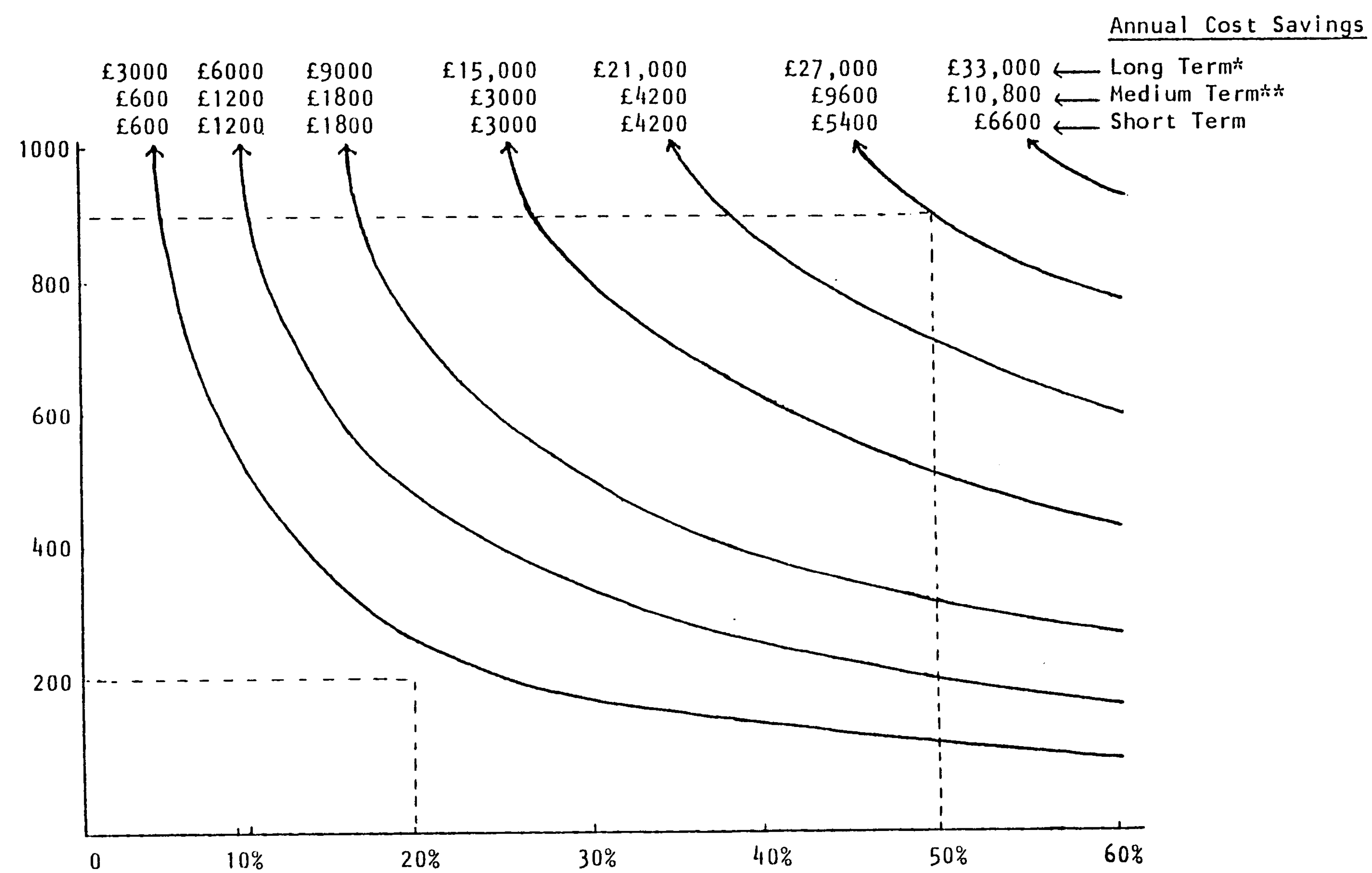
This method of X-ray costing developed by Stilwell is undoubtedly the most sophisticated to date. The costs of a chest X-ray will vary between departments depending upon such factors as the average amount of time spent by radiologists and radiographers on the procedure, costs of the capital equipment and size and nature of other work undertaken in the department. In most departments in 1984, the cost of a chest X-ray using Stilwell's method is likely to be in the region of £5.00 per examination. Chest X-rays performed at the bedside and as on-call procedures would inevitably cost more.

The cost savings resulting from a reduction in the use of pre-operative chest X-rays will not be equal to the product of the cost of the X-ray and the numbers reduced, but will depend on how a radiology department adapts to the change in workload. On the assumption that other procedures do not replace pre-operative chest X-rays, savings in the short term will accrue from reduced use of materials such as film and chemicals and will amount to aapproximately £1.00 per chest X-ray. In the medium term, depending on the surgical workload in the hospital and the size of reduction in the percentage of patients having pre-operative chest X-rays, further savings could be made by dispensing with a half-time or full-time radiographer. Rogers and Matthews (personal communication) in a survey of the work of diagnostic radiology departments in Wales have estimated that approximately 20 pre-operative chest X-rays could be carried out by one radiographer during a half day. Depending on the patterns of work within a department and whether any reduction in pre-operative chest X-rays was spread evenly throughout the week, a half-time radiographer might be released if the reduction amounted to 100 pre-operative chest X-rays per week. It is unlikely that the workload of any other staff, such as radiologists, secretaries, and porters, would be affected to such a degree that would permit a reduction in their establishment. In the long term, with re-organisation of other work in the department, the full costs of the chest X-ray (approximately £5.00 per X-ray) might be saved.

Figure 1 shows the short, medium, and long term savings feasible in a hospital according to the surgical workload and reduction in use of pre-operative chest X-rays. For example, in a hospital performing an average of 900 elective non-cardiopulmonary operations per month and reducing the use of pre-operative chest X-rays from 60% to 10% of operations (50% difference), the annual short, medium and long term savings would be £5,400, £9,600 and £27,000 respectively. A hospital performing 200 operations per month with a 20% difference in use of X-rays would have annual short term savings of £480, and long term savings of £2,400. The medium term savings would be no greater than the short term because the reduced radiological workload would be inadequate to dispense with a half-time radiographer. Some savings would be made if radiographers were employed on an hourly basis.

FIGURE 1

ANNUAL SAVINGS IN EXPENDITURE BY REDUCING PRE-OPERATIVE CHEST RADIOLOGY ACCORDING TO ELECTIVE SURGICAL WORKLOAD IN A HOSPITAL



Average number of elective non-cardiopulmonary operations per month.

Difference in % of elective operations with pre-operative chest X-ray (Initial % - Final %)

* Assuming cost of chest X-ray £5 at all levels of use of pre-operative chest X-rays.
**Based on mid point salary of half-time Senior Radiographer Grade II (including contributions) = £4,200.

2.3.2 Risks

The main risks associated with the use of chest X-rays are those due to exposure to radiation. The untoward consequences of radiation exposure are carcinogenic and genetic. A recent report (Taylor and Webb, 1978) estimated that medical radiation contributed about 30% of the total somatic dose and about 10% of the total genetically significant dose received by the population of Great Britain. Diagnostic radiology is by far the most important component of this medical radiation because of the magnitude of the total dose imparted and because many of the patients have a higher child expectancy and life expectancy than those undergoing radiotherapy. This means that the genetic risk is higher and, in the case of younger patients, there is a greater chance of any radiation induced malignancy having time to manifest itself. In addition to its contribution to the total population dose, medical radiation is important because it results in the highest doses of all manmade radiation to individuals and to individual organs. Therefore, in assessing the risks of pre-operative chest X-rays, the potential somatic and genetic hazard to the individual must be assessed as well as the risk to the population as a whole.

(1) Carcinogenic risk

The evidence that exposure to radiation increases the risk of cancer has been derived from many epidemiological studies. These have been reviewed by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1977). Three of the more important studies carried out in the United Kingdom have involved close collaboration between radiologists and epidemiologists (Doll, 1981). In one study, Court-Brown and Doll (1958) examined the mortality of dentists and doctors who between 1897 and 1954 joined the Roentgen Society, the British Institute of Radiology, the British Association of Radiologists, the Society of Radiotherapists of Great Britain and Ireland, and the Faculty of Radiologists. They found that radiologists who entered the profession before 1921 suffered a death rate from cancer which was 75% higher than that of other medical practitioners. There was a significant excess of deaths from cancers of the pancreas, lung and skin and from leukaemia. However, among those who entered the profession after 1920, there was no excess of deaths from cancer.

In another study, Court-Brown and Doll (1965) identified over 14,000 patients with ankylosing spondylitis who had been treated with irradiation from 1935 to 1954 at radiotherapy centres in the United Kingdom. These patients were followed up in 1960 and it was found that mortality from cancer was increased in practically every organ that was exposed to the radiation beam. The latent period between exposure and death was approximately 6 years (earlier in the case of leukaemia). A third important study carried out in the United Kingdom was the Oxford Childhood Cancer Survey begun in 1954 (Stewart et al, 1956). A preliminary report (Stewart et al, 1956) drew attention to the fact that a greater proportion of the mothers of children who died of leukaemia or other malignant disease, in comparison with mothers of children without malignant disease, reported that they had an abdominal X-ray during pregnancy. These findings were confirmed in subsequent reports (Bithell and Stewart, 1975) and were instrumental in reducing the use of diagnostic X-rays in pregnancy.

The results of these and other studies reviewed by Pochin (1976) provide strong evidence that exposure to ionising radiations increases the risk of cancer in practically every organ in the body. They also suggest that the increase in risk is approximately proportional to the dose received (for doses over 1 rad), that the risk varies with age (being greater in childhood and later middle age), and that for the same dose the mortality from solid tumours is three times that of leukaemia. These investigations have also shown that there is no other detectable effect on life expectancy.

The most recent estimates of the carcinogenic risk presented by ionising radiation are those given by the International Commission on Radiation Protection (ICRP, 1977), the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1972) and by the Committee on the Biological Effects of Ionising Radiation of the US National Academy of Sciences (BEIR, 1980). These estimates range from 70 to 350 fatal cancers per million people irradiated per rem of radiation received. The annual average radiation received per person in the United Kingdom from diagnostic radiology is 50×10^{-3} rem. Given a total population of 55 million and a risk estimate of 100 fatal cancers per million people per rem, the number of deaths per year from cancer attributable to diagnostic radiology in the United Kingdom is

$$55 \times 100 \times 50 \times 10^{-3} = 275 \text{ deaths per annum}$$

For an individual, exposure to a dose of 1 rad carries a risk of 1 in 10,000 of developing a fatal radiation induced cancer (UNSCEAR, 1972; BEIR, 1980).

(2) Genetic risk

The genetic risks of radiation to which a population is exposed are measured according to the genetically significant dose (GSD) (Darby et al, 1980). This index combines information on the frequency of diagnostic radiology, the magnitude of the gonadal doses associated with individual examinations and on the child expectancy of age groups within the population (Wall et al, 1980). The GSD is a measure of the possible genetic damage occurring in the descendents of those exposed and in individuals who have not benefitted directly from the procedure causing the exposure.

In the United Kingdom, the annual GSD from diagnostic radiology is estimated to be approximately 12 milli.rads (Darby et al, 1980). The lack of direct evidence in man of the genetic effects of radiation makes an assessment of the significance of this GSD in clinical terms somewhat uncertain. However, using risk coefficients published by international authorities (ICRP, 1977; UNSCEAR, 1977), the present population GSD of 12 milli.rads from diagnostic radiology would produce approximately 100 cases per annum of serious hereditary disease. When compared with the naturally occurring rate of genetic disease at around 60,000 cases per annum, the additional burden from diagnostic radiology is relatively small. This indeed was the conclusion reached over 20 years ago by the Adrian Committee (Committee on Radiological Hazards to Patients, 1959, 1960 and 1966). They recommended, however, that the situation be kept under review.

Beentjes et al (1979) have estimated the carcinogenic risk of X-ray examinations of the chest. Combining published mortality risk factors per unit of absorbed dose in specific organs and tissues (UNSCEAR, 1977; ICRP, 1977) with data on the average dose absorbed by organs during chest X-ray examinations (Bengtsson et al, 1978), they have calculated the average mortality risk for each organ. The sum of the mortality risks resulting from the mean organ doses represents the individual mortality risk. This risk is between 2 and 6 deaths per million examinations and is slightly higher in females because of the additonal risk of breast cancer. In the United Kingdom, approximately one third of diagnostic radiological examinations are chest X-rays amounting to approximately 9 million chest X-rays per annum (Kendall et al, 1980). Radiological examinations of the chest may therefore account for between 18 and 54 fatal malignancies in the United Kingdom per annum.

During a chest X-ray examination the gonadal dose is minimal (Wall et al, 1980) and thus, despite the high frequency of chest X-ray examinations, they make no significant contribution to the genetically significant dose (Darby et al 1980). Given the relatively small genetic effect attributable to diagnostic radiology as a whole, the risk from chest X-rays can for all practical purposes be ignored.

Patients having pre-operative chest X-rays are undoubtedly exposed to the same carcinogenic risks applicable to chest X-rays in general. But what is also of concern is that the pre-operative chest X-ray may contribute to the cumulative risk experienced by an individual. In the survey of 667 consecutive patients having a pre-operative chest X-ray in the University Hospital of Wales, (Rees et al, 1976), the radiation doses received by the study participants during the previous year were estimated. The estimates were based on information relating only to radiographs taken in the study hospital (although some patients may have received additional exposure elsewhere). They found that the maximum dose, as recommended by the Department of Health and Social Security (1972), had already been superceded in 12.5% of the patients.

2.3.3 Benefits

The yield of abnormalities and the influence of pre-operative chest X-rays on the management of patients (previously described in Section 2.1.2 and 2.1.4) are useful proxy measures of the value of pre-operative chest X-rays. A more realistic estimate of the effectiveness of the procedure can only be obtained by comparing the outcome of a group of individuals who have a pre-operative chest X-ray with a similar group who do not.

The only comparative study on the value of pre-operative chest X-rays has been conducted by Wood and Hoekelman (1981). They compared the process and outcome for paediatric patients admitted to one hospital which required routine pre-operative chest X-rays and to another which did not. The authors failed to report on the similarity of the two groups, but the numbers in each group (over 700) were probably large enough to dilute any effect of casemix. Given these reservations in the design of the study, they found no differences in anaesthetic or post-operative complications between the two groups. Similarly, in the National Study by the Royal College of Radiologists (1979), 12.8% of those patients having a pre-operative chest X-ray had post-operative pulmonary complications compared to 16% of those who did not have a pre-operative chest X-ray. The two groups were however not strictly comparable because although there appeared to be no rationale in the selection of patients for pre-operative chest X-ray, the selection would undoubtedly not have occurred at random.

These studies were also limited in that they did not consider the most important benefit to be derived from pre-operative chest X-rays, namely the prevention of avoidable mortality and increase in life expectancy. Neuhauser (1978) has discussed these concepts in relation to the study by Sane et al (1977) on the yield of pre-operative chest X-rays performed in children. In the absence of available data, Neuhauser made calculations of expected benefits in life expectancy using rough estimates of mortality and survival. He assumed that paediatric patients had a mean age of 10 years and an expected survival of 60 or more years of life. Reducing operative mortality would save many years of life, but since these years would occur in the future they had to be discounted to present value given that a present benefit is more highly valued than a benefit in the future. Neuhauser chose a discount rate of 4%. Using an established discounting formula (Neuhauser, 1978), he obtained a present value of 22.62 years of life saved when operative mortality was reduced by one death. Assuming that pre-operative chest X-rays cause a 5% reduction in the operative mortality of 5 deaths per 1,000 operations, the reduction in operative mortality per patient = .005 x .05 = .00025 deaths. Increased life expectancy per patient is therefore = .00025 x 22.62 = .0057 years = 2 days.

In the study by Sane et al (1977) of 1,500 patients having pre-operative chest X-rays a maximum of 43 patients could have benefitted from the pre-operative chest X-ray in that they were the number in which the pre-operative chest X-ray might have modified their anaesthesia or resulted in a postponement of surgery. On the assumption that these 43 patients did indeed benefit from having a pre-operative chest X-ray, the total years of life saved in carrying out the 1,500 pre-operative chest X-rays = .0057 x 43 = 0.2451 years = 89 days.

In the absence of complete data, any estimate of the costs, risks and benefits of pre-operative chest X-rays must necessarily be imprecise, but the magnitude of the relationship may be such as to allow a reasonably informed opinion to be made of the value of the procedure. In discussing the results of the Royal College of Radiologists' study, Roberts (1984) assumed that the cost of a pre-operative chest X-ray was £15.00 and that at best the procedure was 10% effective in avoiding one death or serious outcome. The Royal College of Radiologists' data indicated that the frequency of this outcome was 1 in 6,770 in patients aged 20 to 59 years of age without cancer or chronic cardio-respiratory disease. The radiological cost of avoiding this outcome was therefore, £(6,770 x 15 x 10) which is equal to £1,015,000.

Neuhauser (1978) assumed that a paediatric pre-operative chest X-ray cost $15 and applying this to his estimates of life expectancy based on the study by Sane et al (1977) calculated that the cost per present value year of life saved was $103,077. The costs of these benefits are increased even further if the risk of a cancer induced death once in every 250,000 chest X-rays is included. Furthermore, both Roberts (1984) and Neuhauser (1978) have used very liberal estimates of benefit in their calculations and the true cost of the benefit is likely to be much higher. Whatever the true costs per benefit may be, the magnitude of these estimates indicate that the cost benefit ratio is unacceptable.

From the evidence that has been presented, there is littte doubt that routine pre-operative and non-pre-operative chest X-rays have a minimal effect in detecting clinical abnormalities and in changing patient management. Consideration of this evidence in conjunction with the above estimates of costs, risks and benefits, would indicate little justification for the use of routine pre-operative chest X-rays in the NHS.

CHAPTER 3.

AIM AND OBJECTIVES

Following approval of the pre-operative chest X-ray guidelines by the Board of the Royal College of Radiologists and given that the level of use was still higher (Roberts et al, 1983) than was considered desirable (National Study by the Royal College of Radiologists 1979), the Working Party on the Effective Use of Diagnostic Radiology decided to take steps to implement the guidelines. It was proposed, in the first instance, to conduct a trial of alternative strategies before making a recommendation on how to implement the guideline nationally. Members of the Working Party, a social scientist with a special interest in organisational change, and the author discussed possible strategies for inclusion in the trial. The following strategies were considered and either accepted or rejected for further study:

1. Financial incentives to be given to those firms who comply with the guidelines and reduce their use of pre-operative chest X-rays. This strategy was rejected in that it had already been tried with some success elsewhere (Wickings, 1977). Furthermore, experiments in clinical budgeting were currently under way in the NHS and were likely to provide more comprehensive information on the effectiveness of this strategy.

2. Personal financial rewards were rejected as a suitable strategy in that a trial in the United States (Martin et al, 1980) had already shown this strategy to have little effect

and to cause considerable conflict for physicians when making clinical decisions.

3. Regular feedback to firms of statistics on their use of pre-operative chest X-rays. This strategy was considered to be worth investigating, but only if information was given in confidence to each consultant. The Chairman of the Division of Radiology was considered to be the most appropriate person to disseminate this information.

4. Utilization Review Committee comprising a representative from the Divisions of Surgery, Obstetrics and Gynaecology, Anaesthetics and Radiology to be established in a hospital. This committee would review statistics on the use of pre-operative chest X-rays by firms within the hospital and take whatever steps it considered necessary to encourage a reduction in utilization. This strategy was accepted for study, particularly as this form of peer review had not been tried previously in the NHS.

5. Letter from the Department of Health and Social Security, District Health Authority or Royal Colleges to be sent to clinicians asking them to implement the pre-operative chest X-ray guidelines. This strategy was rejected in that it was thought unlikely to have any effect.

6. Educational seminar and distribution of guidelines to house officers at the beginning of their appointments. This strategy was rejected for two reasons. Firstly, consultants

had responsibility for the clinical procedures performed on their patients and it was not thought appropriate to interfere with this responsibility by attempting to influence house officers directly. Secondly, a single educational seminar was considered unlikely to have a sustained impact on practice.

7. Introduce separate request forms for chest X-rays so that clinicians were required to answer questions on the reasons for performing a pre-operative chest X-ray (which might discourage the "routine" use of the procedure). This strategy was accepted for further study.

8. Concurrent review of requests for pre-operative chest X-rays by staff in the radiology department. The clinical indications for chest X-rays requested from surgical wards would be reviewed by the radiographers when the requests were received in the department. If the request did not adhere to the pre-operative chest X-ray guidelines, the reviewing radiographer would inform a consultant radiologist who would contact the doctor making the request. The College Working Party initially rejected this strategy because they considered that surgeons and anaesthetists might object to radiologists appearing to interfere overtly with their clinical freedom. However, the strategy was later included in the study because the radiologists in one hospital wished to try this approach.

The following four strategies were thus selected for inclusion in the study:

(a) utilization review committee

(b) information feedback on use to consultants

(c) redesign of chest X-ray request form

(d) concurrent review of chest X-ray requests by radiological staff

The aim and objectives of the study were defined as follows:-

Aim

To determine the effect of alternative strategies for implementing guidelines on pre-operative chest radiology in order to make recommendations on how the guidelines might be implemented nationally in NHS hospitals.

Objectives

1. To determine the effect of implementing each of the following four strategies in one NHS hospital for a period of 12 months:

(a) utilization review committee

(b) information feedback

(c) new request form

(d) concurrent review

The effect is to be measured by changes in the proportions of elective non-cardiopulmonary surgical patients having pre-operative chest X-rays according to

i) hospital

ii) specialty

iii) consultant

2. To determine if any change in use is affected by the following factors:

i) initial use

ii) age of patient

iii) change of house staff

iv) anaesthetists

3. To determine, following implementation of the strategies, the level of compliance with the guidelines in patients having pre-operative chest X-rays.

CHAPTER 4.

METHOD

The method employed in this study was a prospective trial. Each strategy for implementating the guideline was pursued in one hospital for one year; another hospital acted as a control. The use of pre-operative chest X-rays was monitored for periods before and during implementation of the strategies. Compliance with the guideline in patients having a pre-operative chest X-ray was measured for one month during implementation of the strategies.

The study comprised four distinct but overlapping phases:

1.	Selection of study hospitals	4 months
2.	Implementation of strategies	12 months
3.	Data collection	14 months
4.	Data analysis	6months
		2 years

The design of the study, acquisition of funds, and preparation of the report took several months in addition to those above. The total duration of the project was 3 years.

The method of the study will be described according to the above four phases.

4.1 SELECTION OF STUDY HOSPITALS

As the Working Party on the Effective Use of Diagnostic Radiology anticipated that the results of the study would allow them to make recommendations on how the guidelines be implemented nationally, the selection of hospitals to participate in the study was planned to be reasonably representative of surgical hospitals in the United Kingdom. Participating hospitals had thus to comprise both teaching and non-teaching institutions and to be situated in more than one region of the country. The hospitals also had to be within easy travelling distance of the research headquarters in Cardiff, but were not to be limited to the South Wales/London axis (the easiest line of communication from Cardiff). Allowing for the above circumstances, the following regions were thought to offer possible sites for participating hospitals: South West, Wessex, Oxford, West Midlands, North West and Wales.

The key to successful introduction of a strategy would depend on the participation of a senior radiologist in each hospital. This consultant would act as local co-ordinator; much of the success of the project would rely on their enthusiasm. The first step in selecting a participating hospital was to approach a senior radiologist, preferably a consultant known by the Working Party to be interested in reducing the unnecessary use of radiological procedures. The Working Party identified nine such individuals (there may have been many more) in the seven Regions.

The radiologists were contacted by letter and telephone and asked if they were interested in participating in the study. The letter also asked them to consider whether the hospital fulfilled the following criteria for inclusion in the study:

"1. Adequate throughput of non-acute non-cardiopulmonary surgery (i.e. the hospital should ideally have a minimum of 6 wards admitting mostly elective non-cardiopulmonary surgical cases - equivalent to approximately 400 operations per month).

2. Relatively high rate of utilization of pre-operative chest X-rays (around 30-40% of non acute non-cardiopulmonary cases having pre-operative chest X-rays).

3. Good chance that the Divisions of Surgery, Obstetrics and Gynaecology, and Anaesthetics would accept guidelines on the use of pre-operative chest X-rays (as issued by the College Working Party, with minor modifications if necessary).

4. Other radiologists willing to support the study".

Three hospitals did not fulfil the criteria (two were considered to have a low use of pre-operative chest X-rays and another had an inadequate number of elective surgical cases). One hospital did not wish to participate because the radiologists were already involved in other studies conducted by the Working Party. The radiologists in the remaining hospitals were visited by the author. The design of the study was discussed in detail and the radiologists asked to give their preference for the strategy which they would wish to implement in their hospital. The five hospitals which agreed to participate in the study were as follows:

University Hospital of Wales, Cardiff

Singleton Hospital, Swansea

John Radcliffe Hospital, Oxford

Bristol Royal Infirmary, Bristol

North Staffordshire Infirmary, Stoke-on-Trent

4.2 SAMPLE SIZE

The main purpose of the study was to determine the effect of each strategy on the use of pre-operative chest X-rays in elective surgery over a period of one year in a hospital. It was therefore necessary to collect data on an adequate number of operations so that there was a high probability that any expected differences in utilization between the baseline period (prior to introduction of the strategy) and the end of the intervention period did not occur by chance and were of adequate statistical significance.

By projecting forward the results of a previous study examining the use of chest X-rays in the surgical wards of two hospitals in South Wales (Roberts et al, 1983), the pre-operative chest X-ray utilization in the study hospitals during the baseline period was estimated to be approximately 30% (i.e. 30 pre-operative chest X-rays per 100 elective operations). A reduction in utilization to 20% would be of some importance and suggest that a strategy was having some effect. The sample size therefore had to be of sufficient magnitude to indicate that such a reduction was likely to be real (ie there was, say, a less than 5% probability that the differences had occurred by chance).

The minimum sample size (n) was calculated using the following formula (Armitage, 1971):

$$n > 2\,\frac{\mu_{2\alpha}\,\sigma}{do}$$

where $\mu_{2\alpha}$ = standard normal deviate exceeded with probability of 0.05

= 1.96

σ = standard deviation

$= \sqrt{\text{pooled value of utilization rates}}$

$= \sqrt{0.5\,[0.3(1-0.7)+0.2(1-0.8)]}$

= 0.4301

do = difference in utilization rates

= 30% - 20%

= 0.3 - 0.2

= 0.1

$$n > 2\left(\frac{1.96 \times 0.4301}{0.1}\right)^2$$

$n > 142$

Therefore a minimum of 142 elective operations per month were required in each hospital to detect a reduction in utilization from 30% to 20% at $p < 0.05$. However, this sample size was the absolute minimum given that changes in utilization were to be analysed for subgroups within each hospital. Larger sample sizes than 142 in each hopital were desirable, the maximum being dependent on the surgical workload and feasibility of collecting the data.

4.3 IMPLEMENTATION OF STRATEGIES

In each of the four hospitals in which a strategy was to be implemented, the first task of the radiologist who was local co-ordinator was to seek the approval and, where appropriate, cooperation of other radiologists in the hospital. This was carried out informally and also through meetings of the Divisions of Radiology. The guidelines were approved and no radiologist objected to their implementation.

The local co-ordinator then approached the Divisions of Surgery, Obstetrics and Gynaecology and Anaesthetics and in some hospitals the Hospital Medical Executive Committee to seek approval of the pre-operative chest X-ray guidelines. These committees were also asked to approve implementation of the guidelines in the hospital, and to grant ethical approval for the conduct of the study. The guidelines were circulated to members of the respective committees prior to their meetings; the local co-ordinators attended the meetings to answer any queries about the guidelines and their use. The guidelines were approved without modification in each of the four strategy hospitals, although in two hospitals, some members of the Divisions of Anaesthetics initially did not agree with the guidelines but finally gave their approval for implementation. Approval of the guidelines and the study were recorded in the minutes of each divisional meeting. These minutes were then distributed to consultants in the hospitals.

As many consultants probably did not read the minutes of the divisional and executive committee meetings and because not all minutes included a copy of the guidelines, the local co-ordinator sent a personal letter to each consultant surgeon, gynaecologist and anaesthetist in the hospital indicating that the guidelines had been approved and asking for their co-operation with implementation. In order to ensure comparability in each hospital, the research headquarters sent to each local co-ordinator a draft letter (Appendix IIa) to be used as a basis for letters sent to consultants. The base letter was adapted according to local circumstances; two examples of the letters used are shown in Appendices IIb and IIc. Thus, prior to the implementation of a strategy, the guidelines were approved formally by a committee representing clinicians working in the hospital. Also, each consultant was informed personally by letter about the guidelines and the study.

In the control hospital the local co-ordinator did not introduce the guidelines into the hospital and did not communicate it either to the medical committees or to individual consultants. As consultants had consented to their use of pre-operative chest X-rays being monitored in the previous study conducted by the Working Party (National Study of the Royal College of Radiologists, 1979) it was not considered necessary to seek their approval again.

The subsequent implementation of the strategies in the study hospitals is described in the following four subsections.

4.3.1 Utilization Review Committee

In the hospital in which the Utilization Review Committee was to be established (Hospital A), the local co-ordinator asked senior consultants in the Departments of Surgery, Obstetrics and Gynaecology and Anaesthetics if they would be interested in becoming involved in an initiative to reduce the use of pre-operative chest X-rays. These consultants then met with the local co-ordinator and another consultant in the Department of Diagnostic Radiology. At that meeting, a decision was taken to propose the establishment of a pre-operative chest X-ray Utilization Review Committee in the hospital. It was proposed that the committee would meet for approximately one hour on three or four occasions during the following year to review the use of pre-operative chest X-rays in the hospital and to take whatever steps thought necessary to reduce utilization. In contrast to the other hospitals participating in the study, the consultants at that meeting, and not the local co-ordinator, approached their respective divisions to seek approval for the study and the guidelines. Also, they requested each division to approve the establishment of the Utilization Review Committee and to nominate a divisional representative to sit on the committee. In this way, the divisions would have responsibility for the formation and composition of the committee and it would not be perceived as an external body scrutinising the activities of their members. A copy of a letter seeking divisional approval is shown in Appendix IId.

The idea of a Utilization Review Committee was accepted readily by the divisions. In each case the consultant who sought the approval of the division was nominated to sit on the committee. The committee comprised the local co-ordinator, a fellow consultant from the Department of Diagnostic Radiology, a consultant surgeon, a consultant obstetrician and gynaecologist, a consultant anaesthetist and an epidemiologist who was responsible for providing the statistics on the use of pre-operative chest X-rays in the hospital. The committee met on three occasions during the year following the approval of the guidelines by the divisions. On each occasion they were presented with statistics on the percentages of elective patients under the care of individual consultants who had had pre-operative chest X-rays. Examples of the mode of presentation are show in Appendices IIIa and IIIb. Statistics on utilization according to anaesthetist were not included because much of the anaesthetic work was carried out by junior staff who rotated throughout the district during the year. Statistics were also excluded for surgeons who performed less than 10 operations per month. Following discussion of the statistics, the Utilization Review Committee then decided whether any action was required to effect a change in utilization. The committee felt reluctant throughout the year to give information on utilization to individual consultants as they thought that this might be counter-productive by creating conflict between the committee and medical staff in the hospital.

The most important step the committee took was to recommend that a notice be placed in the surgical wards and in the anaesthetic department stating that routine pre-operative chest X-rays were not justified and listing the clinical indications for the procedure. A special notice was printed (Appendix IV). Before posting throughout the hospital, the notice had to be approved by the Unit Management team. The notice was then distributed by the Unit Nursing Officer to sisters on the wards. One week after distribution, a survey of the wards was carried out and it was found that around one third of notices had not been posted in a prominent position in the ward. This was rectified by futher discussions with the Unit Nursing Officer and the sisters in charge of the wards. The notice was not displayed in one ward in which the consultant surgeon refused to allow any notices to be posted on the walls.

4.3.2 Information feedback

In the hospital with the strategy of providing information retrospectively to consultants on their use of pre-operative chest X-rays (Hospital B), statistics on utilization were distributed twice during the year. The process of data collection and computer analysis contributed to a delay of approximately two months between the period under observation and provision of the statistics. The data analysis was conducted at the research headquarters and the results were discussed with the local co-ordinator before distribution to the consultants.

Each consultant received information by means of a letter from the local co-ordinator on the percentage of their elective surgical patients who had had a pre-operative chest X-ray. They were also provided with the lowest and highest consultant chest X-ray rates and the average rate for all consultants in the hospital. Thus each consultant was informed of their own position in relation to the practice of colleagues in the hospital, but did not know the names of other consultants whose chest X-ray rates were quoted.

The letter also requested the consultant to draw the information to the attention of their junior staff and to encourage them where possible to adhere to the guidelines. An example of a letter is shown in Appendix IIIC. The information was provided in this format to all consultant surgeons, gynaecologists and anaesthetists in the hospital.

4.3.3 New request form

The standard X-ray request form in the hospital where a new chest X-ray form was adopted (Hospital C) is shown in Appendix VA. Much of the data on this form was stored and analysed by computer and, in order not to disrupt this process, it was decided that the new chest X-ray request form would consist simply of an additional section attached to the standard request form. The requesting clinician normally completes the top half of the standard request form; the bottom half is completed in the X-ray department. The new chest X-ray request form consisted of a tear-off section which was placed over the bottom half of the standard form and attached on the left hand margin. The requesting clinician completed the top half of the form as per usual and the attached section on the bottom half of the form. On receipt of the form in the X-ray department, the receptionist tore-off the attached section, thus permitting staff in the radiology department to complete the original bottom half of the form.

The tear-off section applied to the bottom half of the standard form is shown in Appendix Vb. The new request form was used for ordering all chest X-rays in the hospital and not just pre-operative chest X-rays because it was thought that clinicians would adopt the form more readily if used for all chest X-rays and not just pre-operative X-rays. Clinicians requesting a pre-operative chest X-ray had to indicate if the patient had any of the clinical indications contained in the guidelines. The purpose of this was to trigger the clinician into thinking whether the guidelines applied to the patient in question. If the guidelines had simply been printed on the request form and not in the format of questions, clinicians would probably have ignored the guidelines once they became familiar with the form. The form was also designed to be simple and rapid to complete because the purpose of the form was to test the effect of providing information on the guidelines rather than the effect of making a request for chest X-ray more cumbersome by requiring clinicians to complete a long and detailed form.

Prior to introducing the new form into the hospital, a draft copy was distributed to members of the District Medical Records Working Party who approved its implementation. The new forms were composed and printed and the tear-off section stuck automatically to the original request forms by the District Health Authority printers. In order to ensure that the new forms were introduced throughout the hospital on the same day, they were distributed to each ward by staff in the radiology department. When a ward had used up their quota of forms, they ordered new forms in the usual way from the printer. Consultants and junior medical staff were sent a letter informing them of the introduction of the new chest X-ray request form. They were also asked to adhere to the guidelines (Appendix IIc).

The introduction of the new form did create resentment among some house officers particularly as requests for chest X-rays which were not on the new form were returned to the house officer by the receptionist in the radiology department. However within two to three weeks the new form had become established as a routine procedure for ordering chest X-rays.

The tear-off sections were stored in the radiology department and a tally made of the numbers of requests for pre-operative and non pre-operative chest X-rays. Those forms requesting pre-operative chest X-rays were forwarded to the research headquarters for data analysis.

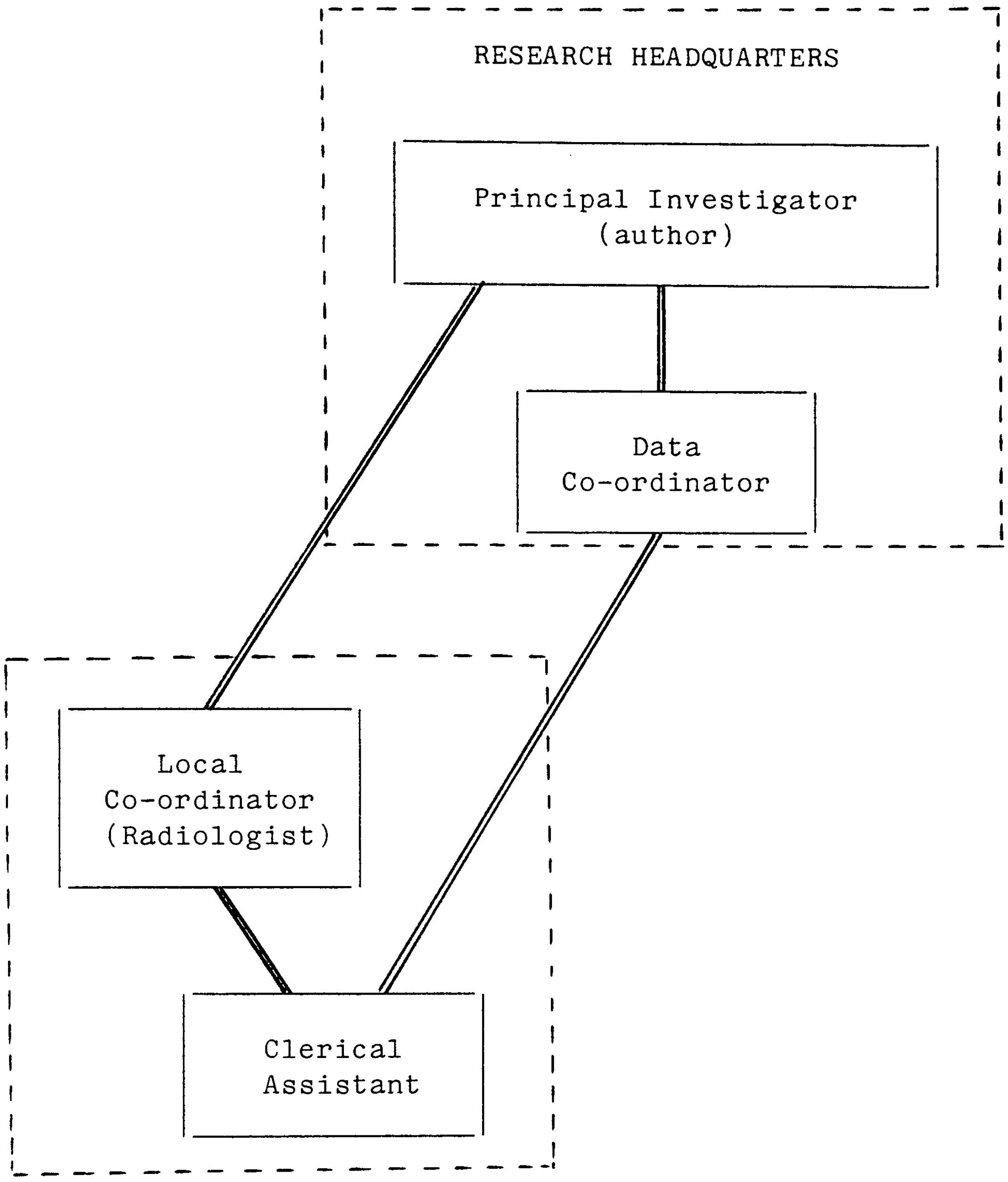
4.3.4 Concurrent review

In the hospital in which staff in the radiology department were to review requests for chest X-rays from surgical wards (Hospital D), the guidelines had been approved by the Medical Executive Committee in the hospital. Consultants, but not junior staff, were informed of this decision. The strategy was then implemented by means of radiographers reviewing requests for chest X-rays. Requests for "routine" pre-operative chest X-rays were forwarded to the superintendent radiographer who then contacted a consultant radiologist. The consultant then telephoned the requesting clinician to indicate that it was no longer hospital policy to carry out "routine" pre-operative chest X-rays. The clinician, usually a house officer, was asked if there were any clinical indications necessitating a pre-operative chest X-ray and, if not, was informed that the chest X-ray would not be carried out.

4.4 DATA COLLECTION

Data was collected on the use of pre-operative chest X-rays over a baseline period of 2 months and an intervention period of 12 months in each hospital. Data on adherence to the pre-operative chest X-ray guidelines was collected over a period of one month. A data co-ordinator was employed in the research headquarters in the Department of Epidemiology and Community Medicine to assist with the organisation of the data collection and with the data analysis. In each participating hospital, at least one part-time clerical assistant was employed to collect the data. The consultant radiologists acting as local co-ordinators played a major part in selecting the clerical assistants and in supervising their appointments. The data co-ordinator in the research headquarters managed the day to day work of the clerical assistants and was the first person contacted if difficulties arose in the process of data collection.

The diagram on the next page indicates the positions and communication network of individuals who participated in the study.



HOSPITAL 1 .... HOSPITAL 5

Prior to designing the data collection systems, each hospital was visited at least once by the author and data co-ordinator. Data collection systems were discussed with the local co-ordinators, with senior radiographers and administrators in the radiology departments, with nursing officers in charge of surgical theatres, and with medical records staff, particularly those with responsibility for admissions data. The routine recording of data in each hospital was also examined, particularly that recorded in theatre registers, master patient indexes, and in computerised patient administration systems. In the X-ray departments, data in day books, on duplicate request forms and reporting forms, and in master patient indexes were also examined. The feasibility of modifying these standard data collection systems for the purposes of the study was explored. For example, could extra information be recorded on theatre registers or on X-ray reports, and what was the possibility of obtaining special computer printouts of admissions data?

4.4.1 Testing data collection systems

Following the visits to each hospital, a provisional data collection system was designed and appropriate recording forms were constructed. Although the data collection systems were not identical in each hospital, they were considered to be of sufficient similarity that testing of the system and the data collection instruments was carried out in one hospital. The purpose of this testing was to examine the feasibility of obtaining data from the various sources, the order in which the data should be collected, and the time required. The design of the recordings forms was also tested, and estimates made of the costs required to collect the data.

Two such studies were carried out in the University Hospital of Wales: in the first, data was collected on the use of pre-operative chest X-rays. Data on 100 consecutive patients having operations in one of the theatres were abstracted from the theatre recording system and the master card index in the X-ray department. This preliminary trial of the process of data collection led to a restructuring of the recording forms. Also, it became apparent that there was a lag period of up to two weeks between an X-ray being performed and the storing of information in the master card index.

In the second study, data on adherence to the pre-operative chest X-ray guidelines was collected from a random sample of the records of twenty patients having pre-operative chest X-rays. Examination of the house officers' admission notes indicated that recordings of histories and physical examinations were reasonably detailed. However there was no means of checking the completeness of recording other than to survey the rest of the record and compare the admission notes with clinical findings elsewhere. Because of the variability in recording and the difficulties in interpreting detailed clinical findings, the study recording form was simplified and many items of information omitted in the final version.

Although the data collection systems were tested formally in only one hospital, data collection was commenced in each hospital for a preliminary period of up to four weeks prior to the official commencement of data collection. During this period the hospitals were visited by the author and data co-ordinator, and minor modifications were made in each system. The clerical assistants were given on-site training in the methods of data collection. The preliminary period allowed them to become familiar with the system and efficient in the process of data collection. During this training period, the need for confidentiality and precision in data collection were emphasised.

4.4.2 Data collection: use of pre-operative chest X-rays

(1) Timing

Data on the use of pre-operative chest X-rays was collected for two baseline months prior to the implementation of the strategies. The baseline months selected were May 1982, and mid January to mid-February 1983. Two separate months at different times of the year were chosen to allow for any seasonal variation in the use of chest X-rays and for other circumstances such as industrial action that might have effected utilization during a specific month. Indeed sporadic industrial actions involving ancillary staff occurred in the NHS from June to December 1982; this could have affected levels of chest X-ray requests. The month selected in 1983 began in mid-January because of possible distortion in normal practices during and immediately after the Christmas and New Year holidays. The strategies were implemented from 1st June, 1983 to 31st May, 1984 except in the hospital with the new chest X-ray form where there was a two month delay in implementation of the strategy. In this hospital, data was collected from 1st August, 1983 to 31st July, 1984. In general, the data collection lagged behind the actual use of pre-operative chest X-rays by up to two months. This occurred because time was required for the recording and storing of data in routine NHS information systems and because some clerical assistants had difficulty in keeping up-to-date with their work on the project.

(2) Data

In each hospital data was collected on patients in specified specialties who had an operation during the study period. For these patients, data was also collected on the use of pre-operative chest X-rays. Further details included the type of operation (elective or emergency), the age of the patient, the consultant surgeon (and his/her specialty), and the anaesthetist. In order to ensure comparability of data from each hospital, the variables were defined as follows:-

Patient having operation: an individual who had any procedure recorded in the theatre register, except those recorded as not having a general anaesthetic.

elective/emergency: emergency operations were those which were not pre-booked on an operating list. In two hospitals this item of information was not recorded in the theatre registers: an emergency was defined as an immediate admission which was not pre-booked or on a waiting list.

age of patient: age in years on day of operation.

consultant surgeon: consultant in charge on day of operation. If the patient was not from a surgical ward, the consultant with responsibility for the operation was designated as consultant surgeon.

specialty: specialty of consultant surgeon as designated by medical personnel department of District Health Authority.

anaesthetist: doctor of any grade providing anaesthetic for operation.

pre-operative chest X-ray: chest X-ray on day of operation or on any of 6 days prior to operation; included only those chest X-rays performed in the same hospital as the operation, either as an in-patient or outpatient.

(3) Process of collection

The data was collected by abstracting from routine recording systems onto a standard form (Appendix VIa). This form had a slightly different format in one hospital where extra information had to be collected on the patient's address as the hospital number was not an adequate means of uniquely identifying patients during various stages of the data collection. In order to eliminate further transcribing of data, the form was designed so that data was entered in a coded format allowing the form to be used as the source document for input of data into a computer. The coding format is shown in Appendix VIb.

This method of collecting data varied slightly between hospitals depending on the availability of established data recording systems. Data was obtained firstly from theatre registers. Registers were excluded if they included a substantial number of elective cardiothoracic or emergency operations. This was because the study was concerned primarily with change in the use of pre-operative chest X-rays prior to elective surgery; patients proceeding to cardiothoracic surgery would inevitably have a pre-operative chest X-ray. From the theatre register the patient's name, hospital number, operation, age, consultant surgeon, anaesthetist, date of operation and whether the operation was elective or emergency was obtained if available.

If the name of the consultant surgeon was not available, this was derived from the name of the surgeon who performed the operation. A time-table (Appendix VIc) was constructed showing the consultants and junior surgical staff who were allocated to sessions in each theatre during the week. The clerk know from the theatre register the day of the week on which the operation was performed and by referring to the chart was able to establish which consultant would have been in charge of junior staff performing the operation. However, in three hospitals this system of identifying the consultant was not feasible because of considerable variations in theatre time-tabling and because some junior staff worked for more than one consultant. In this case the consultant surgeon was obtained from either the hospital master patient index or by keying the patient's hospital number into the patient administration system. In a similar way, data on elective/emergency, if not available in the theatre register, had to be obtained from the patient administration system. If the age of the patient was not obtainable from the theatre register this was obtained either from admission data or from the master patient index in the radiology department.

Having obtained and recorded the names and hospital record numbers of patients having operations, the master card index was then searched in the radiology department to determine if the patients had had a pre-operative chest X-ray. The master patient index was found to be a quicker and more reliable source than duplicate chest X-ray reports (if these were available) or day books kept in the radiology department.

The specialty of each consultant was provided by the medical personnel departments of the local District Health Authorities. This data was not recorded on the standard form, but was entered separately onto the computer files.

In each hospital only those specialties in which a minimum of 20 operations were performed per month, were included in the study:

Strategy Hospital	Specialties
Hospital A:	
Utilization Review Committee	general surgery, orthopaedic surgery, urology, ENT surgery, neurosurgery, oral surgery, gynaecology.
Hospital B:	
Information feedback to clinicians	general surgery, ENT surgery, ophthalmic surgery, oral surgery gynaecology.
Hospital C:	
New chest X-ray request form	general surgery, oral surgery
Hospital D:	
Concurrent review by radiology department	general surgery, urology, oral surgery.
Hospital E:	
Control	general surgery, ENT surgery, gynaecology, ophthalmology.

The data collection systems adopted by each hospital are shown in the form of flow diagrams in Appendix VIIa-e. Clerical assitants were provided with specific instructions on the process of data collection to be employed in their hospital. An example of an instruction sheet is shown in Appendix VIIf.

(4) Supplementary controls

In addition to the control hospital (E) included in the study, control data on the use of pre-operative chest X-rays was obtained from two other sources:-

(i) a hospital in Manchester which already had a computerised data collection system in the radiology department (Supplementary Control Hospital I)

(ii) two hospitals in Cardiff (not the University Hospital of Wales which was a strategy hospital) in which a special survey of the use of pre-operative chest X-rays was carried out around the time of the study (Supplementary Control Hospitals II and III)

In the hospital in Manchester, the X-ray request form was the source of data to be entered into the computer; pre-operative chest X-rays were categorised separately from non-pre-operative X-rays. The specialty of the patient was also entered. It was therefore possible to obtain a printout of the number of pre-operative chest X-rays ordered by specialty. A separate computer system established in the operating theatre provided information on the number of operations performed in each specialty. Although the data was not as precise as in the main study hospitals (for example, operations were not separated into electives and emergencies) the data provided useful control information, given that the main purpose of the study was to monitor trends in chest X-ray utilization over time within hospitals and not to compare rates between hospitals.

In the hospitals in Cardiff, a community medicine trainee on behalf of the South Glamorgan Health Authority, using a similar method to that employed in this study, abstracted data on a 1 in 3 sample of patients having operations during September 1983 and September 1984. The former month was the same as the fourth of the intervention year in this study (except in Hospital C); the latter month occurred soon after completion of the intervention year. Pre-operative chest X-rays performed on the sampled patients were noted from master patient indexes in the radiology departments.

4.4.3 Date collection: adherence to guidelines

The levels of adherence to the guidelines in patients having pre-operative chest X-rays were assessed during the fourth month of the intervention year in the strategy hospitals and in the main control hospital.

The data collection procedure was the same in each hospital. The names and hospital numbers of all patients having pre-operative chest X-rays during the month were listed and assigned sequential numbers. Using random number tables, 60 patients were sampled in each hospital. The names and hospital numbers of these patients were then sent to the medical records officers of the respective hospitals who located and obtained the appropriate records.

The data coordinator, who had been trained previously by the author to abstract the relevant information from the medical records, visited each hospital and collected data on adherence to the guidelines. The data was obtained from the house officers' admission notes recorded prior to the patient proceeding to surgery. The information was abstracted onto a standard form (Appendix VId). The data coordinator used previously defined criteria (Apppendix VIe) in deciding whether the patient had a clinical indication for a pre-operative chest X-ray as depicted in the guidelines. Evidence that the patient had had a chest X-ray in the previous 12 months was only accepted if a report was available in the case notes being examined.

Although the clinical criteria stated on the instruction sheet were extremely detailed, the data coordinator was occasionally uncertain of the significance of clinical symptoms and signs recorded in the notes. When this occurred, the relevant part of the notes was copied and the author, on reading the abstrated notes, decided if the patient had had a clinical indication. If there was doubt about the presence of an indication, it was stated to be present rather than absent. For example a past history of a "breast lump" was recorded as a "possible metastases" even although the breast lump may well have been benign. It was not possible to tell from the records whether symptoms and signs compatible with an indication were the reason for the X-ray being carried out.

The 60 medical records could not be fully traced in each hospital. Because of limitations in available finance and time it was not possible to revisit the hospitals and attempt to locate the medical records which had not been traced on the previous visit.

In the hospital in which the new chest X-ray request form was implemented (Hospital C), clinical adherence to the guidelines was also examined by reviewing the tear-off part of the form on which the clinician had written the reasons for requesting the pre-operative chest X-ray. In Hospital C, the clerical assistant separated out those forms on which a pre-operative chest X-ray had been requested, and sent them each month to the research headquarters for analysis.

4.4.4 Repeatability

During the first month of collection, the data co-ordinator repeated the abstraction of data from 100 consecutive surgical patients in each hospital. If the hospital had more than one theatre register, a proportion of cases were derived from each register. The supplementary control hospitals were not included because of the different methods of data collection.

The variation in pre-operative chest X-ray rates detected by the clerical assistants and the data co-ordinator was between 2%-5%; in four of the hospitals the data co-ordinator had a higher rate, and in one hospital had a lower rate than the clerical assistants. Differences between the observers were attributed to such factors as misfiled index cards in the X-ray department, legibility of recording of X-ray events, miscalculation of period in which a chest X-ray was categorised as pre-operative, and inaccurate coding of the presence or absence of a pre-operative chest X-ray. The level of variability was considered to be satisfactory and was unlikely to be improved with further training of the clerical assistants.

This repeatability exercise was performed on a second occasion in one hospital midway through the intervention year when a sudden change in utilization gave rise to suspicions that the accuracy of data collection may have diminished. This was not found to be the case. The variability in utilization rates between clerical assistants and data coordinator was similar to that found earlier in the study.

After the data co-ordinator had been trained to read medical records and abstract data on clinical adherence with the guidelines, and after the final version of the recording form had been designed, the data co-ordinator and the author abstracted independently data on adherence with the guidelines from the medical records of 20 patients who had had pre-operative chest X-rays. The main variation found between the two observers was in the assignment of "possible metastases" as an indication: the data co-ordinator assigned this on eleven occasions, the author on only six occasions. In view of this variation, the data co-ordinator, during the study proper, wrote on the form the clinical findings justifying the indication. The author subsequently reviewed all the forms and, in this way, was able to judge whether the indication was justified, in particular those assigned as "possible metastases".

4.5 DATA ANALYSIS

The completed forms containing data on the use of pre-operative chest X-rays were sent monthly to the research headquarters by the clerical assistants in each hospital. On receipt at headquarters, the forms were reviewed by hand for errors (such as incorrect dates) and for missing data. If there was missing data (for example, consultant codes) the relevant clerical assistant was contacted to determine if the omissions could be rectified. If so, forms were returned for correction.

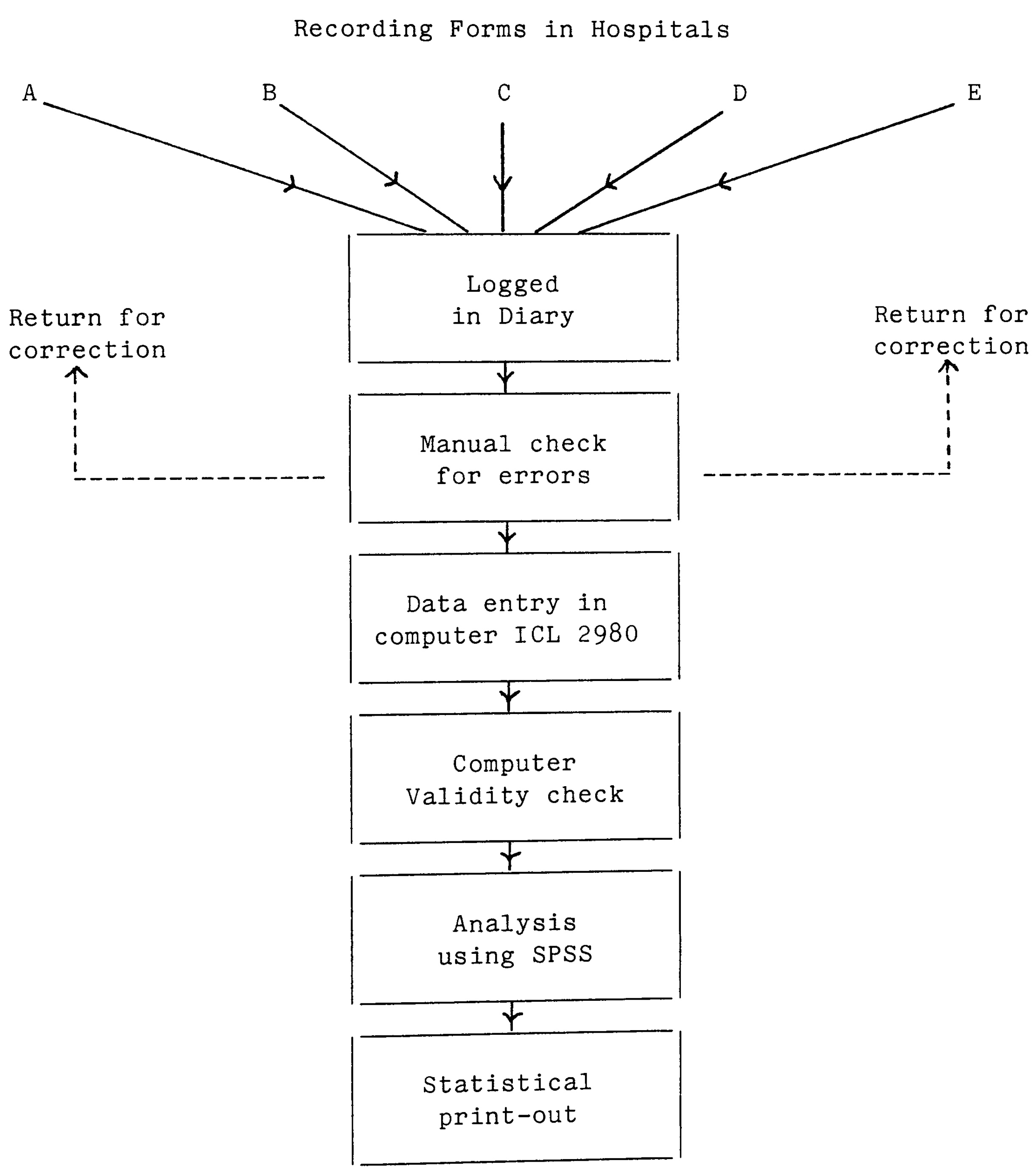
A log of recording forms received was kept in the research headquarters. The processing of large amounts of data from several centres meant that forms could easily go missing unless a careful record was kept.

The forms were then transferred to key punch operators in the Department of Medical Computing and Statistics at the University of Wales College of Medicine. The data was entered directly from the recording form into the computer (located in the South West Universities Regional Computing Centre (SWURCC). This computing centre provides computing resources to six universities in the South West of England and Wales. The computer used was an ICC 2980 running under the VME operating system which has the capability to run very large programmes (up to 22 Megabytes of virtual store). Analysis was performed using on-line terminals in the College of Medicine. If the

ICL 2980 was not connected into the South West Universities Computer Network at any moment in time, batch jobs could still be submitted at anytime and queued until they could be transmitted.

Following validity checks on the data and organisation of files, the data was analysed using the Statistical Package for Social Sciences (SPSS).

Data Analysis : Flow Diagram



For most of the statistical analyses, particularly those examining differences in the rates of use of pre-operative chest X-rays, the χ^2 test of statistical significance was used.

The data on clinical adherence to the guidelines was aggregated and analysed manually. The relatively small number of forms and limited amount of data on each form did not justify computer anaylsis.

In summary, the method employed in this study was complex in that data had to be collected from several centres for a period of over one year. Although a minimum amount of data was collected on each patient, almost 50,000 patients were included. The large number of staff involved in the study and the slightly different data collection procedures in each hospital meant that the process of data collection required careful organisation and management. This was reflected in the costs of the study (itemised in Appendix VIII) in which a considerable percentage of the total cost (£34,000) was due to the need to employ staff at the research headquarters to co-ordinate the data collection and the need to travel frequently between the participating hospitals.

CHAPTER 5.

RESULTS

The main results of this study are concerned with trends in the use of pre-operative chest X-rays in elective surgical patients during the intervention period. Firstly, the characteristics of the sample of patients included in the study are presented. This is followed by results on the use of pre-operative chest X-rays by specialty and consultant in each of the study hospitals. Factors which might affect change in utilization, such as the age of patients, are then examined. Finally, adherence to the guideline is assessed in a sample of patients who had pre-operative chest X-rays. Tables and figures are presented on separate pages at the end of each subsection of the results.

5.1 SAMPLE CHARACTERISTICS

Data was collected on 44,632 patients having operations in the five main hospitals included in the study. Eighty per cent of these patients (35,586) had elective operations and this proportion was similar in each hospital (Table 1). The minimum number of elective operations was 4,164 in hospital D and the maximum was 10,270 in hospital A. In approximately 1% of patients the category of operation (elective or emergency) was unknown due to missing data on the recording forms.

The specialty mix of elective operations varied between the hospitals (Table 2). General surgery accounted for 36% of all elective operations and was the most common specialty in each hospital, except in the control (hospital E). General surgery was the only specialty occurring in all hospitals; oral surgery occurred in four hospitals but comprised only 6% of all elective operations. Due to difficulties in assigning a consultant to operations in hospital C, the specialty of 21% of elective operations was unknown.

The number of elective operations performed each month during the baseline and intervention periods varied between 2,024 and 3,018 (Table 3). The monthly variation occurred because of seasonal variation in the presentation of disease, holiday periods, refurbishing of surgical facilities and other temporary changes in the provision of services. During intervention month 5 in hospital A, month 9 in hospital B and month 10 in hospital E, an abnormally high number of elective operations were recorded. The data during these months was re-examined in detail but no explanation, such as double counting of operations, was discovered. As the main purpose of the study was to examine pre-operative chest X-ray rates and not absolute numbers, these monthly variations in numbers of elective operations were considered acceptable.

The age distribution of patients was similar in all hospitals (Table 4). However, hospital D had relatively few patients under 15 years of age and relatively more aged 45-64 years.

Table 1

Elective and emergency operations by hospital

Percentage operations

Hospital

Operation Category	A	B	C	D	E	All
	n=12245 (100%)	n=7816 (100%)	n=9123 (100%)	n=5027 (100%)	n=10421 (100%)	n=44632 (100%)
Elective	84%	80%	73%	83%	79%	80%
Emergency	15%	14%	26%	17%	21%	19%
Unknown	1%	6%	1%	<1%	<1%	1%

Table 2

Elective operations by specialty and hospital

Percentage operations

Hospital

Specialty	A n=10270 (100%)	B n=6263 (100%)	C n=6649 (100%)	D n=4164 (100%)	E n=8240 (100%)	All n=35586 (100%)
General Surgery	28%	25%	59%	73%	17%	36%
ENT	17%	22%	-	-	28%	15%
Gynaecology	17%	24%	-	-	20%	14%
Ophthalmology	-	14%	-	-	18%	7%
Urology	14%	-	-	19%	4%	7%
Oral Surgery	5%	9%	10%	7%	-	6%
Neurosurgery	7%	-	-	-	-	2%
Orthopaedics	6%	-	-	-	-	2%
Miscellaneous	<1%	3%	11%	0%	3%	3%
Unknown	7%	3%	21%	1%	11%	9%

Table 3

Elective operations per month by hospital

Number of elective operations

Month	Hospital A	B	C	D	E	All
Baseline						
1	601	332	358	277	456	2024
2	835	286	420	330	544	2415
Intervention						
1	721	410	393	288	538	2350
2	751	384	451	292	667	2545
3	732	431	406	279	487	2335
4	782	487	531	292	526	2618
5	912	394	623	304	599	2832
6	813	449	492	360	682	2796
7	601	373	581	236	550	2341
8	653	415	567	284	619	2538
9	779	829	503	325	582	3018
10	742	549	438	325	809	2863
11	657	467	506	283	542	2455
12	691	457	380	289	639	2456
Total	10270	6263	6649	4164	8240	35586

Table 4

Age of patients having elective surgery by hospital

Percentage of patients having elective surgery

	Hospital					
	A	B	C	D	E	All
Age (Years)	n=10270 (100%)	n=6263 (100%)	n=6649 (100%)	n=4164 (100%)	n=8240 (100%)	n=35586 (100%)
0-14	8%	16%	20%	1%	21%	14%
15-24	12%	11%	13%	9%	9%	11%
25-44	29%	26%	21%	25%	24%	26%
45-64	29%	25%	22%	35%	24%	26%
65-74	14%	13%	13%	19%	12%	14%
75-84	8%	8%	9%	9%	9%	8%
85+	1%	1%	2%	2%	1%	1%

5.2 PRE-OPERATIVE CHEST X-RAY USE IN STUDY HOSPITALS

5.2.1 Baseline period

The pre-operative chest X-ray rate during the baseline period indicates the level of activity in the hospitals prior to the introduction of the interventions (Table 5). Overall 27.7 out of 100 elective surgical patients had pre-operative chest X-rays during the baseline period. The rate varied from 22.9 in hospital E to 32.6 in hospital D. Within each hospital rates varied between the two baseline months. For example, in hospitals A and D the rates were substantially higher during the second month (mid January to mid February, 1983) compared to the first baseline month (May 1982). This may have been due to seasonal variations in the the prevalence of respiratory disease. In hospital C the rate was higher during the first month which may have been due to some variation in the provision of services.

The pre-operative chest X-ray rates varied during the baseline period between specialties and consultant surgeons within each hospital (Table 6). For example, in hospital A the rate varied between specialties from 11.1 per 100 elective operations in gynaecology to 42.1 in general surgery, and between consultants from 3.9 to 55.6 per 100 elective operations. Hospital B had the highest variation between specialties (co-efficient of variation 92.8%) and hospital A had the lowest (co-efficient of variation 48.2%). There were also substantial differences in the variation between consultants within each hospital ranging from a co-efficient of variation of 33.5% in hospital C to 82.7% in hospital E.

Within the same specialty there were still marked variations between hospitals in baseline rates. Table 7 shows that the mean consultant rate in general surgery varied from 27.6 pre-operative chest X-rays per 100 elective operations in hospital D to 66.2 in hospital B. Some variation also occurred between consultants in general surgery within each hospital; co-efficients of variation ranged from 17.4% in hospital B to 38.4% in hospital D.

These results indicate that, although the overall baseline pre-operative chest X-ray rate varied by less than 10 X-rays per 100 elective operations between hospitals, there was substantial variation within hospitals between specialties and between consultants. In the light of these findings, changes in pre-operative chest X-ray rates during the intervention months are presented for both specialties and consultants in each hospital.

Table 5

Pre-operative chest X-ray rates for elective operations during baseline months by hospital

Pre-operative chest X-rays per 100 elective operations

Month	Hospital A	B	C	D	E	All
Baseline 1 (May 1982)	24.6	27.4	29.1	24.9	21.9	25.3
Baseline 2 (Mid Jan - Mid Feb 1983)	33.7	31.8	20.7	39.1	23.7	29.7
Baseline mean	29.9	29.5	24.6	32.6	22.9	27.7

Table 6

Variation in pre-operative chest X-ray rates for elective operations during baseline period by specialty and consultant,in each hospital

Pre-operative chest X-rays per 100 elective operations

	Specialty			Consultant		
Hospital	Mean	Range	Co-eff.* Var.	Mean	Range	Co-eff.* Var.
A	25.7	11.1-42.1	48.2%	31.7	3.9-55.6	50.8%
B	27.6	1.6-64.2	92.8%	38.4	1.5-81.5	71.4%
C	15.7	5.1-25.0	63.7%	28.1	15.2-46.9	33.5%
D	26.8	5.1-56.0	81.0%	27.6	16.7-45.5	38.4%
E	25.5	5.5-60.4	66.3%	27.2	1.0-70.4	82.7%

* Co-efficient of variation = Standard deviation as percentage of mean chest X-ray rate. $(CV = \frac{SD}{Mean} \times 100\%)$

Table 7

Variation in pre-operative chest X-ray rates for elective operations in general surgery during baseline period by consultant in each hospital

Pre-operative chest X-rays per 100 elective operations

Hospital	No of Consultants	Consultant Mean	Consultant Range	Co-eff. var.
A	5	43.6	25.8-55.6	26.8%
B	4	66.2	53.8-81.5	17.4%
C	8	28.1	15.2-46.9	33.5%
D	7	27.6	16.7-45.5	38.4%
E	2	58.0	45.5-70.4	30.3%

* Co-efficient of variation = Standard deviation as percentage of mean pre-operative chest X-ray rate. (CV = $\frac{SD}{Mean}$ x 100%)

5.2.2 Hospital A: Utilization Review Committee

Figure 2 shows the monthly trend in use of pre-operative chest X-rays in hospital A (Utilisiation Review Committee). During the six months following approval and distribution of the guidelines within the hospital, the monthly pre-operative chest X-ray rates were lower than during the baseline period. But a substantial and rapid decrease did not occur until notices displaying the pre-operative chest X-ray guidelines were posted throughout the hospital. However, this low level was not maintained, increasing slightly during the latter months of the study.

Changes in the pre-operative chest X-ray rate are summarised in Table 8 in which the data are aggregated for each quarter year of the intervention period. During intervention months 4-6 the pre-operative chest X-ray rate was almost 10 chest X-rays per 100 elective operations lower than during the baseline period suggesting that the distribution of the guidelines had some effect on utilization. Despite a slight increase during the last quarter, the pre-operative chest X-ray rate during the final intervention month was still substantially lower (by almost 20 chest X-rays per 100 elective operations) than during the baseline period. Corresponding to this fall in the rate, the absolute number of pre-operative chest X-rays performed in the radiology department showed a marked decrease. During the period of least use (months 7-9) 58 pre-operative chest X-rays were performed, which was 73% fewer than during the baseline period (215 pre-operative chest X-rays). This decrease corresponded to approximately six fewer chest X-rays per day in the radiology department. During the final intervention month the pre-operative chest X-ray rate was approximately one third of that during the baseline period.

The pattern of change for each specialty in hospital A is shown in Figures 3a-g. In general surgery, urology, ENT surgery and orthopaedics, the change mirrored that seen in the hospital as a whole. A moderate decrease occurred within the first six months and a substantial and highly significant decrease occurred in the third quarter (general surgery, urology, and ENT $p < 0.001$; orthopaedics $p = .014$). In the specialties with low baseline rates, namely neurosurgery, gynaecology and oral surgery, the pattern of change was not consistent with that observed in the hospital as a whole. Only gynaecology showed a statistically signficant reduction in pre-operative chest X-ray use after the notice was posted in the hospital. The rate decreased from 7.8 to 3.9 pre-operative chest X-rays per 100 operations ($p = 0.037$). Other changes occuring in these low use specialties were not statistically significant between the various periods ($p > 0.05$) except for an initial reduction of 9.1 pre-operative chest X-rays per 100 operations between the baseline period and the first quarter in oral surgery ($p = 0.041$).

The pre-operative chest X-ray use by consultant was examined in those specialties with two or more consultants each conducting at least twenty operations per month during the baseline and intervention periods (Figures 4a-d). In general surgery, ENT surgery and urology the patterns of change were similar: all consultants showed a reduction in use following the posting of the notice in the hospital.

This included the one consultant who had refused to allow the notice to be displayed in his ward. In gynaecology, one consultant showed a substantial reduction in use from the baseline to the first quarter (from 31 to 6.7 per 100 operations ($p = 0.003$). Two consultants in gynaecology showed no significant change throughout the year.

The extent of change by consultant before and after the notice was posted in the hospital is shown in Table 9. Except for one consultant in gyanaecology, every consultant had a reduction in use varying from -28% to -93% of levels before the notice was posted (although not all the changes were statistically significant). One consultant in general surgery (consultant e) had the greatest absolute reduction from 39.7 per 100 elective operations before the notice was displayed to 5.8 thereafter.

Figure 2

Pre-operative chest X-rays per elective operations by month in hospital A

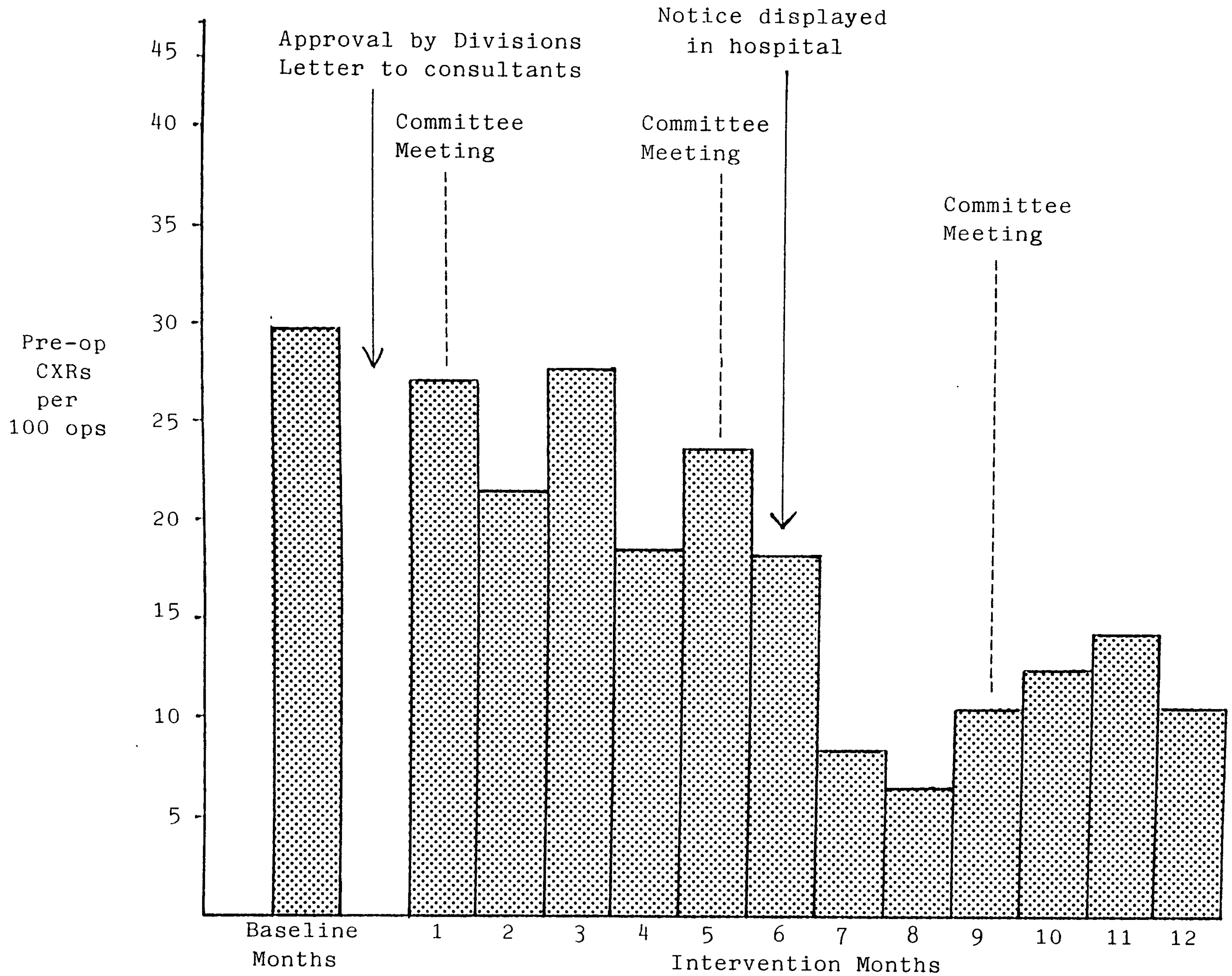


Figure 2

Table 8

Pre-operative chest X-rays for elective operations in Hospital A

	Baseline Months	Intervention Months				Final Intervention Month
	1-2	1-3	4-6	7-9	10-12	12
No. elective operations (monthly mean)	718	975	836	678	697	691
No. pre-operative chest X-rays (monthly mean)	215	252	170	58	86	73
Pre-operative chest X-rays/ 100 elective ops.	29.9	25.8	20.3	8.5	12.4	10.6
Change in pre-operative chest X-rays/ 100 elective ops.		-4.1	-5.5	-11.8	+3.9	-19.3*
Significance of change (p)		.006	<.001	<.001	<.001	<.001*

* Change between baseline period and final intervention month

Hospital A : Utilisation Review Committee

Figure 3a-d

Pre-operative chest X-rays per elective operations by specialty in hospital A

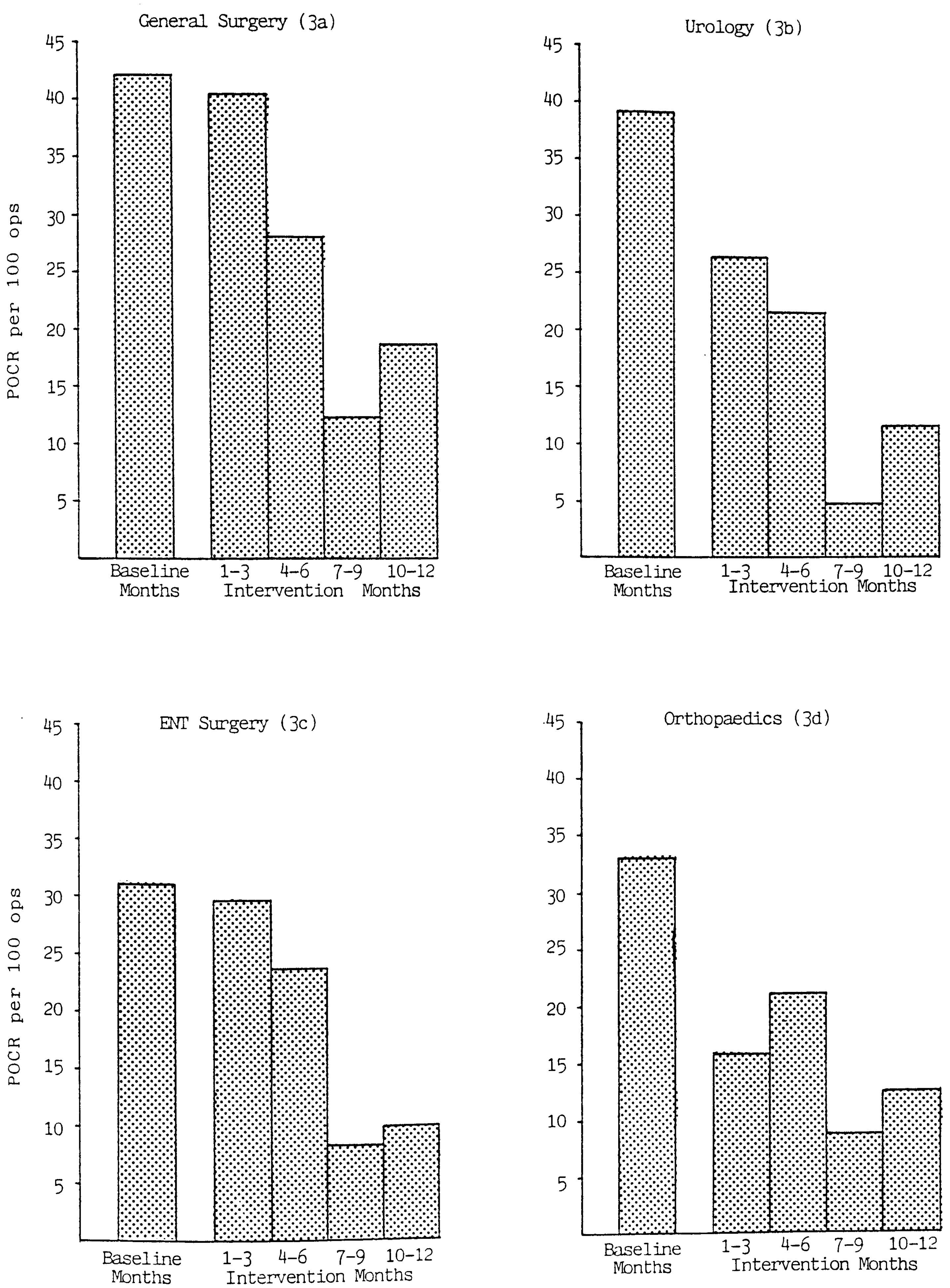
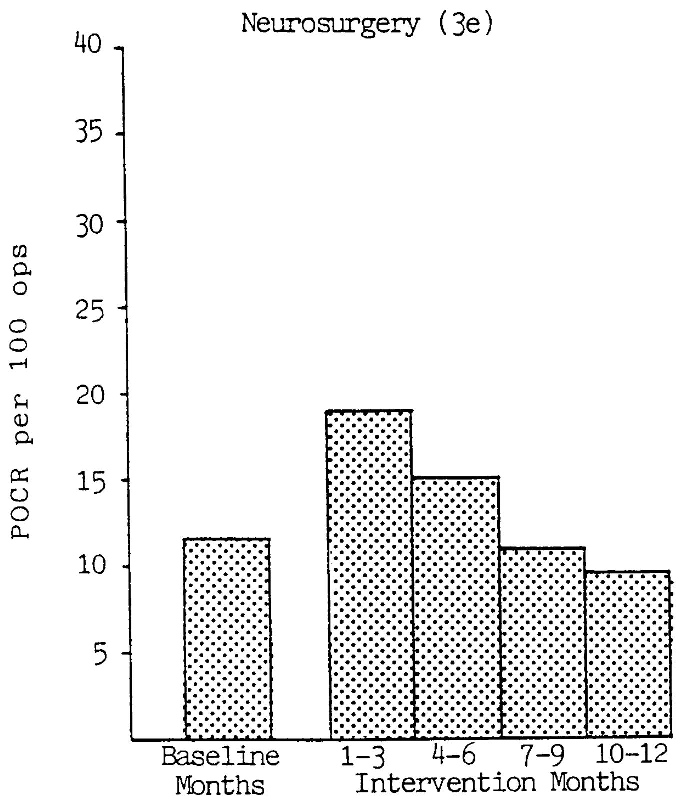
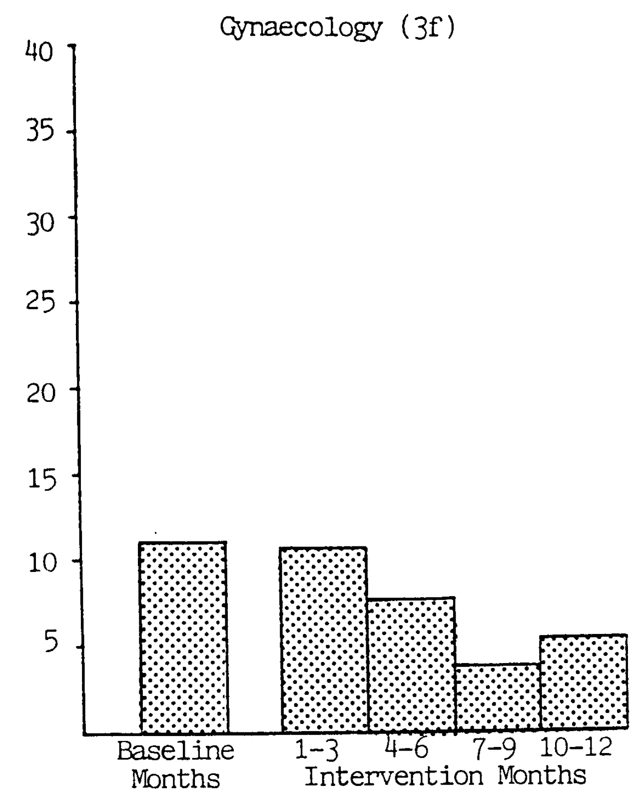
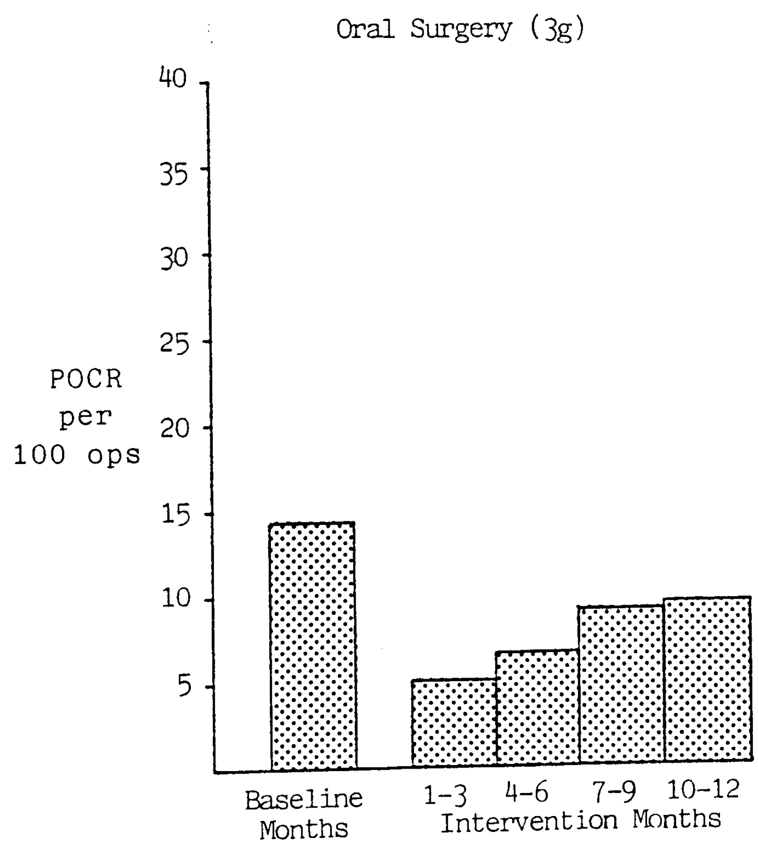


Figure 3e-g

Pre-operative chest X-rays per elective operations by specialty in hospital A







Pre-operative chest X-rays per elective operations for consultants in each specialty in hospital A

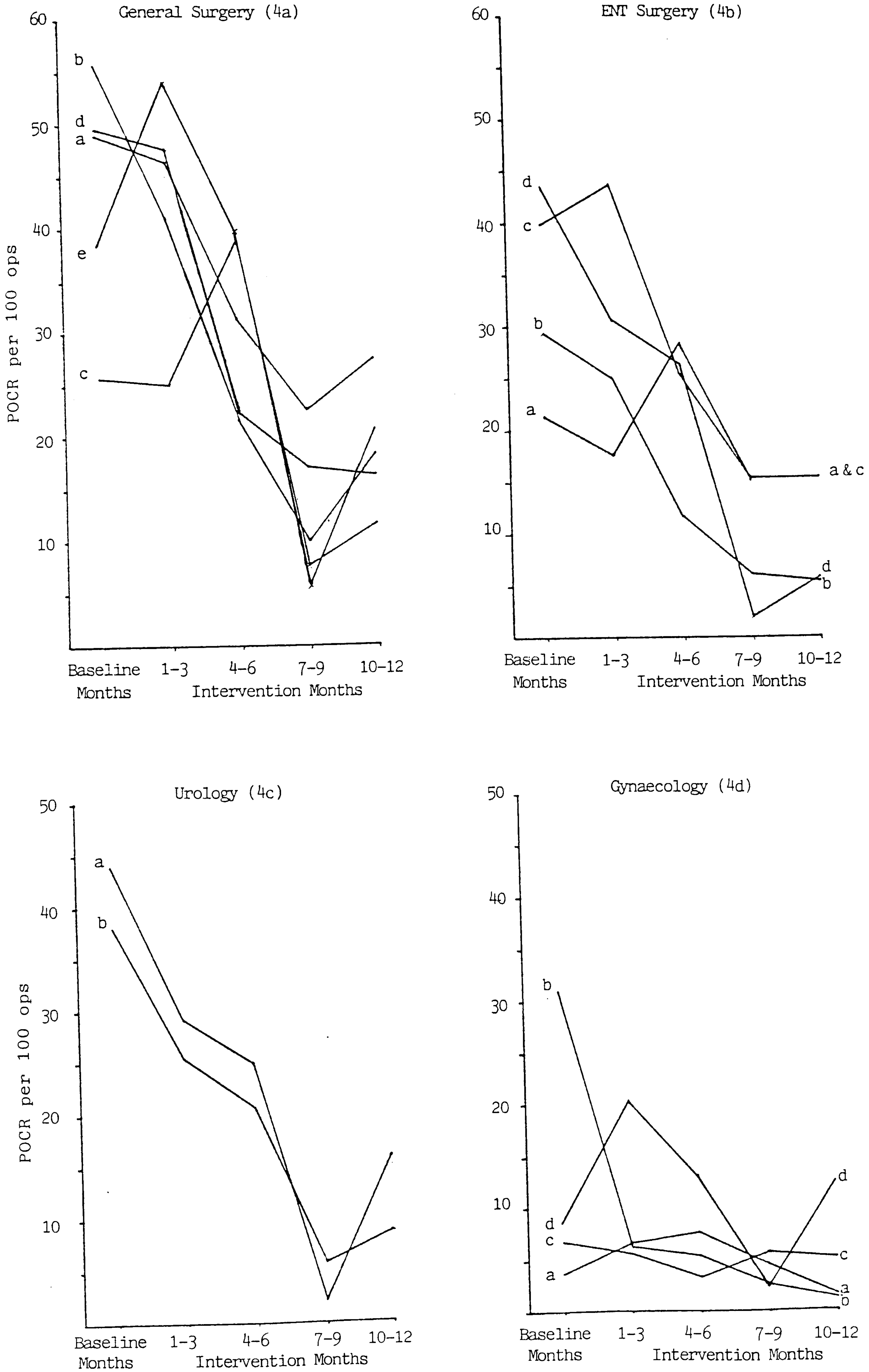


Table 9

Pre-operation chest X-ray rates for elective operations by consultant before and after introduction of notice in Hospital A

Pre-operative chest X-rays per 100 elective operations

	Before Notice (Months 4-6)	After Notice (Months 7-9)	Change: Before and After Notice		
			Difference	(%)	Significance (p)
General Surgery					
Cons a	31.3	22.6	-8.7	-28%	0.255
b	21.6	10.0	-11.6	-56%	0.083
c	38.8	7.8	-31.0	-80%	< 0.001
d	22.3	17.0	-5.3	-24%	0.306
e	39.7	5.8	-33.9	-85%	< 0.001
Urology					
Cons a	25.0	2.1	-22.9	-92%	< 0.001
b	20.8	6.0	-14.8	-71%	< 0.001
Gynaecology					
Cons a	7.8	4.6	-3.2	-41%	0.532
b	5.4	2.9	-2.5	-46%	0.742
c	3.3	5.8	+2.5	+76%	0.707
d	13.1	2.8	-10.3	-79%	0.045
ENT Surgery					
Cons a	28.4	15.3	-13.1	-46%	0.093
b	11.8	6.0	-5.8	-49%	0.283
c	25.4	15.3	-10.1	-40%	0.137
d	26.4	1.9	-24.5	-93%	< 0.001

Hospital A: Utilisation Review Committee.

5.2.3 Hospital B: Information feedback

Figure 5 shows the use of pre-operative chest X-rays in hospital B where data on utilization was fed back to consultants on two occasions during the intervention year. Except for an elevated rate of use during the third intervention month, the use of pre-operative chest X-rays fell quite consistently during the intervention year. The high rate during the third intervention month (August 1983) was probably due to the appointment of new house staff in the hospital. Indeed, the new house staff were students in a teaching hospital known to have a relatively high utilization rate during the preceeding years. (The influence of change of house staff on pre-operative chest X-ray rates is described in detail in section 5.3.3). The approval of the guidelines by the divisions and distribution to consultants was followed by a slight reduction in utilization. On each occasion that data was fed back to the consultant, a reduction in utilization occurred during the following two months.

In Table 10 the data has been aggregated according to the main periods of change: baseline months; intervention months 1-5 (prior to data feedback); months 6-8 (after first feedback); months 9-12 (after second feedback). The change after the first and second feedbacks was -7.5 and -4.2 pre-operative chest X-rays per 100 elective operations respectively. Overall, the rate decreased by 16.1 (55%) between the baseline months and the final intervention month ($p < 0.001$). However, the absolute number of pre-operative chest X-rays only decreased by one third in the radiology department because, during the final intervention month, there were 50% more elective operations performed than during the baseline months.

General surgery and ophthamology had extremely high pre-operative chest X-ray rates during the baseline period (Figures 6a,b). Divisional approval and distribution of guidelines to consultants was followed by a highly significant reduction in general surgery ($p < 0.001$) and a slight but non significant change in ophthalmology. Both these specialties showed a significant reduction after the first feedback of data ($p < 0.001$) and a non significant reduction after the second feedback ($p > 0.05$). ENT was the only specialty showing a significant reduction during the four months following the second feedback of data (Figure 6d). Gynaecology which had a low initial pre-operative chest X-ray rate (7.7 pre-operative chest X-rays per 100 elective operations) had a significant reduction after the first feedback ($p = 0.006$) but no significant change after the second feedback. A negligible number of pre-operative chest X-rays were performed in oral surgery and this did not change significantly throughout the year.

In summary, most specialties had a significant reduction after the first feedback, but not after the second feedback; no specialty increased their rate after the first or second feedback. Overall, all specialties reduced their use during the intervention year.

Figures 7a-d show the change in pre-operative chest X-rays rates for consultants in those specialties with two or more consultants each performing at least twenty operations per month. In ophthalmology, gynaecology and ENT surgery, trends for consultants within a specialty were similar. In general surgery, however, one consultant (d) had a different pattern of change from the other three consultants. This consultant's initial level of 81.5 pre-operative chest X-rays per 100 elective operations was followed by a dramatic reduction in use during the following two periods to a level of 10.2 which was well below that of the other consultants. However, during the final four months of the intervention periods, his rate regressed towards the mean of his colleagues. By the end of the intervention period, there were no substantial differences between the consultants, (range 24.1 to 31.1 chest X-rays per 100 elective operations.

In Tables 11 and 12, the extent of change for each consultant before and after the first feedback and before and after the second feedback are shown. The first feedback was associated with a statistically significant reduction ($p < 0.05$) among five of the ten consultants, whereas only two consultants, one in ENT surgery and one in ophthalmology, showed a significant reduction following the second feedback. The first feedback appeared to influence more consultants' utilization than the second feedback.

Pre-operative chest X-rays per elective operations by month in hospital B

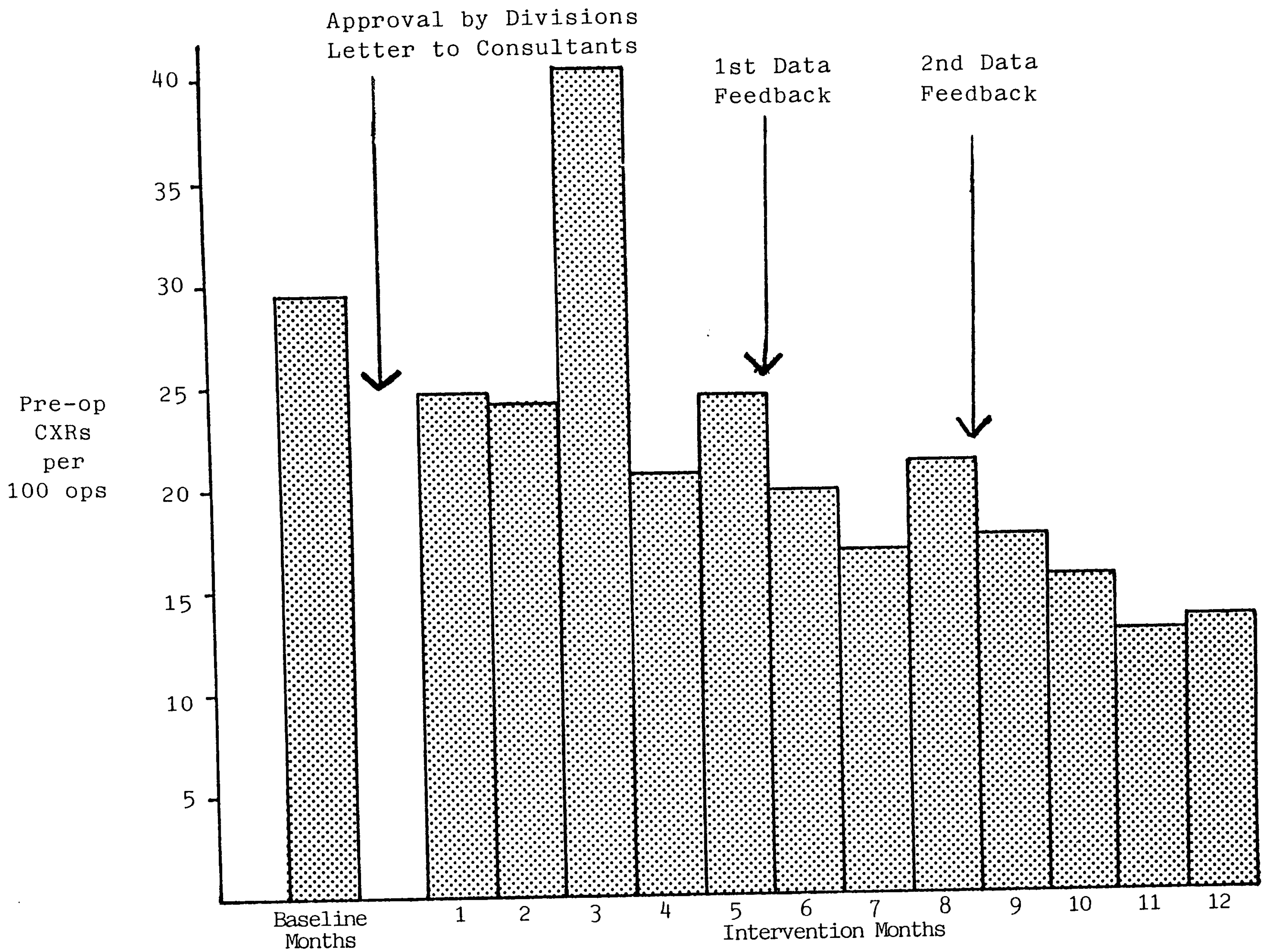


Figure 5

Table 10

Pre-operative chest X-rays for elective operations in hospital B

	Baseline Months	Intervention Months			Final Intervention Month
	1-2	1-5	6-8	9-12	12
No. elective operations (monthly mean)	309	421	412	576	457
No. pre-operative chest X-rays (monthly mean)	91	113	80	88	61
Pre-operative chest X-rays/ 100 elective ops.	29.4	26.9	19.4	15.2	13.3
Change in pre-operative chest X-rays/ 100 elective ops.	-2.5	-7.5	-4.2		-16.1*
Significance of change (p)	.236	<.001	0.002		<.001*

* Change between baseline period and final intervention month

Hospital B: Information Feedback

Figure 6a&b

Pre-operative chest X-rays per elective operations by specialty in hospital B

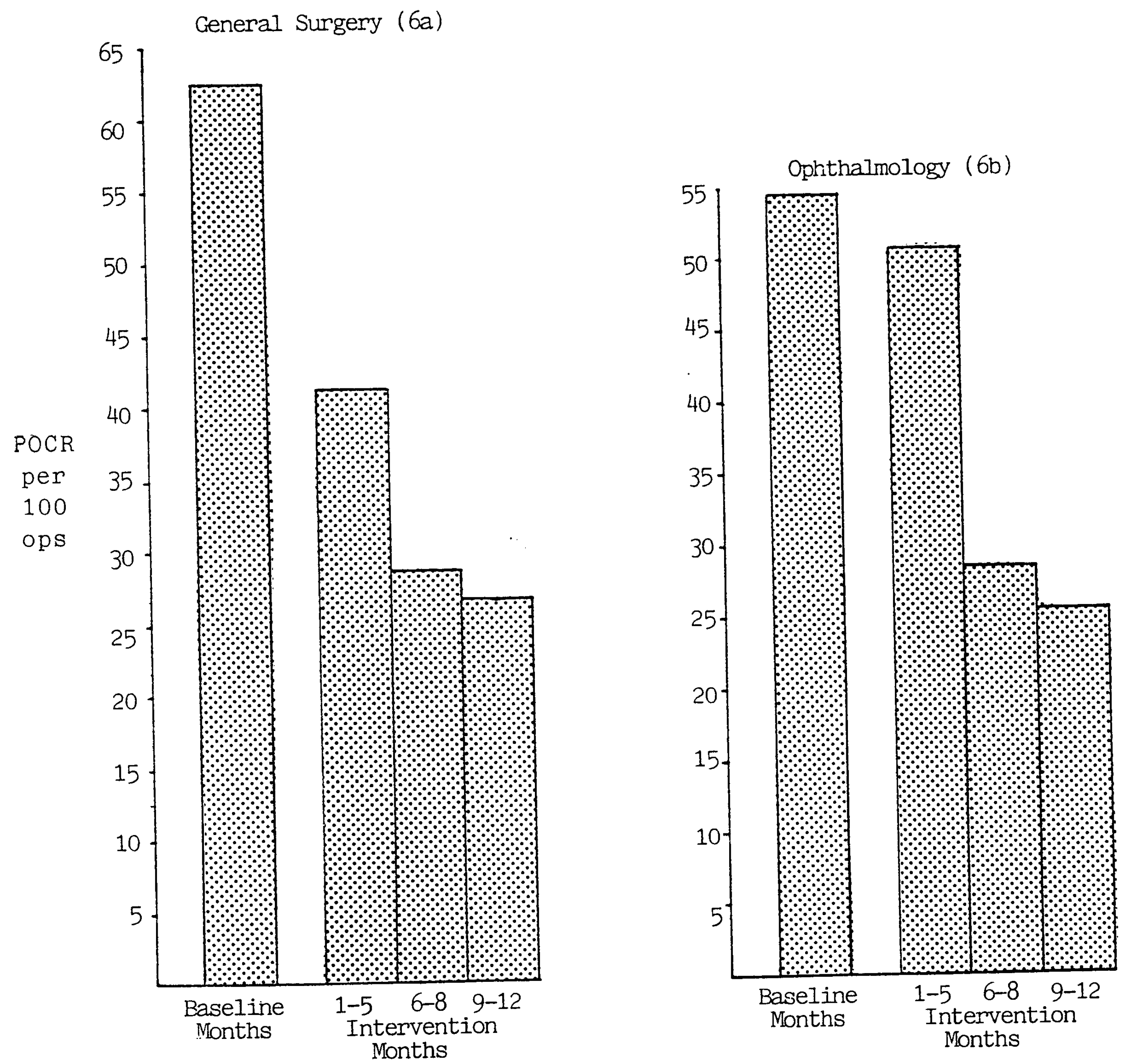
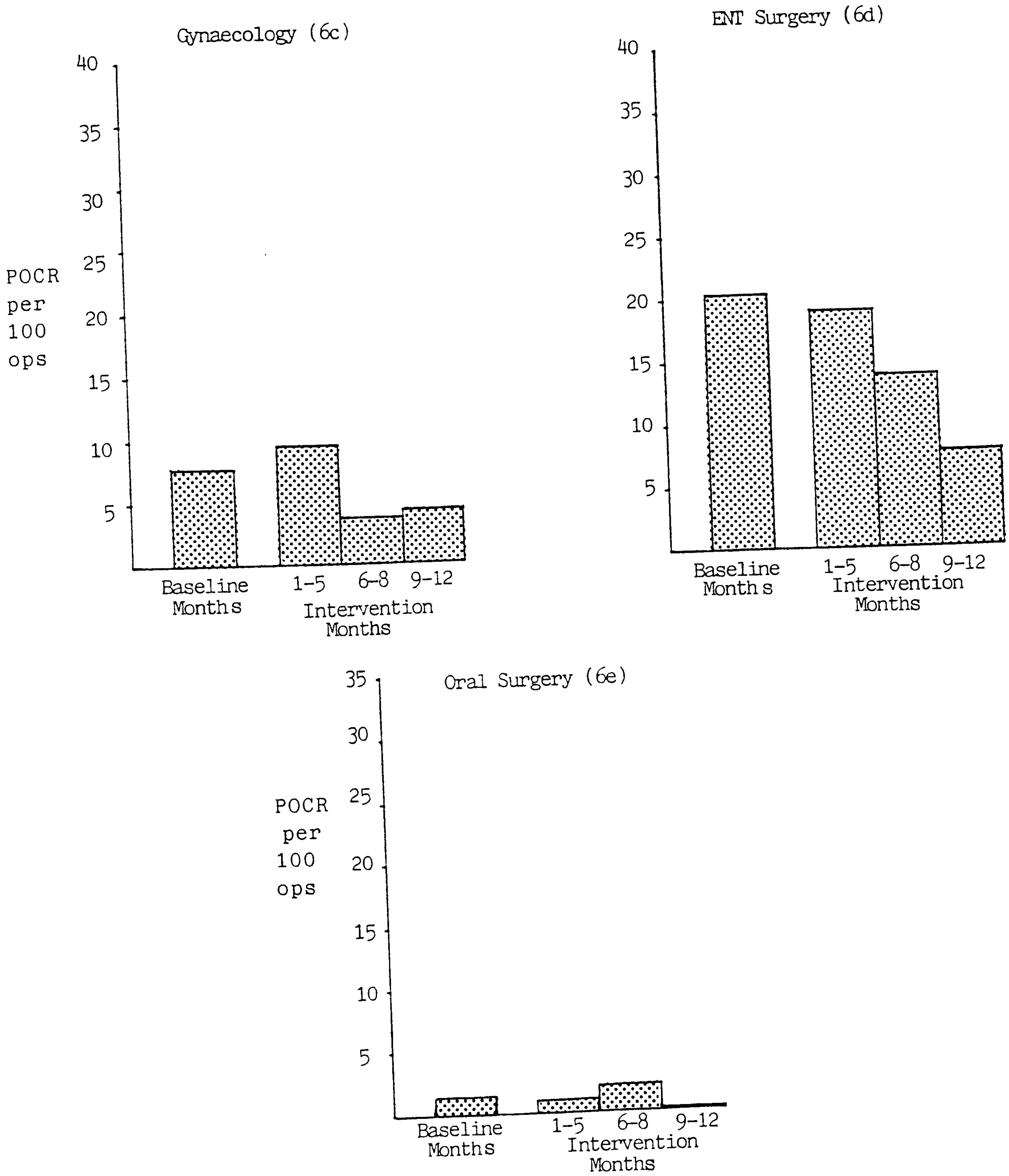


Figure 6c-e

Pre-operative chest X-rays per elective operations by specialty in hospital B



Pre-operative chest X-rays per elective operations for consultants in each specialty in hospital B

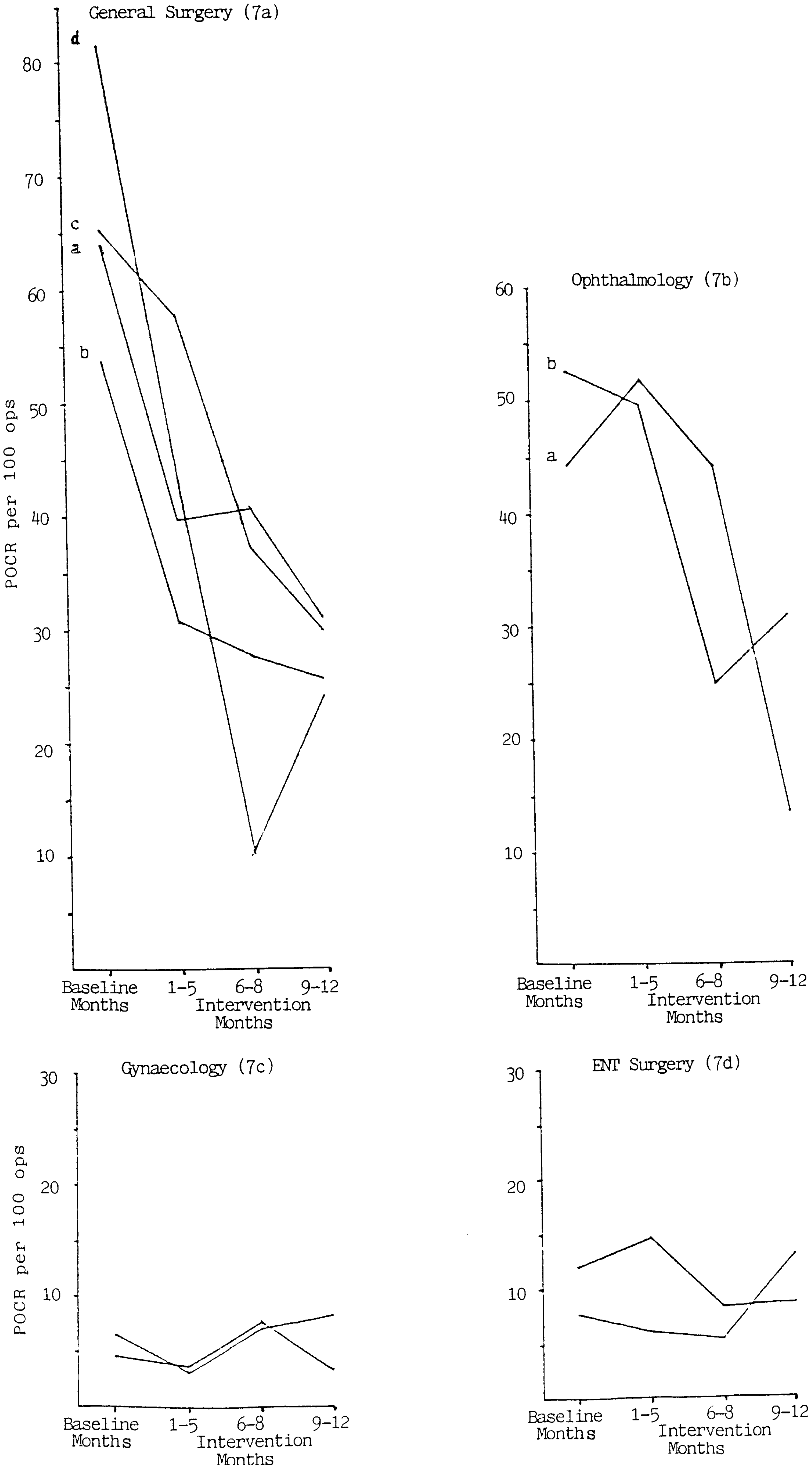


Table 11

Pre-operative chest X-ray rates for elective operations by consultant before and after 1st information feedback in hospital B

Pre-operative chest X-rays per 100 elective operations

	Before 1st Feedback	After 1st Feedback	Change Before and After 1st Feedback		
	Months 1-5	Months 6-8	Difference	(%)	Significance (p)
General Surgery					
Cons a	39.6	40.6	+1.0	+3%	1.000
b	30.8	24.7	-6.1	-20%	.367
c	57.6	37.2	-20.4	-35%	.008
c	43.2	10.2	-33.0	-76%	<.001
Gynaecology					
Cons a	10.3	8.8	-1.5	-15%	.953
b	9.0	2.8	-6.2	-69%	.032
ENT Surgery					
Cons a	23.4	8.9	-14.5	-62%	.001
b	15.1	17.2	+2.1	+14%	.683
Ophthalmology					
Cons a	52.0	44.4	-7.6	-15%	.587
b	49.7	25.9	-23.8	-48%	<.001

Hospital B: Information Feedback

Table 12

Pre-operative chest X-rays per elecive operations for consultants before and after 2nd Information Feedback in Hospital B

Pre-operative Chest X-rays per 100 Elective Operations

	Before 1st Feedback	After 1st Feedback	Change Before and After 1st Feedback		
	Months 1-5	Months 6-8	Difference	(%)	Significance (p)
General Surgery					
Cons a	40.6	31.1	-9.5	-23%	.233
b	24.7	25.5	+0.8	+3%	1.000
c	37.2	29.6	-7.6	-20%	.342
e	10.2	24.1	+13.9	+136%	.061
Gynaecology					
Cons a	8.8	7.0	-1.8	-21%	.881
b	2.8	3.0	+0.2	+7%	1.000
ENT Surgery					
Cons a	8.9	8.6	-0.3	-3%	1.000
b	17.2	6.9	-10.3	-60%	.002
Ophthalmology					
Cons a	44.4	13.7	-30.7	-69%	<.001
b	25.9	31.2	+5.3	+21%	.387

Hospital B: Information Feedback

5.2.4 Hospital C: new request form

The new chest X-ray request form was introduced into hospital C during the middle of the first intervention month. Figure 8 shows that during the second intervention month the pre-operative chest X-ray rate fell from 24.2 to 16.2 pre-operative chest X-rays per 100 elective operations ($p < 0.001$). This reduced level of use was maintained during the following four months but, during the seventh month (when new house staff took up their posts in the surgical wards), the rate rose almost to its original level. During most of the remainder of the intervention period, the rate remained at a level higher than during the first few months.

Table 13 shows that the reduction in use occurring between the baseline months and the early months (2-6) was statistically significant ($p < 0.001$). The increase during the latter part of the year was also significant ($p < 0.001$). Because of this increase, the overall change during the year was not significant (-4.6 pre-operative chest X-rays per 100 elective operations, $p = 0.064$). During the period of least utilization, the rate was still moderately high at 17.3 pre-operative chest X-rays per 100 elective operations.

Data was collected on only two specialties in this hospital (Figure 9a,b). Because most operations were performed in general surgery, the pattern of change in this specialty was similar to that occurring in the hospital as a whole. In oral surgery the baseline rate of 5.1 pre-operative chest X-rays per 100 elective operations was not followed by any significant change during the intervention year.

The eight consultants in general surgery, despite wide variations in baseline pre-operative chest X-ray rates, showed the same trends in utilization: reductions occurred in the early months and increases in the later months (Figure 10). Although all consultants in general surgery reduced their use of pre-operative chest X-rays following the introduction of the new request form (varying from -15% to -68%) the reduction was statistically significant ($p < 0.05$) for only one consultant (Table 14). This lack of significance may have been due to a combination of the relatively low numbers of operations performed by each consultant per month and only a moderate decrease in the pre-operative chest X-ray rate between the two periods. Given that each consultant responded in a consistent way, it is likely that most of these changes were real and did not occur by chance.

Figure 8

Pre-operative chest X-rays per elective operations by month in hospital C

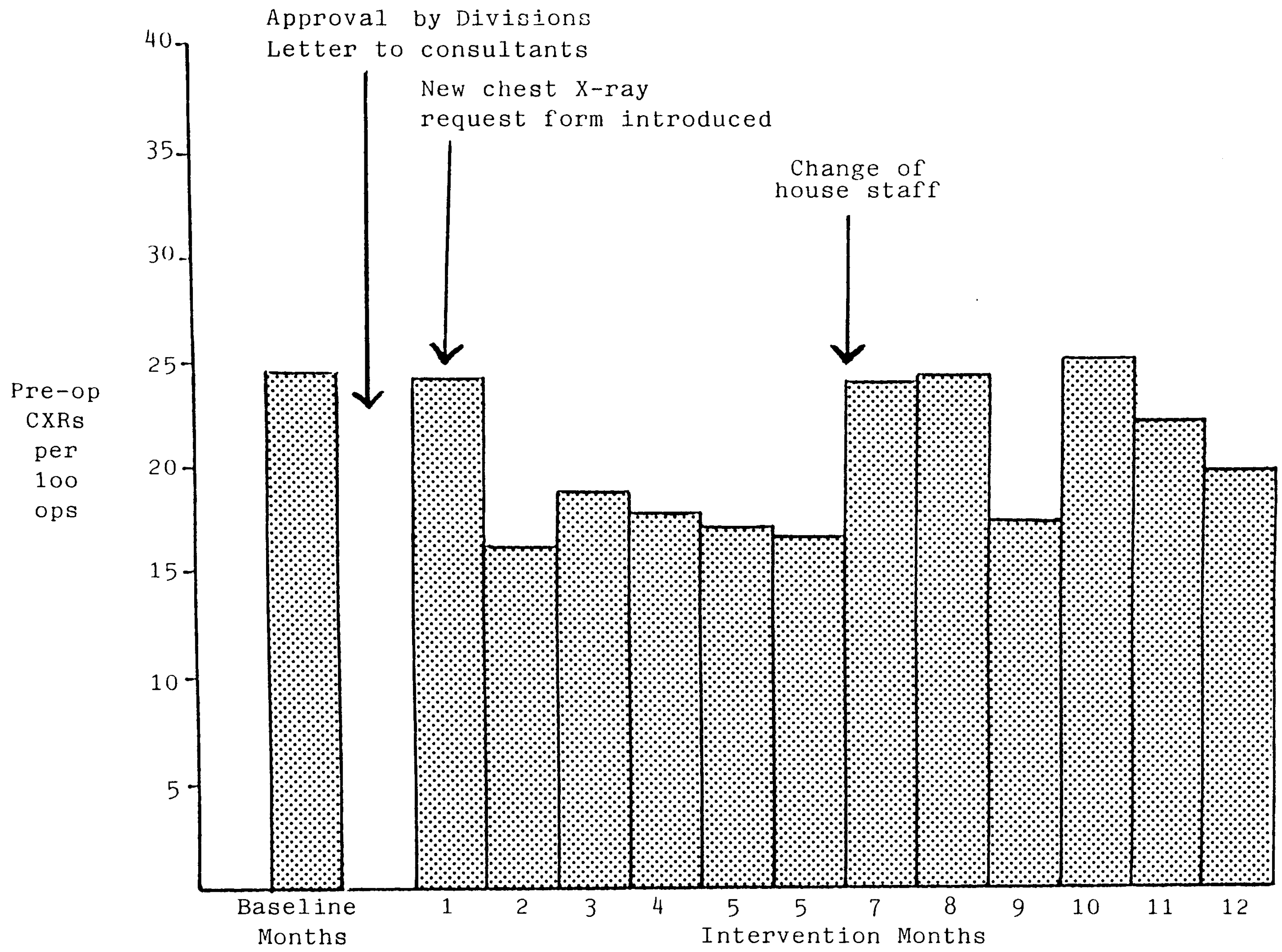


Figure 8

Table 13

Pre-operative chest X-rays for elective operations in hospital C

	Baseline Months	Intervention Months		Final Intervention Month
	1-2	2-6	7-12	12
No. elective operations (monthly mean)	389	501	496	506
No. pre-operative chest X-rays (monthly mean)	96	87	110	101
Pre-operative chest X-rays/ 100 elective ops.	24.6	17.3	22.2	20.0
Change: pre-operative chest X-rays/ 100 elective ops.	-7.3	+4.9		-4.6*
Significance of change (p)	.001	.001		0.064*

* Change between baseline period and final intervention month

Hospital C: new request form

Figure 9a&b

Pre-operative chest X-rays per elective operations by specialty in hospital C

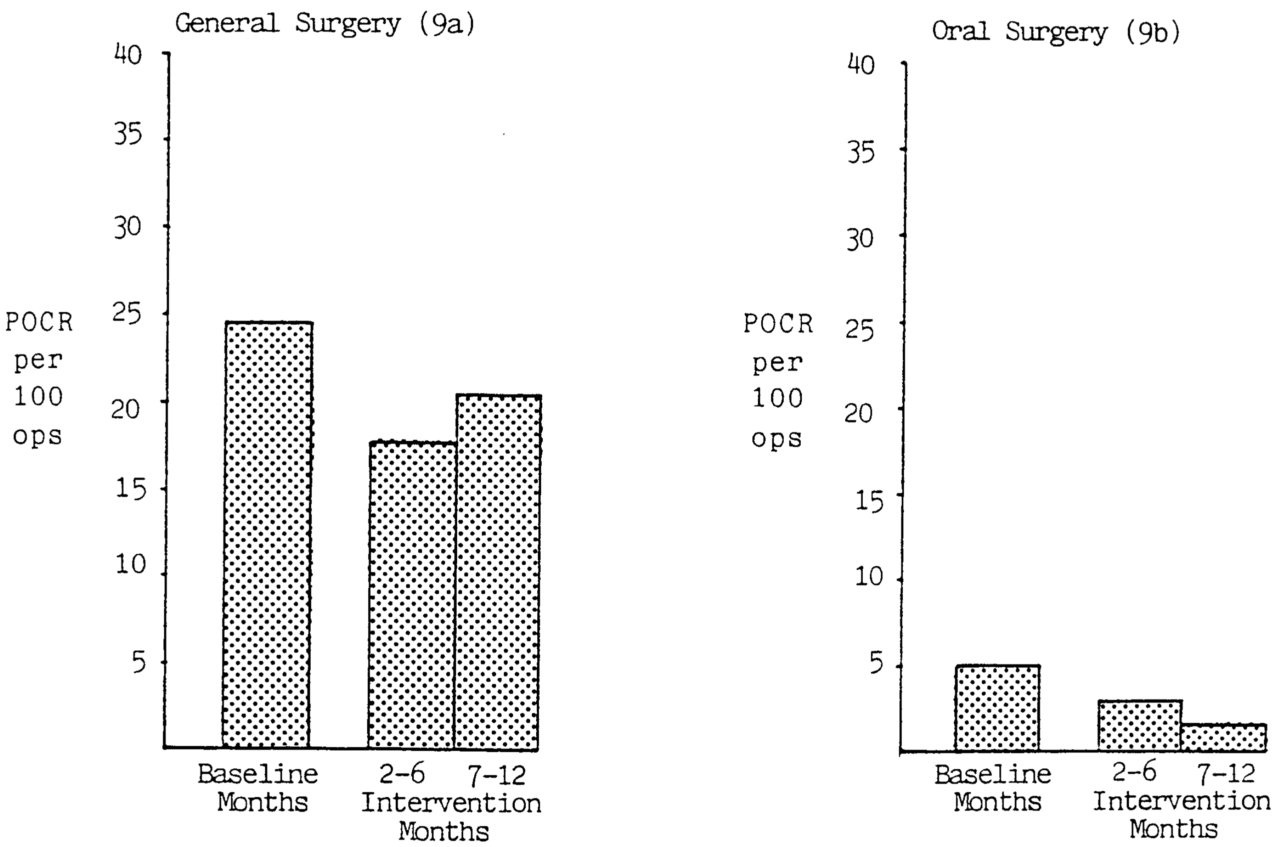


Figure 10

Pre-operative chest X-rays per elective operations for consultants in general surgery in hospital C

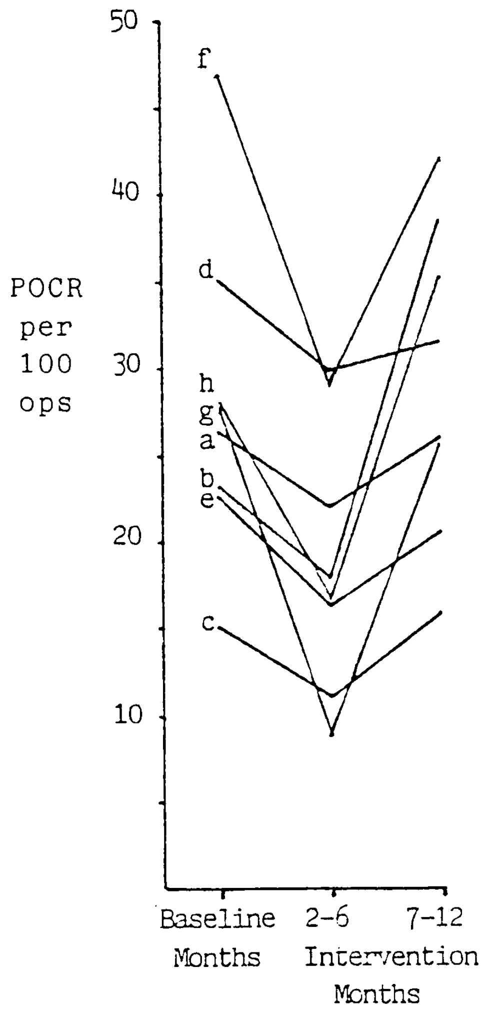


Table 14

Pre-operative chest X-ray rates for elective operations by consultant before and after introduction of new chest X-ray request form in hospital C

	Before Request Form (Baseline)	After Request Form (Months 2-6)	Change Before and After Request Form: Difference	(%)	Significance (p)
General Surgery					
Cons a	26.3	22.2	-4.1	-16%	.932
b	23.2	18.0	-5.2	-22%	.343
c	15.2	11.2	-4.0	-26%	.277
d	35.0	29.9	-5.1	-15%	.854
e	22.7	16.3	-6.4	-28%	.355
f	46.9	29.1	-17.8	-40%	.100
g	27.4	16.7	-10.7	-39%	.073
h	28.0	8.9	-19.1	-68%	.030

Hospital C: new request form

5.2.5 Hospital D: concurrent review

In hospital D in which requests for pre-operative chest X-rays were screened by staff in the radiology department, the monthly use of pre-operative chest X-rays is shown in Figure 11. The screening process (concurrent review), was begun during the first month of the intervention period. During the first four months the pre-operative chest X-ray rate was slightly lower than during the baseline period. Since this reduction in use was not substantial, it was decided to inform staff in the radiology department of the current levels of use. In addition, radiography staff were reminded of their role in the review process. Following this feedback the use of pre-operative chest X-rays decreased further during the next three months. The lower levels of use were not maintained consistently throughout the remainder of the intervention year and some fluctuation occurred during the latter five months. Further feedback was not provided to the radiology department.

In Table 15 the monthly use of pre-operative chest X-rays are aggregated according to consistent periods of use. The decrease of 6.8 chest X-rays per 100 elective operations between the baseline period and the first four months of the study was statistically significant ($p = 0.003$). The decrease following feedback to the radiology department was also significant (-8.3 pre-operative chest X-rays per 100 elective operations, $p < 0.001$). Despite fluctuations in use during the latter five months, the overall rate of 23.2 was still less than the 32.6 during the baseline period. Indeed during the final intervention month the use of pre-operative chest X-rays was at a level 42% lower than during the baseline period ($p < 0.001$). Also the absolute number of pre-operative chest X-rays carried out in the radiology department was approximately half that occuring during the baseline period. Thus, despite some fluctuation during the year, the strategy was associated with an overall reduction in use of pre-operative chest X-rays.

Within the three specialties, general surgery, oral surgery and urology, the pattern of change was similar to that in the hospital overall (Figures 12a-c). However in oral surgery, the pre-operative chest X-ray rate was low initially (5.1 per 100 elective operations) and the changes observed during the year were not statistically significant ($p > 0.05$).

In general surgery, despite variations in baseline pre-operative chest X-ray rates, all consultant surgeons showed similar changes between different periods (Figure 13). Between the baseline period and the first four intervention months, consultants (b) and (c) showed a substantial reduction in use, consultants (a), (d), (e) and (g) showed minor changes, and consultant (f) showed a substantial increase. However, during the months following feedback to the radiology department, all consultants showed a reduction in use. The feedback was associated with reductions in use ranging from -14% to -60%, although only two of these changes were statistically significant (Table 16). All consultants, except consultant (a), showed an increase during the latter months of the intervention period. The process of concurrent review appeared to be associated with reasonably consistent changes among consultants in the hospital.

Figure 11

Pre-operative chest X-rays per elective operations by month in hospital D

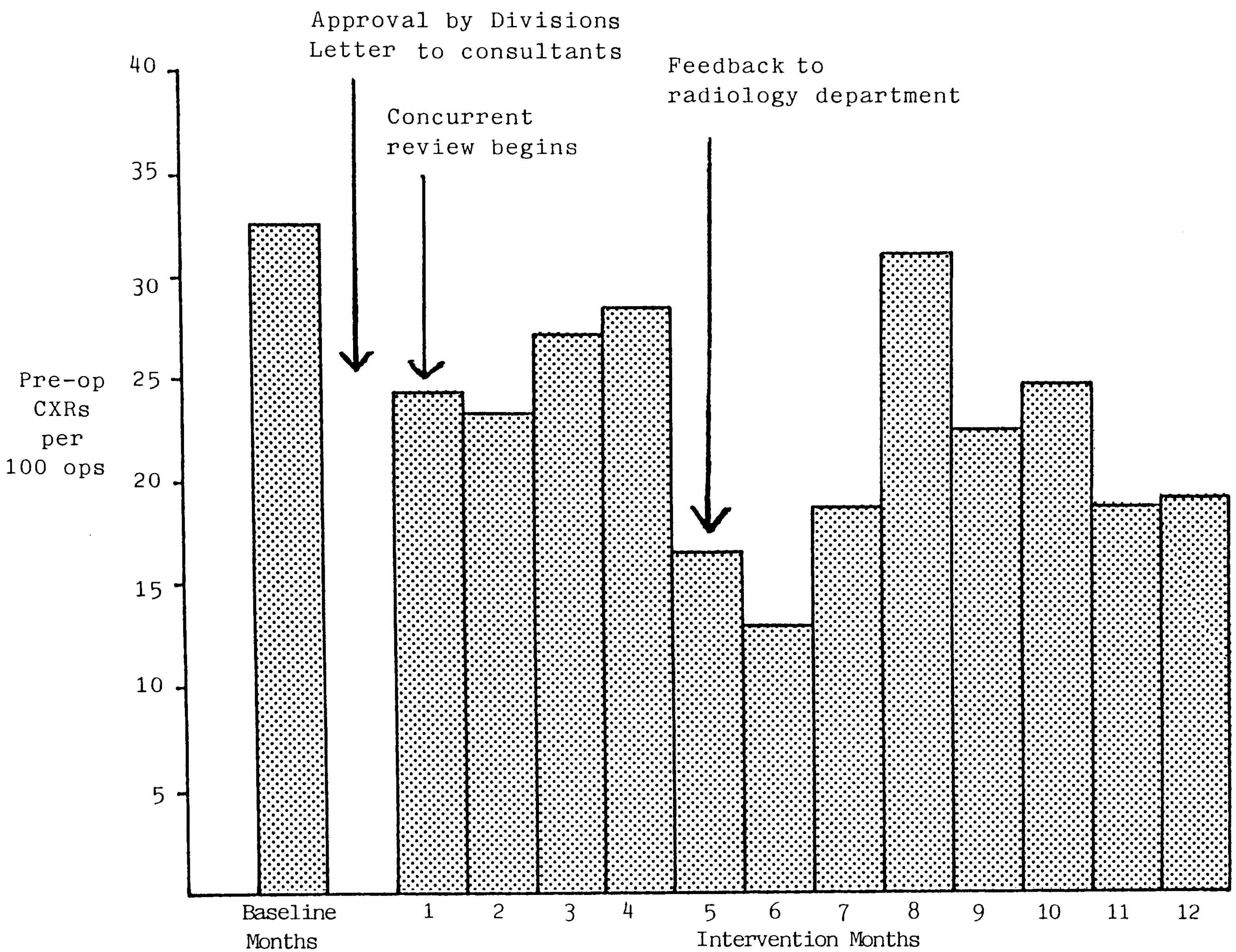


Figure 11

Table 15

Pre-operative chest X-rays for elective operations in hospital D

	Baseline Month	Intervention Months			Final Intervention Month
	1-2	1-4	5-7	8-12	12
No. elective operations (monthly mean)	304	288	300	502	289
No. pre-operative chest X-rays (monthly mean)	99	74	53	116	55
Pre-operative chest X-rays/ 100 elective ops.	32.6	25.8	17.5	23.2	19.0
Change: pre-operative chest X-rays/ 100 elective ops.		-6.8	-8.3	+5.7	-13.6*
Significance of change (p)		.003	.001	.001	<.001*

* Change between baseline period and final intervention month

Hospital D: concurrent review

Figure 12a-c

Pre-operative chest X-rays per elective operations by specialty in hospital D

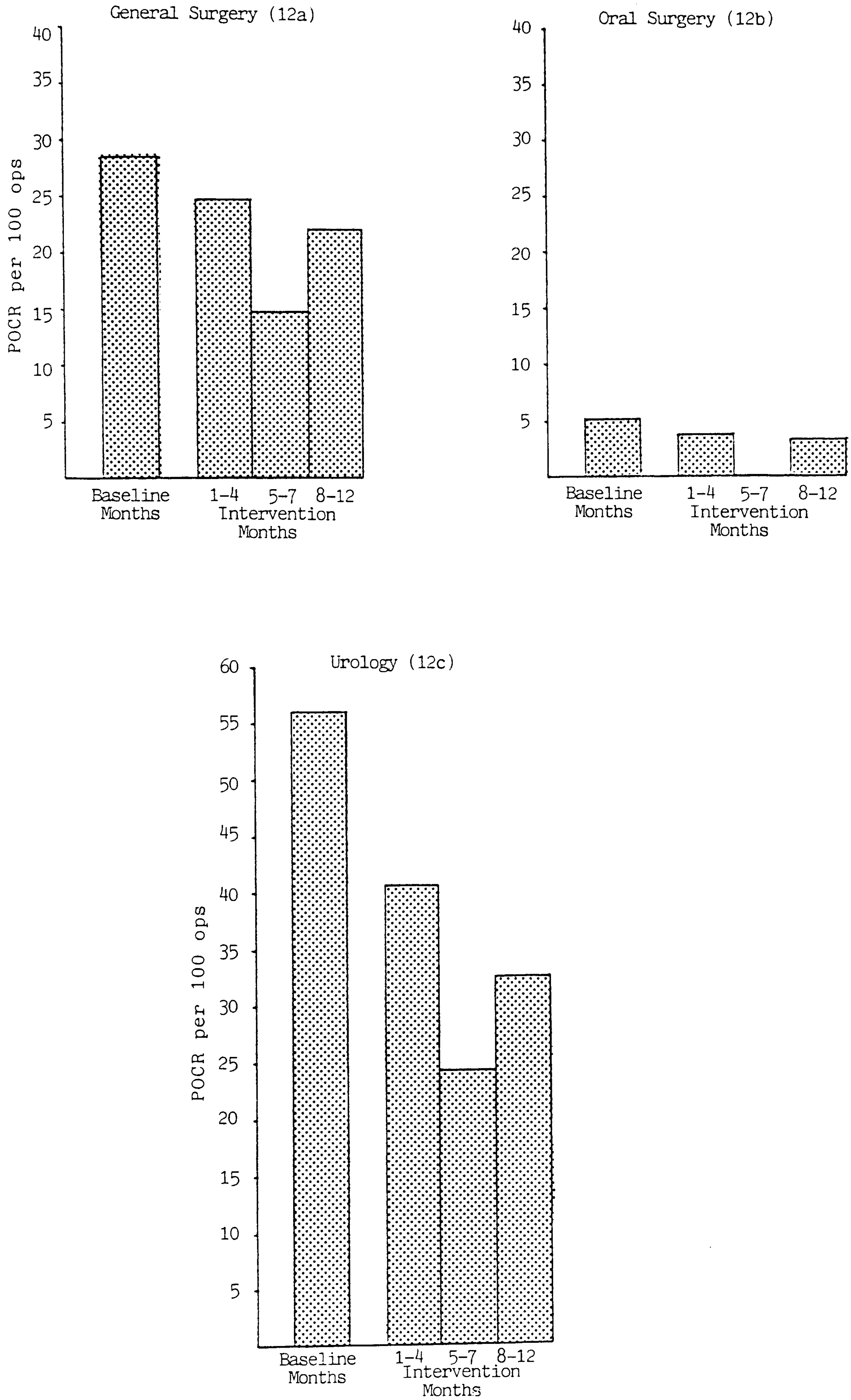


Figure 13

Pre-operative chest X-rays per elective operations for consultants in general surgery in hospital D

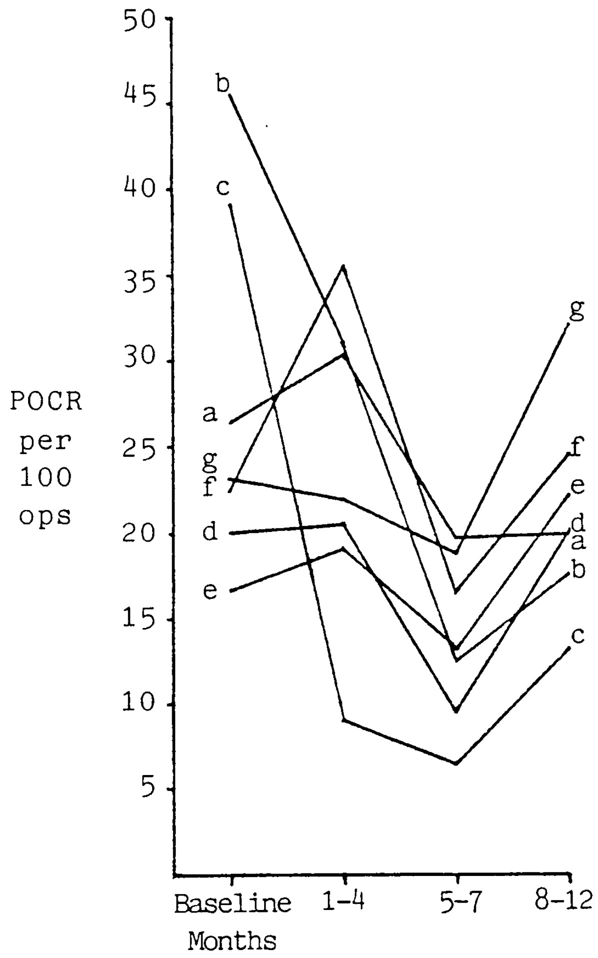


Table 16

Pre-operative chest X-ray rates for elective operations for consultants before and after feedback on performance to radiology department in hospital D

Pre-operative chest X-rays per 100 elective operations

General Surgery	Before Feedback (Months 1-4)	After Feedback (Months 5-7)	Change Before and After Feedback: Difference	(%)	Significance (p)
Cons a	30.4	19.7	-10.7	-35%	.160
b	31.0	12.5	-18.5	-60%	.003
c	9.1	6.7	-2.4	-26%	.731
d	20.5	9.5	-11.0	-54%	.113
e	19.0	13.1	-5.9	-31%	.379
f	35.4	16.3	-19.1	-54%	.001
g	21.9	18.9	-3.0	-14%	.754

5.2.6 Hospital E: control Hospitals I,II and III: supplementary controls

In hospital E, the main control hospital, there was no substantial change in the pre-operative chest X-ray rate during the 12 months in which interventions took place in the other hospitals (Figure 14). The rates were aggregated into four monthly periods for ease of comparison (Table 17). Between successive periods there was no statistically significant change in utilization ($p > 0.05$). The rate during the final control month (21.8 pre-operative chest X-rays per 100 elective operations) was not significantly less than the baseline rate of 22.9 pre-opeative chest X-rays per 100 elective operations. During the final control month, however, the absolute number of pre-operative chest X-rays was slightly higher than during the baseline period due to a greater number of operations performed during that month.

Among the specialties of general surgery, ophthalmology, gynaecology and ENT surgery there were no significant changes in pre-operative chest X-ray rates (Figures 15a-d) except for a reduction in general surgery from a baseline rate of 60.4 pre-operative chest X-rays per 100 operations to 47.2 pre-operative chest X-rays per 100 operations during the first third of the control year ($p = 0.009$). This baseline pre-operative chest X-ray rate in general surgery was substantially higher than the pre-operative chest X-ray rate in the other specialties (Figures 15a-d).

In each specialty two consultants performed a minimum of twenty operations per month during the 14 months of the study. The decrease in general surgery between the baseline period and the first third of the intervention year (Figure 16a) was due to a substantial reduction in use by one general surgeon whose pre-operative chest X-ray rate decreased from 70.4 to 42.2 per 100 elective operations (p 0.001). In ophthalmology (Figure 16b), there was a considerable difference in utilization between the two consultant surgeons but neither changed significantly during the year. The ENT surgeons also showed no significant change (Figure 16c). In gynaecology (Figure 16d), both consultants showed a downward trend in utilization, but the only significant change occurred between the middle and last four months for consultant (b), ($p = 0.002$). These relatively minor changes do not support the notion that a substantial influence on the use of pre-operative chest X-rays occurred in the control hospital.

Figure 17 shows the use of pre-operative chest X-rays in the Supplementary Control Hospital I, which had an established computerised system of data collection in the radiology department. It was not possible to distinguish between elective and emergency operations and so the figures relate to pre-operative chest X-rays for all patients having surgical operations. The baseline period comprised January and February 1983 and did not include May 1982 (included in the baseline periods in the other hospitals). The baseline rate of 7.5 pre-operative chest X-rays per 100 operations was extremely low. This may have been due to a substantial number of emergency operations in the sample, a relatively high number of operations in specialties known to have low pre-operative chest X-ray rates, such as gynaecology and oral surgery, and under reporting of pre-operative chest X-rays. The reporting of pre-operative chest X-ray was dependent upon house officers assigning chest X-rays to this category on the request form. If pre-operative chest X-rays were not categorised as such; they would be counted as non pre-operative chest X-rays. Given this low baseline rate, the pre-operative chest X-ray rate remained relatively constant throughout the year except for a rate of 15.1 pre-operative chest X-rays per 100 operations during the sixth month.

The pre-operative chest X-ray rates in Supplementary Control Hospitals II and III are shown in Table 18. September 1983 was equivalent to the fourth intervention month (except in hospital C) and September 1984 was eqivalent to the fourth month after completion of the intevention year. In both Hosptials II and III the pre-operative chest X-ray rate was very consistent between the two months sampled. Furthermore, the rate in hospital II of approximately 20 pre-operative chest X-rays per 100 elective operations was sufficiently high to suggest that any lack of change during the control year was not due to rates being at a minimum level and hence unresponsive to factors influencing change.

The evidence from Control Hospital E and Supplementary Control Hospitals I, II and III would suggest that during the period of the study no substantial changes were occurring in the use of pre-operative chest X-rays in NHS hospitals.

Figure 14

<u>Pre-operative chest X-rays per elective operations by month in hospital E</u>

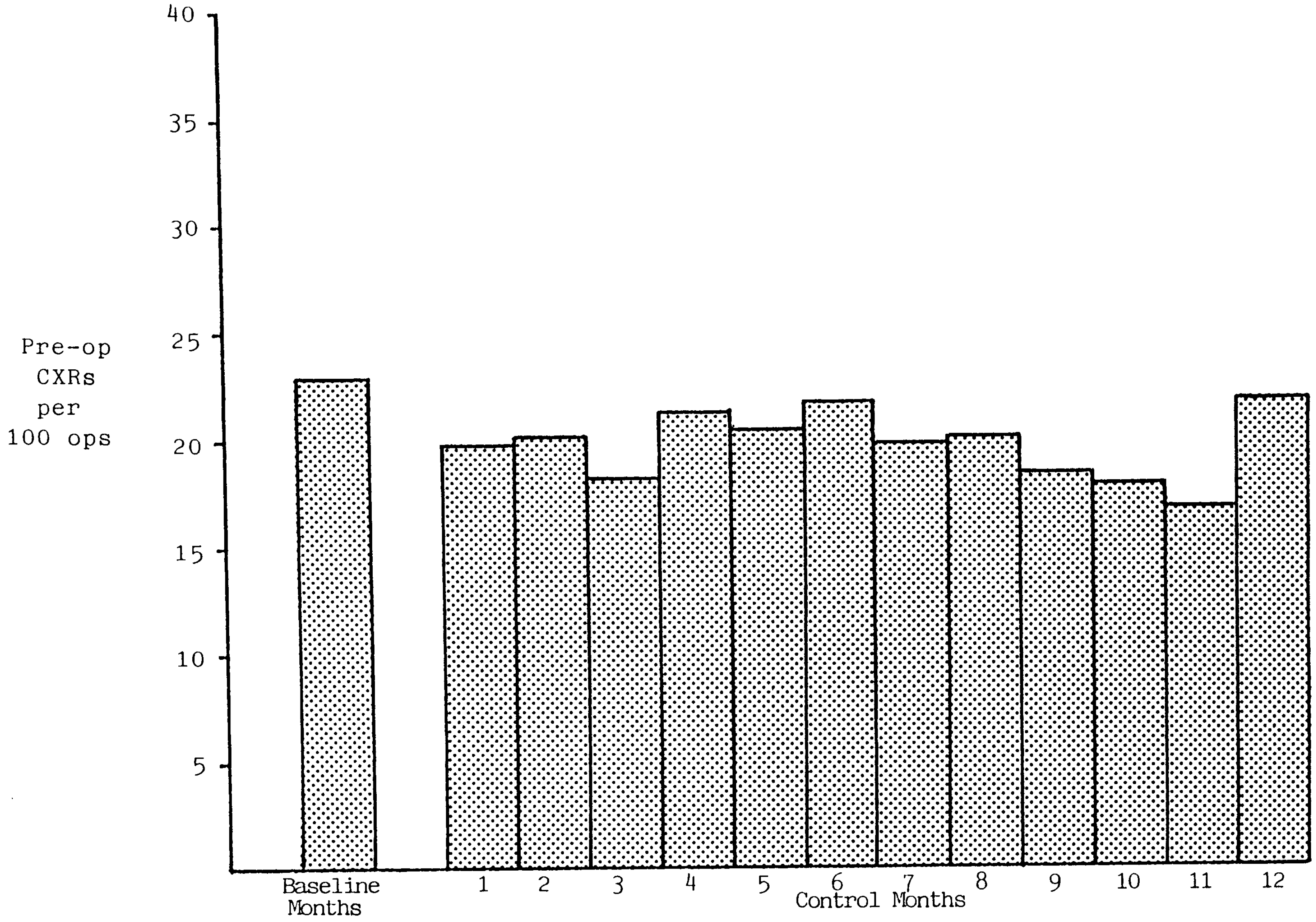


Figure 14

Table 17

Pre-operative chest X-rays for elective operations in Hospital E

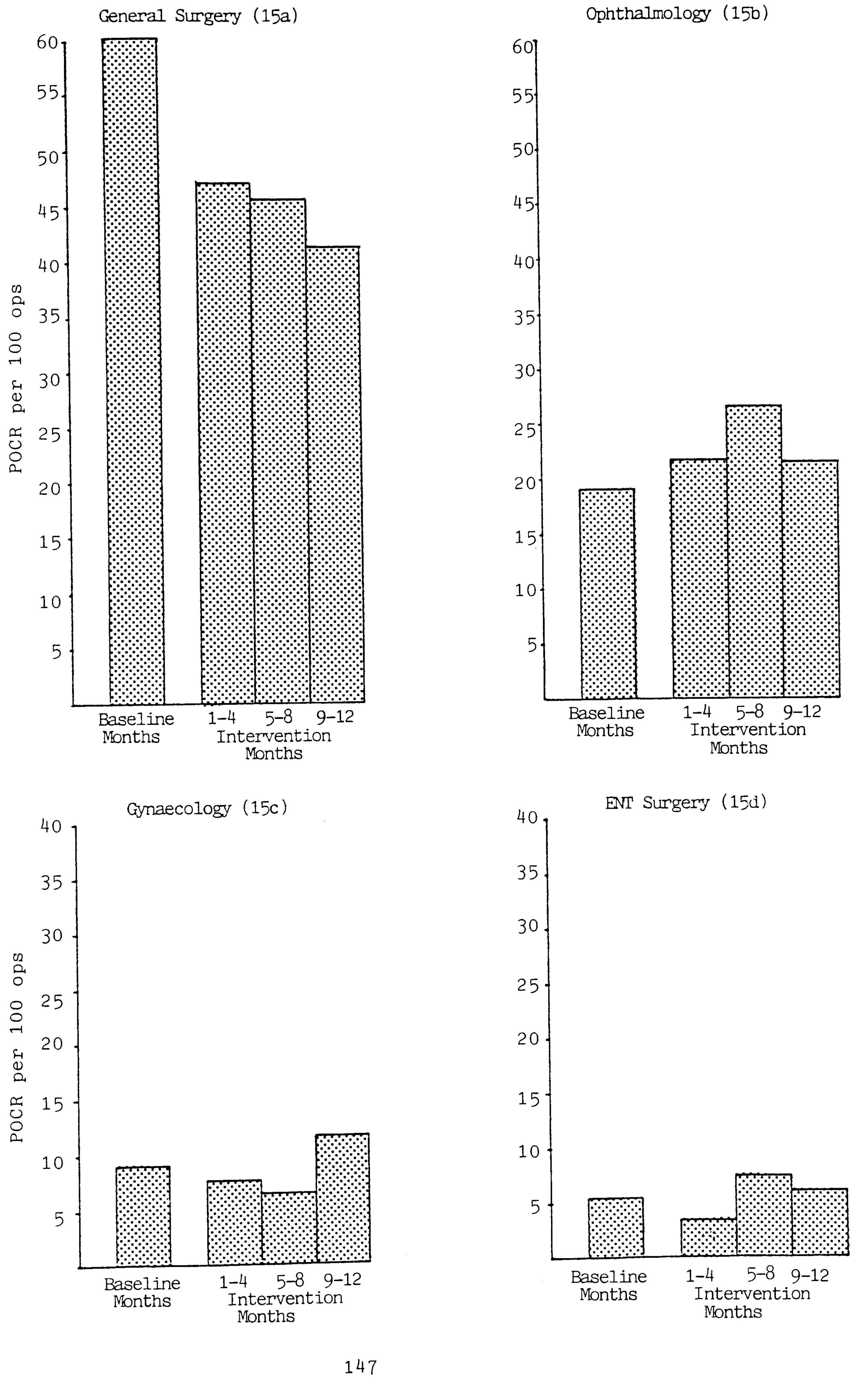
	Baseline Months	Control Months			Final Control Month
	1-2	1-4	5-8	9-12	12
No. elective operations (monthly mean)	500	555	613	803	639
No. pre-operative chest X-rays (monthly mean)	115	111	127	156	139
Pre-operative chest X-rays/ 100 elective ops.	22.9	19.9	20.7	19.4	21.8
Change: pre-operative chest X-rays/ 100 elective ops.	-3.0	+0.8	-1.3		-1.1*
Significance of change (p)	.061	.563	.243		.547*

* Change between baseline period and final control month

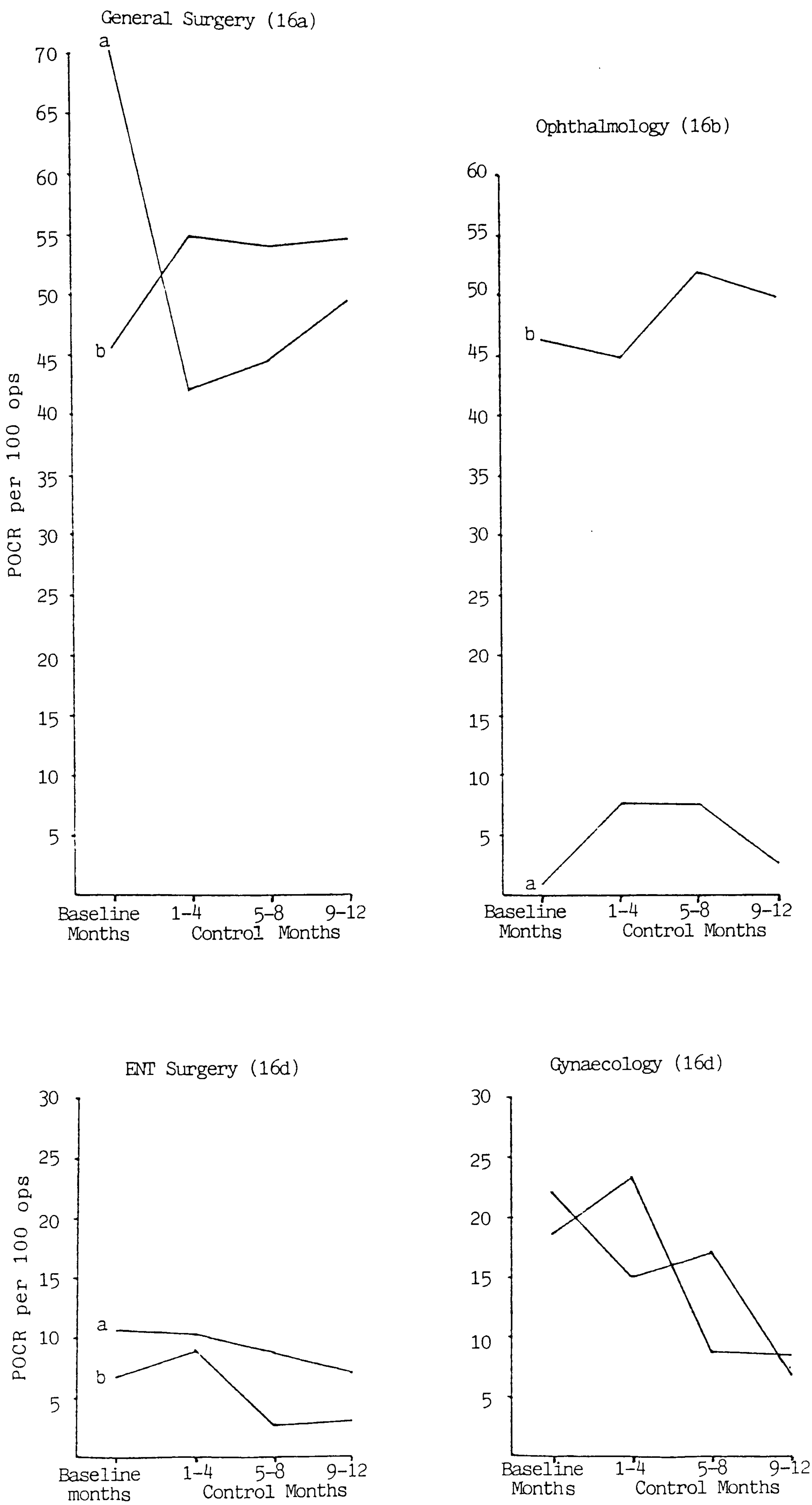
Hospital E: control

Figure 15a-d

Pre-operative chest X-rays per elective operations by specialty in hospital E



Pre-operative chest X-rays per elective operations for consultants in each specialty in hospital E



Pre-operative chest X-rays for elective and emergency operations by month in Supplementary Control Hospital I

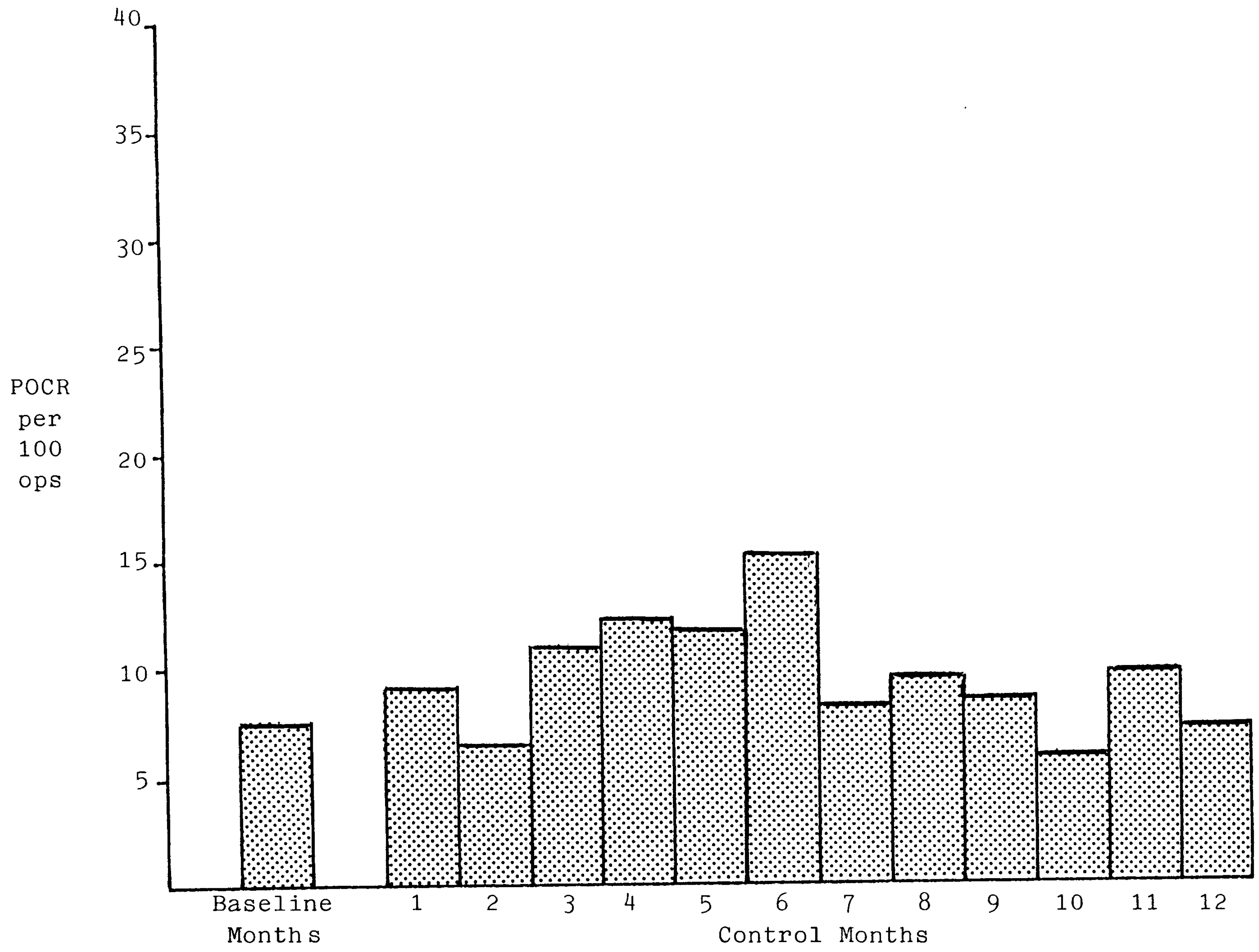


Figure 17

Table 18

Pre-operative chest X-rays for elective operations in supplementary control hospitals II and III

	Hospital II		Hospital III	
	Sept 1983	Sept 1984	Sept 1983	Sept 1984
No elective ops	305	284	350	348
Sample size	102	95	117	116
No pre-op CXRs per sample	20	18	17	17
No pre-op CXRs per 100 elective ops	20	19	14.5	14.5

Source M C Charny (unpublished information)

5.2.7 Emergency operations

Although the main purpose of the study was to collect data on the use of pre-operative chest X-rays in elective surgery the method necessitated collecting data on some patients who had emergency operations. Since this data was available, the opportunity was taken to examine pre-operative chest X-ray rates amongst these emergency patients. Table 19 shows that the pre-operative chest X-ray rate for emergency operations varied between hospitals from 15.6 X-rays per 100 emergency operations in Hospital A to 37.6 per 100 emergency operations in Hospital D. Overall, the pre-operative chest X-ray rate was slightly lower for emergency operations than for elective operations in that three hospitals had baseline rates of less than 20 pre-operative chest X-rays per 100 operations. By contrast, no hospital had an elective rate lower than 20 pre-operative chest X-rays per 100 operations.

During the intervention period, only one hospital (Hospital C) showed a significant reduction in the use of pre-operative chest X-rays from 27.6 to 17.1 pre-operative chest X-rays per 100 operations ($p = 0.006$). The comparable change in pre-operative chest X-ray rates for elective operations in hospital C was from 24.6 to 20 per 100 elective operations (Table 13). In three of the hospitals (A, B and D) a substantial reduction in the use of pre-operative chest X-rays in elective surgery took place and a corresponding decrease did not take place for emergency operations. These results would suggest that interventions to influence the use of pre-operative chest X-rays before elective surgery did not affect use before emergency surgery.

Table 19

Pre-operative chest X-ray rates for emergency operations during baseline and final intervention months by hospital

Pre-operative Chest X-rays per 100 Emergency Operations

Hospital	Baseline Months	Final Intervention Month	Difference	Significance (p)
A	15.6	14.2	-1.4	.825
B	15.8	20.0	+4.2	.625
C	27.6	17.1	-10.5	.006
D	37.6	42.4	+4.6	.714
E	18.5	19.3	+0.8	.903

In summary, these results on the use of pre-operative chest X-rays in the study hospitals indicate that each strategy had an effect in reducing utilization. The lowest level of 8.5 pre-operative chest X-rays per 100 elective operations was achieved by the Utilization Review Committee following the posting of notices in the surgical wards of the hospital. Information feedback was associated with a consistent and gradual reduction in use during the intervention year from a baseline level of 29.4 to 13.3 chest X-rays per 100 operations during the final intervention month. (However, only 50% of consultants showed a statistically significant change following the first feedback and 20% following the second feedback). Introduction of the new chest X-ray request form was associated with an immediate but moderate reduction in use (-7.3 chest X-rays per 100 operations), but this was not sustained following a change in house staff. Concurrent review of requests by radiological staff had an intermittent effect which was enhanced by feedback on utilization to the radiology department. The control hospital showed no significant change in utilization throughout the year of the study.

Changes in use by specialty in each hospital matched, with few exceptions, those occurring in the hospital as a whole. Less consistent changes were observed in specialties which already had low levels of utilization. Within each specialty, changes in use by consultants matched those occurring for the specialty as a whole, with a few exceptions, notably in hospital B (information feedback). Thus implementation of the strategies had a reasonably universal effect within each hospital.

5.3 FACTORS AFFECTING CHANGE IN USE

The interventions applied in the study hospitals undoubtedly contributed to the change in use of pre-operative chest X-rays, but other factors may have affected the extent of change. Relationships were examined between rates of change and the following factors: initial use of pre-operative chest X-rays; age of patients; change of house staff; and anaesthetists.

5.3.1 Initial use

In each of the four hospitals the pre-operative chest X-ray rate was aggregated for periods prior to and after the point of greatest change during the intervention year.

In Table 20 the changes in pre-operative chest X-ray rates between these periods are shown according to three initial levels of use of pre-operative chest X-rays. These initial levels do not correspond to the baseline period but to the periods prior to the greatest change (as shown in the notes to Table 20). It can be seen that the higher the initial rate of utilization in each hospital, the greater the absolute decrease in the pre-operative chest X-ray rate. However, the percentage rate of change did not show a consistent trend according to the level of initial use. For example, in hospital B a reduction of approximately 50% occurred irrespective of the initial level of use. For high initial levels of use, a greater absolute reduction in rates is to be expected because any activity when changing tends to regress towards the mean.

5.3.2 Age of patient

Table 21 shows pre-operative chest X-ray rates by age of patients during the periods before change took place. Except for children under 15 years of age, pre-operative chest X-ray rates tended to increase up to aged 75 years. But for patients aged 75 years or older, the pre-operative chest X-ray rate was no higher than for those patients aged between 65-74 years.

In each hospital the percentage change in pre-operative chest X-ray rates according to the age of patients is shown in Table 22. There was no age which had consistently higher rates of change then other age groups. However, given that older age groups had higher initial rates of use, they had greater absolute reductions in use.

5.3.3 Change of house staff

In order to examine the effect of a change of house staff on pre-operative chest X-ray rates, utilization was compared within each intervention hospital between July and August 1983 and between January and February 1984, both these periods corresponding to times when house staff changed appointments (Table 23). In hospital C, data for July 1983 was not available because the intervention year commenced in August 1983. During the remaining seven periods of change of house staff, statistically significant increases in the use of pre-operative chest X-rays occurred during four change over preriods and a non significant increase during one period. During one of these periods (Hospital A, January - February 1984), there was an increasing trend in the use of pre-operative chest X-rays from January to April 1984 which might have accounted for the increase during the changeover period. In the other hospitals the general trends around the changeover periods were either static or decreasing. During the seven changeover periods, one hospital (D) showed a significant decrease from January to February 1984, but this was associated with a generally decreasing trend in the hospital from January to April. Similarly, hospital B showed a decrease from January to February but this was not statistically significant. Although this data is not conclusive, it would suggest that changeover of house staff is associated frequently with an increase in the use of pre-operative chest X-rays.

5.3.4 Anaesthetists

In each of the hospitals a substantial number of anaesthetists attended patients during the 14 months of the study. Because many were junior anaesthetists who worked complex rota systems and were not directly responsible to the same consultant anaesthetist, it was impossible to assimilate the data to show trends in the use of pre-operative chest X-rays by anaesthetist.

In order to assess whether anaesthetists might have had a consistent effect on the use of pre-operative chest X-rays (and perhaps influenced use more than consultant surgeons) six anaesthetists were identified who anaesthetised the patients of two consultant surgeons. Pre-operative chest X-ray rates were then compared between the two consultant surgeons (Table 24).

Four of the consultant anaesthetists showed substantially different rates of pre-operative chest X-ray use between the two consultant surgeons, and only two (consultants 4 and 6) had similar rates of use for each surgeon. Although varying pre-operative chest X-ray rates between surgeons were undoubtedly affected by other factors such as the specialty of the surgeon and age of patients, the results in Table 24 do not suggest that the anaesthetist had a dominant effect on the use of pre-operative chest X-rays. Consequently, it is unlikely that anaesthetists had a dominant effect on changes in the use of pre-operative chest X-rays. However anaesthetists may have had some effect on rates of change.

In summary, these results would suggest that the monthly change in pre-operative chest X-ray rates may have been affected by changeover of house staff. Greater absolute reductions in rates occurred with high initial levels of use including those manifest in older patients.

Table 20

Change in pre-operative chest X-ray rates for elective operations by initial rate in each hospital

Change in pre-operative chest X-rays per 100 elective operations

Initial rate (Pre-op CXRs per 100 ops)	Hospital A		Hospital B		Hospital C		Hospital D	
40+	-32.9	-70%	-25.4	-49%	-16.6	-36%	-	-
20-39	-24.5	-79%	-13.0	-49%	-7.3	-28%	-12.1	-44%
0-19	-6.5	-51%	-5.0	-54%	-3.2	-22%	-8.2	-45%

NB Change in pre-op chest X-ray rates were calculated between periods of greatest change in each hospital:

	Initial rates		Final rates
A :	Baseline + Months 1-3	:	Months 7-9
B :	Baseline + Months 1-5	:	Months 9-12
C :	Baseline + Months 1	:	Months 2-6
D :	Baseline + Months 1-4	:	Months 5-7

Table 21

Pre-operative chest X-ray rates for elective operations in each hospital by age of patients

Pre-operation chest X-rays per 100 elective operations

Hospital: Age (years)	A	B	C	D
0-14	12.0	5.5	7.4	0.0
15-24	8.3	3.3	4.4	5.9
25-44	16.3	13.6	13.4	9.5
45-64	38.0	44.8	31.9	34.0
65-74	45.3	53.5	50.3	46.4
75-84	44.0	56.8	53.3	45.9
85+	47.1	68.0	31.2	61.1

NB Pre-operative chest X-ray rates are for initial periods as shown in Table 20.

Table 22

Change in pre-operative chest X-ray rates for elective operations by age of patients in each hospital

change in pre-operative chest X-rays per 100 elective operations

Age (years)	Hospital A	Hospital B	Hospital C	Hospital D
0-14	-63%	-8%	-24%	0%
15-24	-66%	-39%*	+14%*	-76%*
25-44	-79%	50%	-34%*	-24%*
45-64	-64%	-55%	-34%	-46%
65-74	-73%	-37%	-29%	-48%
75-84	-69%	-19%	-16%*	-47%
85+	-70%*	-42%*	+38%*	-73%

* Change not significant at $p \geqslant 0.05$.

NB Changes in pre-operative chest X-ray rates were calculated between periods shown in Table 20.

Table 23

Change in pre-operative chest X-ray rates for elective operations during change over of house staff in each hospital

change in pre-operative chest X-rays per 100 elective operations

Hospital	July-August	General Trend June-September	January-February	General Trend January-April
A	+29%	0	+62%	+
B	+67%	0	-17%*	-
C	n.a.	-	+44%	0
D	+17%*	0	-27%	-

* Change not significant at $p \geqslant 0.05$

n.a. : data not available

Table 24

Pre-operative chest X-ray rates for elective operations for anaesthetists working with more than one consultant surgeon

Pre-operative chest X-rays per 100 elective operations

Consultant Anaesthetist	1st consultant surgeon	2nd consultant surgeon
1	15.3	52.9
2	10.3	0.8
3	64.7	27.7
4	45.8	42.2
5	23.5	7.1
6	12.5	18.7

NB Pre-operative chest X-ray rates are for initial periods as shown in Table 20.

5.4 ADHERENCE TO GUIDELINES

In each of the five study hospitals, data on the indications for pre-operative chest X-rays were abstracted from the medical records of a sample of patients having pre-operative chest X-rays during the fourth intervention month. Overall, 39% of patients had possible metastases, 38% had chronic cardio-respiratory disease and no chest X-ray within the previous year, and 17% had acute respiratory symptoms (Table 25). Some patients had more than one indication. No patient had the indication of "recent immigrant who had not had a chest X-ray within the previous year". Seventy five per cent of patients had indications for pre-operative chest X-rays as listed in the guidelines; conversely 25% had no indications. Among those patients with no indications, 28% smoked cigarettes (according to the medical record), but this smoking rate was no higher than for patients who had indications ($p > 0.05$).

The main variation found between the hospitals was that in hospital D a higher proportion of patients had acute respiratory symptoms than in the other hospitals ($p < 0.001$). This higher level in hospital D may however have been due to a different research assistant collecting the data than in the other hospital. This research assistant had assigned patients to the indication of "acute respiratory symptoms" even if there were other indications such as chronic respiratory disease accounting for the acute respiratory symptoms. In the other hospitals acute respiratory symptoms were only designated as present if there were no other indications which might cause acute respiratory symptoms.

Clinical indications were also examined according to specialty (Table 26). Seventy-three per cent of patients in ophthalmology had no indications for a pre-operative chest X-ray which was much higher than in general surgery, urology and ENT surgery ($p < 0.001$). Among these latter specialties, there was no substantial differences in the proportion of patients with various indications except that a greater number of ENT patients had chronic cardio-respiratory disease and no previous chest X-ray ($p < 0.01$).

The proportion of patients having indications for pre-operative chest X-rays increased slightly with age up to those age 75 years or more (correlation co-efficient 0.99, $p < 0.01$) (Table 27). In those aged less than 25 years, 62% had indications in contrast to 79% in those aged 65-74 years. This increasing trend with age was accounted for partly by an increase the proportion of patients with "possible metastases". "Chronic cardio-respiratory disease and no previous chest X-ray within the previous year" occurred in 46% of patients under 25 years of age. This was due mainly to patients with a history of asthma or congenital cardiac abnormalities. These variations in adherence according to age were similar for both males and females.

Clinical adherence to the guidelines was also examined by reviewing the pre-operative chest X-ray request forms in hospital C on which house officers had ticked indications for requesting pre-operative chest X-rays. Sixty-eight percent of request forms had one or more guideline indications ticked; 6% stated other indications for requesting pre-operative chest X-rays and 26% had no indications (Table 28). The most common indication was "chronic cardio-respiratory disease and no previous chest X-ray" (on 43% of forms). Possible metastases" was ticked on 23% of forms. The proportion of request forms with indications did not increase consistently with age except that only 37% of patients aged less than 25 years had indications in contrast to approximately 70% in other age groups. Only 3% of patients under 25 years of age had "possible metastases" as a clinical indication.

The results of these two approaches to determining adherence to the pre-operative chest X-ray guidelines were dependent upon the completeness and accuracy of recording by house officers. The relatively consistent results found between hospitals and between the two studies would suggest that the results are reasonably valid and that around 75% of patients sampled had indications for a pre-operative chest X-ray.

During the fourth intervention/control month, a total of 2618 elective operations and 535 pre-operative chest X-rays were performed in the study hospitals (20.4 pre-operative chest X-rays per 100 elective operations). Assuming that 75% of the patients having pre-operative chest X-rays had clinical indications, a pre-operative chest X-ray rate of $20.4 \times \frac{75}{100}$ would include only patients with indications.

Thus a rate of 15.3 pre-operative chest X-rays per 100 elective operations would on these grounds be acceptable.

Clinical Indications in Patients having Pre-operative Chest X-rays by Hospital

Percentage of Pre-operative Chest X-ray Patients

Hospital:	A (n = 53)	B (n = 54)	C (n = 52)	D (n = 60)	E (n = 41)	ALL (n = 260)
Indications						
Acute respiratory symptoms	15%	2%	6%	48%	5%	17%
Possible metastases	34%	28%	46%	42%	46%	39%
Chronic cardio-respiratory disease and no previous CXR	40%	35%	42%	32%	46%	38%
Recent immigrant and no previous CXR	0%	0%	0%	0%	0%	0%
ANY GUIDELINE INDICATIONS	70%	59%	83%	87%	76%	75%
NO INDICATIONS	30%	41%	17%	13%	24%	25%

Table 25

Clinical Indications in Patients having Pre-operative Chest X-rays by Specialty

Percentage of pre-operative chest X-ray patients

Specialty:	General Surgery	Urology	ENT Surgery	Ophthalmology	Other	Unknown
	(n = 129)	(n = 29)	(n = 24)	(n = 22)	(n = 27)	(n = 29)
Indications						
Acute respiratory symptoms	19%	28%	17%	5%	11%	10%
Possible metastases	40%	62%	54%	0%	22%	41%
Chronic cardio-respiratory disease and no previous CXR	38%	41%	67%	23%	22%	41%
Recent immigrant and no previous CXR	0%	0%	0%	0%	0%	0%
ANY GUIDELINE INDICATIONS	79%	93%	87%	17%	67%	72%
NO INDICATIONS	21%	7%	13%	73%	33%	28%

Table 26

Table 27

Clinical Indications in Patients having Pre-operative Chest X-rays by Age of Patients

Percentage of Pre-operative Chest X-ray Patients

Age (years):	0-24 (n = 13)	25-44 (n = 24)	45-64 (n = 95)	65-74 (n = 67)	75+ (n = 54)
Indications					
Acute respiratory symptoms	7%	0%	17%	22%	19%
Possible metastases	15%	33%	44%	43%	37%
Chronic cardio-respiratory disease and no previous CXR	46%	38%	36%	39%	41%
Recent immigrant and no previous CXR	0%	0%	0%	0%	0%
ANY GUIDELINE INDICATIONS	62%	67%	76%	79%	74%
NO INDICATIONS	38%	33%	24%	21%	26%

NB 7 patients of unknown age excluded

Table 27

Table 28

Clinical Indications for Pre-operative Chest X-ray Stated on Request Forms in Hospital C by Age of Patients

Age (years):	0-24 (n = 20)	25-44 (n = 47)	45-64 (n = 161)	65-74 (n = 139)	75+ (n = 142)	* ALL AGES (n = 561)
	Percentage of Requests for Pre-operative Chest X-rays					
Indications						
Acute respiratory symptoms	10%	9%	4%	10%	10%	8%
Possible metastases	3%	34%	22%	19%	27%	23%
Chronic cardio-respiratory disease and no previous CXR	23%	34%	45%	49%	44%	43%
Recent immigrant and no previous CXR	7%	0%	1%	0%	1%	1%
ANY GUIDELINE INDICATIONS	37%	70%	67%	71%	74%	68%
OTHER INDICATIONS	13%	13%	6%	2%	5%	6%
NO INDICATIONS	50%	17%	27%	27%	21%	26%

* Includes 22 patients with unknown ages

Table 28

CHAPTER 6.

DISCUSSION

This discussion will focus on (i) constraints with the method of research, (ii) the results of other studies evaluating the strategies employed in this study, and (iii) issues in medical care relevant to the containment of diagnostic services in the NHS. As the results of this study are relevant to both clinicians and administrators concerned with changing the use of clinical resources, the discussion will not be limited to radiological examinations, but will consider the use of other diagnostic tests and resources.

6.1 METHOD OF RESEARCH

6.1.1 Study design

The purpose of this study was to measure the effect of alternative interventions on the clinical practice of doctors working in hospitals. The ideal study design for evaluating the effect of an intervention is a randomised controlled trial; in such a study, doctors would be randomly allocated to receive or not receive one of the interventions. This approach was not feasible in this study for two reasons. Firstly, in randomly allocating doctors within a hospital to alternative interventions, contamination between the groups would occur because doctors receiving one intervention would be inadvertently exposed to other interventions. For example, doctors receiving information feedback on the use of pre-operative chest X-rays might discuss the results with doctors in a control group. Such contamination has been implicated (Grossman, 1983) in one of the few randomised studies of strategies for reducing the use of diagnostic tests (Martin et al, 1980). In that study, there was a significant decline in use of tests by the control group as well as the intervention groups. In a study conducted by the author (unpublished information) of the effect of weekly consultant led seminars on the use of laboratory tests in the general medical wards of one hospital, doctors in the control ward showed a significant reduction in the use of tests, although not to the same extent as doctors in the intervention ward.

The second reason for not choosing a randomised study was that most of the interventions were essentially hospital based. Although the doctors were the target for the intervention, the effect in the hospital as a whole was an important effect of the interventions. If any of the interventions were to prove successful, they would be adopted at the hospital or specialty level rather than by individual doctors. In an ideal study, hospitals would be randomly allocated to receive or not receive an intervention, but such a study would require the participation of many hospitals and would be extremely costly and difficult to administer.

Given these difficulties in carrying out a randomised controlled trial, a comparative study in which each intervention was implemented in one hospital and compared against a control hospital was the design considered to be most feasible. The hospitals were comparable to the extent that they were of similar size and had a range of acute surgical specialties. They were reasonably typical of large acute hospitals in the United Kingdom and in each of the towns they were the principal surgical hospital. There was a minimum of seven surgical consultants in each hospital operating on at least 20 cases per month;

this level of staffing was probably of sufficient size to encompass a typical cross section of surgical consultants. It is unlikely that any hospital had a particularly aberrant group of consultants who, because of atypical opinions and attitudes, might have affected significantly the impact of the intervention. The ease with which the pre-operative chest X-ray guidelines were accepted in these intervention hospitals suggested that the spectrum of opinions on the guidelines within the hospitals was probably similar.

6.1.2 Confounding variables

The radiologists acting as local coordinators in each of the hospitals might have been one of the main confounding variables influencing the success or otherwise of the strategies. The enthusiasm of the local coordinator and his prestige within the institution could conceivably have affected implementation. For example, the response of clinicians to the feedback of information on the use of pre-operative chest X-rays might have depended on their views of the credibility and political power of the radiologist. Although varying enthusiasm of local coordinators may have had differing effects on implementation of the guidelines, in practice this was likely to be minimal. Each local coordinator was either a member of the Royal College of Radiologists' Working Party on the Effective Use of Diagnostic Radiology or had elected to participate in previous research conducted by the Working Party. All had declared an interest in reducing the use of pre-operative chest X-rays in their hospitals.

It would be naive to expect the effect of each strategy to be exactly the same in other hospitals in the NHS as in the hospitals in this study. But given a similar size and type of hospital and level of interest expressed by radiologists, each strategy would probably have an effect similar to that demonstrated.

The inclusion of control hospitals was necessary because of extraneous factors, which might have affected the use of pre-operative chest X-rays. For example, financial limits imposed on health authorities and exhortations from government to use resources efficiently might conceivably have had some effect on utilization. The need for control groups in studies examining the effectiveness of educational interventions in hospitals was demonstrated in a study by Devitt and Arnside (1975). They examined trends in pre-operative cross matching, numbers of biochemistry investigations, post-operative complication rates and lengths of stay in cholecystectomy patients before and after an educational intervention which comprised information feedback on these parameters to clinicians attending grand rounds. All the parameters improved over the period of the study. There was no control group, and it was only by measuring parameters over a two year baseline period that the authors observed that improvement had commenced prior to the intervention. Part of the improvement during the intervention period was probably due to factors other than the intervention. On the other hand improvements, which were not caused by the intervention, would probably have been detected if a control group had been included in the study.

The possible influence of extraneous factors on utilization not only emphasises the need for control groups but also that care should be taken in interpreting the reasons for minor changes in utilization (over and above that of the control groups). In studies such as this, a reduction of say 20% or more below the baseline level (assuming the control levels remain the same) can probably be attributed to the effect of the intervention.

6.1.3 Data collection

In many types of research (such as in the laboratory field), preparations required to implement a project may consume a relatively minor part of the total research effort. But in a study such as this, where an attempt was made to change the established working practices of clinicians in several hospitals, the preparatory work particularly that concerning "public relations" with hospital staff, is substantial. The success of this study required the goodwill of not only radiologists, surgeons and anaesthetists, but also theatre staff, administrators, radiographers and secretarial staff in radiology departments.

Although the interventions were designed to influence clinical practice, they also impinged upon the work of non-medical staff particularly those working in radiology departments. During preliminary visits to hospitals participating in the study, radiographers expressed on more than one occasion their concern that, if the interventions were successful, their workload would be reduced and jobs might be placed at risk. The possible impact of interventions on working practices and the degree of consensus that had to be achieved within the NHS, meant that the introduction of each intervention had to be carefully planned. A sound knowledge was required of the organisational infrastructure within hospitals, particularly the pattern of committees and hierarchical working relationships between categories of staff.

The amount of data collected on an individual patient was not substantial but, because this was a multicentre study and the data was collected for a period of over one year, the process of data collection was not simple to administer. The multiplicity of established data recording systems in the hospitals required a unique collection system to be established in each hospital. Although each of the clerical assistants in the hospitals were given prior training, their level of interest and enthusiasm for the project varied and it was difficult at times to keep the data collection up to date. Also, additional clerical assistants had to be trained if difficulties arose in the collection of data or if a clerical assistant decided not to continue employment. The difficulty in administering the data collection and the complexity of the systems in each hospital should be borne in mind when considering whether such information could be collected on a regular basis in the NHS. In two hospitals, simply collecting figures on the proportion of consultants' elective surgical patients having pre-operative chest X-rays required obtaining data from four separate sources in each hospital.

Despite the complexity of the data collection system and the large number of clerical assistants employed at various times during the study (a total of 14 assistants) the data was reasonably reliable. Errors which were most likely to occur were those due to under-recording. This was checked at the beginning of the study by the data coordinator and at intervals throughout the study, especially if there was a change in employment of clerical staff or a substantial rise or fall in the rate of use of pre-operative chest X-rays.

Although the method of data collection was not exactly the same in each hospital, this was unlikely to account for differences in the recorded use of pre-operative chest X-rays between hospitals (and certainly not for changing trends within a hospital). The only difference in definition of a variable was that for an elective/emergency operation. In three hospitals this data was obtained from the theatre register, an emergency operation being defined as one that was not booked on a theatre list; in two hospitals the data was obtained from admission statistics in which an emergency was defined as an immediate admission which did not occur from a waiting list or was pre-booked. (In one of the hospitals acting as a supplementary control, only total operations were used in the analysis as pre-operative chest X-rays could not be assigned to elective or emergency operations/admissions). However, these differences in assigning category of operation would not be substantial as most elective admissions would have elective operations and most emergency admissions would have emergency operations. In any case, such differences that do exist in categorising electives and emergencies between hospitals is not of great importance as the main purpose of this study is to examine trends within hospitals and to compare trends (and not absolute levels) between hospitals.

6.2 SUCCESS OF STRATEGIES

During the intervention year the use of pre-operative chest X-rays decreased in each of the strategy hospitals. No significant change in utilization occurred in either the control or supplementary control hospitals. The effects of similar interventions on the use of other diagnostic tests, when examined in conjunction with the results of this study, allow some conclusions to be drawn about the success of these strategies in changing the use of diagnostic tests.

In Hospital A (Utilization Review Committee) and Hospital B (information feedback), the interventions took place a few months after the implementation of the strategy because data on utilization had to be collected before the intervention was applied. Utilization during the first four months in these hospitals, when compared with that during the baseline period, gives some indication of the impact of introducing the guidelines to the divisions and to the consultants. Knowledge that their performance was being monitored might also have affected consultants' utilization. The decline in use in both hospitals suggests that introduction of the guidelines and the monitoring process had some effect, but these reductions were relatively small compared to those that took place when he interventions were applied. Obtaining approval of guidelines by divisions and requesting consultants to implement them would appear to be insufficient to create the extent of change which is possible. Furthermore, the response to the introduction of the guidelines varied considerably between consultants whereas there was a more consistent response to the specific interventions applied within each strategy.

6.2.1 Utilization Review Committee

During recent years many hospitals in the NHS have established drug utilization review committees. The Utilization Review Committee in this study was probably one of the first committees established within a hospital in the United Kingdom to perform a regular peer review of the use of a diagnostic test. This innovation might well have been perceived by the clinicians in the hospital as a threat to their clinical freedom. However, the concept of the committee was accepted readily by the divisions; this was due undoubtedly to the political skill and high standing of the local co-ordinator (who was also chairman of the Utilization Review Committee). The opportunity for each division to nominate their representative on the committee was probably another factor which enhanced support. The committee was perceived not as an external body but as an internal review committee performing a form of self audit. It is unlikely that the consultants felt threatened by the committee in that utilization fell only marginally during the first few months when they knew that the committee had been established.

A substantial reduction in utilization did not take place until the committee took positive action by directing that a notice describing the guideline be posted on the walls of each surgical ward. The committee felt sufficiently confident of the support of consultants that they attempted to influence the actions of house officers directly and bypass consultants, who had responsibility for the clinical actions of their junior staff. When a low level of utilization was obtained, the committee did not take further action to sustain this level of use. However, the effect of the notices did not continue at the same level: during the latter months of the intervention period, the pre-operative chest X-ray rate increased, but the level of 10.6 during the final month was still well below the baseline level of 29.9 pre-operative chest X-rays per 100 operations.

In the United States, many hospitals have had experience with utilization review committees. These committees were established during the early 1970s to review the appropriateness of admission and length of stay of hospital inpatients. This programme of 'Utilization Review' was instituted by the Federal Government in an attempt to contain the rapidly increasing costs of medical care. Other reviews, which examined clincial practice in more detail, were developed on an experimental basis. For example, in one "pre-paid health plan" in which patients paid a fixed sum for medical care each year, clinicians were reimbursed for the services which they provided (Buck and White 1974). A process of review under the supervision of a Medical Review Committee was established to monitor the use of certain procedures, including three diagnostic tests (urinalysis, haemoglobin and blood glucose). If utilization was considered inappropriate, clinicians were not reimbursed. This process of review led to a reduction in use of thirteen procedures including the three diagnostic tests.

In a similar peer review system, which was conducted experimentally in New Mexico, a review of the use of injections in primary health care clinics resulted in a decline in utilization by more than 60% (Brook and Williams, 1976). These experiments using utilization review committees differed from the strategy used in this study in that they combined both peer review and a financial or other penalty for non-adherence with good clinical practice as established by the review committee.

A few studies have examined the effect of review committees on the use of diagnostic tests including X-rays. In one primary care programme in New York City a reduction in the use of most diagnostic tests was achieved including a marginal but statistically significant reduction ($p < 0.001$) in the use of chest X-rays from 4.6% to 3.9% of patient attendances (Paris et al, 1980). In another experiment in a

University Hospital in Atlanta, the review committee was very similar to the one participating in this study. The "Medical Care Evaluation Sub-Committee on Cost Containment" was composed of representatives of the medical staff in each department, senior surgical and medical registrars, and three members of the hospital administrative staff. The purpose of the committee was to evaluate patterns of practice and make recommendations on strategies for cost containment to the Medical Staff Executive Committee. These recommendations included a new policy for carrying out chest X-rays on patients admitted to hospital. This policy, which was adopted by the Executive Committee, stated that routine chest X-rays should not be performed on patients under 20 years of age, postero - anterior views should be performed on patients aged 20 to 39 years of age, and postero - anterior and lateral views should be performed on patients 40 years of age or over (Armistead and Hofmann, (1981). There was no indication as to how the policy was implemented but, despite the relatively conservative guidelines adopted, the authors stated that "follow-up studies have indicated that the annual savings to patients amount to approximately $20,000".

Utilization review committees concerned with the use of diagnostic tests have not been widely adopted in the U.S.A. although there is still considerable support for the idea. In a recent review, Griner and Glaser (1982) recommended that "hospitals should develop mechanisms for examining patterns of test use in a systematic way and compare these patterns with appropriate standards, just as infection/control committees monitor patterns of antibiotic use and recommend remedial strategies when indicated". Such initiatives have however been superceded by the introduction of reimbursement to hospitals according to Diagnostic Related Groups (DRGs) (Editorial, Lancet, 1983) in which hospitals are reimbursed fixed amounts according to patients' diagnoses.

The notice describing the guidelines, which was displayed in the surgical wards, had a substantial effect on use. Eisenberg (1977) noted a similar effect in a trial designed to reduce the use of prothrombin time as a screening procedure on patients admitted to a hospital in the United States. Following education of housestaff on appropriate utilization, notices urging discretion in the use of the procedure were posted in the wards in the hospital. At the beginning of the study prothrombin times were performed on 87% of hospital admissions; on displaying the notices in the hospitals use declined during the following six months to 55% of admissions. However, somewhat in keeping with the findings of this study, the low level of use was not sustained and eighteen months later had returned to original levels. In Eisenberg's view, the lower level of utilization could have been maintained if the same or a different stimulus for change was repeated or if the original stimulus had been accompanied by an incentive. He also recommended that senior medical staff in hospitals should be involved in attempts to change the practice of house officers because junior medical staff on hospital rotations often changed positions every few months.

The success of the Utilization Review Committee in implementing change in this study was probably due to several factors. Firstly, the Committee was concerned with the use of only one procedure and there was considerable resolve among the members to reduce utilization and demonstrate the effectiveness of the Committee. Secondly, the Committee was provided with reliable and up-to-date data on current practice, which gave them confidence to respond accordingly. And thirdly, the Committee was not restricted to one intervention but had the flexibility to act according to the prevailing situation in the hospital. If the study was extended over a longer period of time, different measures would probably have to be introduced to sustain a low level of use until such a time that this low level became accepted practice. The enthusiasm of the Committee did not wane during the intervention year. As the commitment required by the members was for only one hour every three months, the committee could probably have functioned for a much longer period.

6.2.2 Information feedback

The feedback of information on use of pre-operative chest X-rays had a consistent effect on utilization during the study period. During the months following the first feedback, use fell from 26.9 X-rays to 19.4 X-rays per 100 elective surgical patients; following the second feedback, use fell to a monthly average of 15.2 X-rays per 100 patients. The lowest level of use attained in the hospital (during the final intervention month) was 13.3 pre-operative chest X-rays per 100 elective surgical patients. After the first feedback 8 out of 10 consultants decreased their use of pre-operative chest X-rays; 6 out of 10 consultants doing likewise after the second feedback.

The information on use of pre-operative chest X-rays did not appear to generate a great deal of interest among the consultant surgeons and anaesthetists. According to the local co-ordinator in the hospital, the use of X-rays was discussed occasionally between consultants and radiologists, but only one consultant wrote to the local co-ordinator asking for further information. This consultant had a relatively high utilization rate and requested further information on the rate according to the age of his patients. Additional statistics provided to the consultant showed that his utilization was high at all ages and that his high rate overall could not be explained by a relatively large number of older patients.

(1) Feedback of statistics on use of tests

Other studies in which statistics on the use of diagnostic tests were provided retrospectively to clinicians have shown the strategy to be of mixed value. In an outpatient clinic in Baltimore, feedback of haematological, biochemical and radiological tests ordered on each patient and the percentage of those tests found to be abnormal produced no effect on the use of tests over a period of one year. Indeed the number of tests per patient increased from 0.7 to 1.5 (Pozen and Gloger, 1976). No commentary was provided on the statistics fed back to the medical staff; this may partly explain why utilization was not reduced. Rhyne and Gehlbach (1979) coupled feedback to residents on their use of thyroid function tests with an educational seminar. This created a reduction in use for a period of three months but with no further feedback, use returned to pre-intervention levels.

In another study aimed at reducing the use of a specific test, Eisenberg et al (1977) informed house officers and consultants about their inappropriate use of the lactate dehydrogenase test (LDH). Overutilization remained at the same level both before and during the intervention period. The authors postulated several reasons for this failure to change practice. Firstly, the clinicians may have been unconcerned about the costs of care and even if they were, the feedback on only one test may have been perceived as inconsequential when considered against the battery of other tests ordered each day. Secondly, the feedback was provided by junior and not senior staff in the hospital; house officers would be more likely to respond to figures of authority in the hospital. Finally, there was no incentive, in the form of a reward or sanction, for the house officers to change their practice and respond to the information on overutilization.

(2) Feedback on costs

In several experimental studies feedback has included costs in addition to numbers of tests requested. In a recent experiment in Brent Health District (Wickings et al, 1983), consultants were provided with monthly reports of their use and costs of diagnostic and other services. The information was also presented intermittently to divisions; this allowed consultants to compare their own firm's performance with those of colleagues. After a period of three years, there was no evidence to suggest that any consultant's pattern of work or expenditure had changed markedly. The authors concluded that to effect change, the provision of information on expenditure must be accompanied by another intervention in the form of education or an incentive.

In a similar study conducted in Australia, feedback at four weekly intervals to consultants on the numbers and costs of tests requested by members of their team produced no effect on levels of use (Grivell et al 1981). The authors suggested that a major reason for the lack of change was that feedback was provided to senior staff when in fact the junior staff ordered tests. The consultants may not have discussed the information with their junior staff. This lack of communication between senior and junior medical staff may also have occurred in this study. In a subsequent study, Grivell et al (1982) included in their feedback of information a league table of named consultants ranked according to costs generated in clinical chemistry. Even this widely publicised information comparing costs between clinicians had no influence on numbers of biochemistry tests ordered per month. As the authors pointed out, high users may well have justified their position by referring to the supposedly special nature of patients under their care.

Some studies including feedback on costs have been successful. In one study conducted in the United States (Schroeder et al, 1973) clinicians were sent information on their costs and use of tests and drugs. Anonymous rankings of physicians according to levels of expenditure were also included. The total costs of laboratory tests requested (including diagnostic X-rays) fell during a three month period by almost 30% (although drug costs increased by 6%). In a general medical unit in a teaching hospital in the United States, regular review once a month by consultants and house officers of the costs and use of services by patients under their care over a period of three and a half years resulted in a smaller increase in the costs of services than those provided by other specialties (Lyle et al, 1979).

Provision of daily information on charges incurred by patients has been shown to produce a substantial change in the use of diagnostic investigations (Henderson et al, 1979). Interns were randomly allocated to receive or not receive daily printouts of patient charges: this resulted in laboratory and radiological charges being over one third lower in the intervention group than in the control group. In another trial, however, conducted in a surgical unit provision on a daily basis of services rendered and costs attributable to patients undergoing cholecystectomy, appendicectomy, breast biopsy, and inguinal hernia repair produced no significant decrease in costs of care for these patients when compared with a control surgical unit (Forrest et al, 1981). The cost information was inserted into the notes each day and it is conceivable that the medical staff may not have looked at the information on a regular basis, thus accounting for the lack of change.

(3) Feedback by audit of medical records

Medical staff can also acquire information on their use of diagnostic tests by reviewing the medical records of patients currently in hospital or recently discharged. (This method of feedback does not involve the provision of summary statistics on utilization). In a trial attempting to modify the test ordering behaviour of medical residents, Martin et al (1980) randomly allocated 24 junior doctors in one hospital into three groups. The first group reviewed at regular intervals the medical records of patients in their wards; the second group received a moderate financial incentive if they reduced the use of tests; the third group acted as a control. During the year of the study the group reviewing medical records showed the greatest decrease in the numbers of laboratory tests ordered (a reduction of 47%). Repeat testing decreased significantly in all three groups but there was no change in the use of radiological tests. The impact on radiological utilization may have been limited because baseline levels of use may already have been low and because relatively few X-rays are repeated in comparison with other laboratory investigations. When the strategies were withdrawn, the record review group continued to use fewer diagnostic tests while the financial incentive and control groups returned towards baseline levels of use. The authors concluded that this form of record review was successful because the process of feedback was accompanied by education of residents. Also, exposure during the record review to the opinions of senior staff may have affected residents'attitudes towards the use of diagnostic tests. That personal contact in a tutorial may have an impact on clinical practice has been suggested by the results of other studies which have shown that tutorials may effect a change in practice, for example, in the use of antibiotics (Klein et al, 1981) and in the management of hypertension (Inui et al, 1976).

However, regular review of medical records in a Birmingham hospital did not produce a greater reduction in numbers of tests ordered by clinicians participating in the review than by those in a control group (Heath, 1981). The author suggested that no substantial change took place because only emergency medical admissions were reviewed, and these patients were unlikely to have had many investigations. Another explanation, however, is that the review of medical records involved the assessment of many aspects of care; hence, the detection of overutilization of diagnostic tests may have been diluted by concentration on other issues.

(4) Feedback on other clinical activities

Feedback on other aspects of clinical care has also had mixed success on, for example, the use of drugs (Brown and Uhl, 1970), the process of care for cholecystectomy patients (Mitchell et al, 1975) and tonsillectomy rates (Wennberg et al 1977). In the United Kingdom one of the most ambitious programmes concerned with feeding back information to consultants was conducted by the Information Services Division of the Scottish Health Service in the form of Scottish Consultant Review of Inpatient Statistics (SCRIPS). Statistics on numbers of discharges, diagnoses, ages, and lengths of stay of patients discharged from wards were provided regularly to consultants. This feedback of information had almost no effect on clinical practice and was subsequently withdrawn. A survey of consultants' opinions of the system (Parkin et al, 1976) showed that 61% thought it was of no value, 44% found it difficult to understand, 46% thought there was too long a delay in the provision of data and 64% were concerned at the extent of errors in the data. However, 82% stated that they would in the future like to receive routine data of some sort. The lack of involvement by consultants in the planning and provision of data was probably a major factor in the failure of SCRIPS. The system was undoubtedly perceived as an external review of practice and was probably counterproductive in motivating behavioural change.

On balance the results of studies examining the effect of feeding back information to clinicians on their use of diagnostic tests would suggest that feedback per se has little effect in changing practice. The success of the strategy is partly dependent upon the method of feedback and in particular whether it is accompanied by some form of comment on performance, educational intervention or incentive. The provision of cost information may also be useful. But whatever technique is used, success is unlikely unless the recipients participate fully in the process of feedback and are motivated to change their practice.

The change in use of preoperative chest X-rays in this study probably occurred because, in addition to providing data on use, each consultant was aware of his or her position in relation to colleagues in the hospital and an ideal target of use was presented. Also by approving the guidelines and their implementation, the consultants had in principle accepted that change could take place. Furthermore, consultants were unlikely to justify high usage on the basis of differences in their patients from those in other specialties because most patients were relatively fit and proceeding to elective surgery.

In the United Kingdom radiologists would appear to be sceptical about the value of information feedback to clinicians. In a survey of diagnostic departments, which included 217 radiology departments, West (1984) found that 15% of radiology departments routinely reported data on utilization to clinicians and of these almost half did so only "occasionally". Doubts about the value of the information and lack of staff for data analysis were the reasons given for not reporting data to clinicians. Interestingly, 14% of radiologists stated that they were reluctant to restrain clinical demand.

6.2.3 New request form

The introduction of the new chest X-ray request form in Hospital C was associated with an almost immediate reduction in use of pre-operative chest X-rays which was maintained throughout the first half of the intervention year. The return of utilization to almost baseline levels co-incided with the change of house staff in the hospital. This pattern of utilization was consistent for most consultants, indicating that the new form had a universal effect on the requesting behaviour of house officers.

The form was constructed in such a way as to remind the house officers of the guidelines and to discourage their use of routine X-rays. It was not possible for house officers to tick "routine" or "no clinical indication", the implication being that these were not acceptable reasons for requesting pre-operative chest X-rays. The new form could be filled in rapidly, taking only a few seconds longer to complete than the original request form. Thus, the reduction in requests was probably not due to a disincentive associated with the completion of a long and tedious request form, but was more likely to be due to changing attitudes to the use of routine pre-operative chest X-rays consequent upon repetitive reminders to house officers whenever the forms were used.

The main difficulty experienced with the new form was it's introduction into the hospital. When chest X-ray requests were submitted on old forms and returned to house officers for resubmission on new forms, considerable resentment was caused. However, once the forms had been in use for about three weeks there was no further difficulty. This initial resentment may have been partly responsible for the relatively high pre-operative chest X-ray rate during the month when the forms were introduced. The first month did however coincide with the changeover of house-staff and the forms were not introduced at the very beginning of the month.

Few attempts have been made to influence requesting of tests by alteration of request forms. In a teaching hospital in the United States, Wong et al (1983) modified the request form for thyroid function panels from a checklist to a problem orientated format in which the sequence of tests necessary to confirm a suspected diagnosis was displayed on the form. Prior to introduction of the new forms, the medical staff were informed of the appropriate use of thyroid function panels at various medical staff meetings and in a laboratory bulletin which was circulated to every clinician in the hospital. The educational initiatives had no effect on the use of thyroid function tests, but when the new forms were introducted, numbers of tri-iodothyromine (T3) and thyroid stimulating hormone (TSH) tests ordered per month fell by an average of 38% and 61% respectively.

The authors of this study (Wong et al, 1983) concluded that reductions in use were not only due to information on the form indicating appropriate requesting but also because previous forms had encouraged over-use by simply requiring house officers to tick a box opposite each test. House officers who were ignorant of the appropriate test to request would simply order all the tests. Indeed, Lundberg (1983) has pointed out that laboratory request forms with lists of tests, which he calls "menus", and rapid reporting of results encourages over-use. On the other hand, blank request forms and delays in reporting decrease use, but tend to lead to administrative confusion. An appropriate balance between these two extremes is required in order to encourage optimum use of tests.

In this study, the new request form acted as a reminder to the clinician on the appropriate use of a test. In recent years other forms of diagnostic reminders have been explored, particularly those based on computerised information systems. For example, Young (1980) has described a house officer information system which is used in a medical unit in Birmingham. Diagnostic problems are entered into the system and the computer responds with a printed sheet of useful information for managing the problem (including the appropriate diagnostic tests to use). Although he reported the effects of the system on the use of investigations by only two house officers, the numbers of unnecessary tests performed on patients cared for while the system was in operation decreased and led to a slight saving in patient laboratory costs. De Dombal et al (1974) in Leeds have developed a similar system to assist in the diagnosis of abdominal pain. Clinicians' diagnostic performance improved markedly when using the computer, but when the computer facility was withdrawn performance returned to the pre-trial level. In the United States, computer reminders of the appropriate use of drugs (MacDonald 1976) and of the follow-up treatment of patients having throat cultures (Barnet et al 1978) have led to improvements in the quality of care.

From the results of this study and others in which diagnostic reminders are incorporated into clinical practice at the point of request, it would appear that such reminders are successful in changing utilization of diagnostic tests. There is a danger, however, of regression to former levels of activity if the reminder is withdrawn (or if there is a change of staff). Also, clinicians may become immune to the reminders. It would be interesting to know if the house staff using the new form in the first half of the intervention year still had relatively low rates of utilization during subsequent appointments.

6.2.4 Concurrent review

In hospital D in which the radiology department attempted to limit routine pre-operative chest X-rays by screening requests, utilization fell overall during the intervention year. However, there was considerable variation in use from month to month which may have occurred because of difficulties in screening every chest X-ray request that reached the department. Utilization fell markedly after the radiology department was fedback information on utilization suggesting that the review process had improved. The lowest level obtained was 13.1 chest X-rays per 100 elective operations during the sixth intervention month. This was a 60% reduction in utilization from baseline levels which suggests that if consistently applied, concurrent review has considerable potential in reducing utilization.

Control of the use of clinical resources after a request has been made, but before the resource is consumed, has been attempted in hospitals in the United States. In one hospital an antimicrobial control programme was instituted in which requests for certain expensive antibiotics generated an automatic consultation by an infectious disease specialist. The recommendations of the specialist were not mandatory, neither was there a restriction on the use of drugs, but this process of concurrent review resulted in a 30% reduction in the costs of antimicrobial drugs prescribed in the hospital (Craig et al, 1978). With the development of hospital formularies in the United Kingdom similar mechanisms for reviewing the prescribing of non formulary drugs have been developed.

Preoperative cross matching has also been subject to the same type of review. Following the development in a New York State hospital of guidelines for cross-matching prior to surgery, a request for cross matching which exceeded the level stated in the guidelines resulted in a physician from the blood bank contacting the clinician who ordered the cross match. This process led to a substantial reduction in preoperative cross matching in the hospital (although the guidelines were not followed strictly). (Mintz et al, 1978). Reports from other hospitals have also indicated that substantial reductions in cross matching can be obtained by this procedure (Nelson, 1976).

Another approach to the control of requests by diagnostic departments has been initiated in the clinical chemistry laboratories in British Columbia (Hardwick et al, 1982). In a system called "structuring complexity" the intensity of laboratory examination is escalated according to a pre-determined protocol. For example, multiple thyroid function tests will only be performed after an initial thyroxin (T4) test has been shown to be abnormal. The laboratory controls this process by determining which test to perform according to the protocols, irrespective of the request made by the clinician. This system of control has resulted in a 15% reduction in thyroid testing and a 12% reduction in laboratory charges.

Thus, concurrent review has the potential to achieve reductions in the use of diagnostic tests and other resources. Success however is dependent upon the acceptability of the review process to clinicians and to the method of review. Ideally, an unnecessary request for a specific test should generate an automatic review and should not be dependent upon the continuous surveillance of busy professional staff in a diagnostic department. For example, criteria might be drawn up so that the receptionist in a department could easily classify requests as "acceptable" or "possibly unacceptable". The latter designation would result in an automatic review of the request by a professional staff member assigned this responsibility.

The results of this study and of other trials examining strategies for change in the use of diagnostic tests suggest that each of the four strategies examined may have an effect in changing practice. Information feedback is probably the least successful unless it is combined with intensive and persistent educational programmes or some form of incentive or sanction. Concurrent review may be extremely successful but only if the method is acceptable, automatic and easily enforced. Also staff in the diagnostic department may have to spend some time in reviewing and discussing requests with clinicans. Redesigning request forms to remind clinicians of the indications for applying tests combined with appropriate education would appear to have the potential to sustain consistent change in practice (at least for several months) with minimal effort on the part of radiologists and other professionals within a hospital. There is however the possibility that forms may not be completed correctly and lose their value as a reminder. (Note for example the lack of information currently provided by clinicians on the "clinical details" sections of current request forms). A Utilization Review Committee would appear to offer the greatest opportunity for changing practice particularly as the committee can respond to changing patterns of use and institute a variety of interventions. However, the Utilization Review Committee per se is not the agent of change but is the authoritative body implementing interventions within the hospital. These interventions might comprise one or more of those evaluated in this study.

One of the greatest difficulties in implementing a change in clinical practice, is to sustain the change. Ideally this study might have continued for considerably longer than one year. No matter what strategy is used, sustaining change requires the long term interest and commitment of individuals within a hospital. Such individuals might comprise the members of a Utilization Review Committee or a consultant radiologist providing feedback on use to clinicians or providing concurrent review in the radiology department. This on-going interest and commitment is unlikely to be sustained unless information on utilization is provided either continuously or intermittently so that the success or otherwise of the strategies are known. Monitoring of utilization is thus a necessary complement to any of the strategies examined in this study.

Choice of a strategy for change need not be limited to one intervention. Indeed, a combination of interventions is likely to be more successful (Eisenberg and Williams, 1981). Griner et al (1979) sustained a reduction in the use of chest X-rays and other tests in a hospital over a seven year period. Several interventions were used including (a) administrative changes (for example, the elimination of an automatic chest X-ray on admission), (b) weekly seminars for residents on the use of tests, (c) weekly distribution to residents of the itemised account sent to one of their patients, (d) education of new house officers on "good" laboratory practices, (e) participation of medical staff in research projects on the optimum use of the laboratory and finally (f) critical review of laboratory tests by consultants during ward rounds. These multiple interventions were successful but they did require a substantial commitment in time and energy to promote a more discriminating use of tests. Such enthusiasm might not be encountered in many hospitals.

6.3 CONTAINING THE USE OF DIAGNOSTIC SERVICES IN THE NHS

The effect of the strategies employed in this study in implementing change in the use of pre-operative chest X-rays, when considered in conjunction with the results of other trials of these strategies, permits some judgements to be made on what strategies might be implemented in the NHS to change the use of radiology and other diagnostic services. But before making recommendations on this mattter, other issues of medical care in the NHS need to be discussed. What are the causes of the high use of diagnostic tests? What is the place of regulatory control, financial incentives and clinical budgeting? How should monitoring be a component part of a strategy for change? How useful are clinical guidelines? What are current medical attitudes and how might they be changed to encourge more discriminating use of diagnostic tests?

6.3.1 Causes of high levels of use

In recent years the results of several surveys of the use of diagnostic tests in hospitals in the NHS suggest that unnecessary investigation is commonplace (Hampton et al, 1975; Sandler, 1979; Stilwell et al, 1980; Roberts, 1984; Sandler 1984). There are several reasons why clinicians tend to over-investigate. In the case of preoperative chest X-rays and many other tests, house officers usually take decisions to order the tests. Often tests are ordered as a matter of habit (Cummins, 1980; Eisenberg & Williams 1981) and the house officer is frequently ignorant about the value of tests requested (Wong, 1983). These habits tend to be passed from one generation of doctors to another, comprising "occupational rituals in patient management" (Bosk,1980).

It is also customary for many diagnostic tests, such as the pre-operative chest X-ray, to be used for routine screening purposes rather than to elicit the cause of symptoms and signs (Editorial, Lancet, 1984). The prevailing attitude is that patients should be investigated widely "just in case" a diagnosis is missed, many house officers feeling the need "to be complete" in their assessment of patients (Hardison, 1979). The fear of uncertainty that an apparently healthy patient proceeding to surgery may have a respiratory condition leads the clinician to carry out a pre-operative chest X-ray. The over-riding reason for this action is reassurance of the clinician while the perceived benefit to the patient becomes a secondary consideration.

In the United States and to a lesser extent in the United Kingdom, the fear that omission of a test might lead to a legal suit on the grounds of medical negligence also contributes to the unnecessary use of tests (Hardison, 1979; Cummins, 1980; Eisenberg and Williams, 1981; Wong, 1983). This is particularly true for the use of skull X-rays in patients with head injuries (Cummins, 1980) but may also be a factor influencing the use of other radiological procedures including preoperative chest X-rays.

House officers often believe that consultants wish them to perform certain tests although the consultants' "wishes" may never have been stated overtly (Hardison, 1979). Informal discussion with houseofficers participating in this study revealed that some attributed their high use of preoperative chest X-rays to the wishes of consultant anaesthetists and surgeons. Not only is there perceived pressure from consultants, but also that "we will get in trouble if we don't" (Hardison, 1979). Indeed, consultants do tend to criticise junior staff for failing to obtain particular tests (Eisenberg and Williams 1981; Wong, 1983). These attitudes may well explain the greater use of diagnostic tests by younger and less experienced clinicians than those who are older and in more senior positions (Childs and Hunter, 1972; Freeborn et al, 1972; Greenland et al, 1979). The situtation persists because consultants do not tend to rebuke their junior staff for performing unnecessary investigations and there is no incentive for the consultant to do so. Consultants may perceive that limiting the use of diagnostic tests is not a clinical responsibility (patients under their care will not benefit) but is a managerial responsibility of more relevance to administrators than doctors (Fowkes and Roberts, 1984). The evidence from this study would support this hypothesis in that consultants approved of the preoperative guidelines but probably did not take steps to advise their junior staff to change their practice. Distribution of letters and guidelines to consultants at the beginning of the intervention period had only a slight effect on utilization. The consultants may have been reluctant to impose on their junior staff a code of practice, which they felt was not entirely "clinical".

6.3.2 Controlling clinical expenditure

The organisational structure and management arrangements within the NHS are currently inadequate to overcome those factors tending to maintain a high use of tests. There is no effective procedure controlling clinical expenditure at its point of commitment. Cogwheel divisions and district management teams enable clinicians to contribute to major planning and policy decisions but these committees have almost no influence on the consumption of resources at the clinical level (Kinston, 1982). This study has shown that simply requesting doctors to exercise clinical restraint in the use of a procedure in the name of economic efficiency and social responsibility is unlikely to be very effective. However, appropriate use may be achieved by clinicians themselves working within an organisational framework that permits freedom of activity within certain well defined and regulated limits (Kinston, 1982).

(1) External and internal regulation

Attempts at external regulation (such as the imposition of rules on the use of tests by the DHSS or district health authorities) would probably be unsuccessful. Not only would the rules be difficult to formulate because of our lack of knowledge of appropriate use, but would be extremely difficult to implement because of resistance by many clinicians to external regulation. Kassirer and Paulker (1978) have argued strongly against the imposition of such regulation in the United States, particularly as the potential costs of regulation would be substantial. Furthermore, rigid regulations determining when diagnostic testing would be permitted could result in sub-optimal care for patients who did not fit into certain diagnostic categories.

Internal regulation, using techniques such as those explored in this study, may not be entirely successful because they require self restraint and a continuing voluntary commitment to controlling the use of tests. The ideal approach might be some form of internal regulation combined with incentives or restrictions agreed in advance by doctors and their employing authorities. Such incentives or restrictions could still allow considerable flexibility in the use of tests. Indeed, over ten years ago, Ashley et al (1972) put forward the idea of a "wide tolerance tariff system" in which the use of each diagnostic test would be permitted up to certain levels of utilization. As Kinston (1982) states, "rationing may be arranged so as to maximise and sharpen the use of clinical judgement. For example, working ------------ within a certain amount of radiography use, leaves much room for discretion for each patient".

Few attempts have been made to restrict the use of diagnostic tests by placing an upper limit on utilization. In a trial in a Veteran's Hospital in the United States (Dixon and Laslo, 1974), house officers were permitted to request only an average of eight clinical chemistry and haematological tests per patient per day (which was less than the current level of use in the hospital). The upper limit could however be exceeded in an emergency. The authors did not state how the limits were imposed but the restrictions did cause a reduction in the use of laboratory tests by 25%. Repeat tests were virtually eliminated. The percentage of tests considered by the authors to have some influence on patient management increased substantially, which suggested that the reduction in testing was accompanied by a more discriminating approach to utilization. It should be noted that such limitations on the use of diagnostic tests required an adequate system of monitoring and control in the diagnostic departments and was dependent upon good relationships between clinical and laboratory staff.

(2) <u>Financial incentives</u>

Health care systems structured on a fee for service basis provide incentives for clinicians to administer more services (Schroeder and Showstack, 1978): the higher the use of diagnostic tests, the greater the profit. Moloney and Rogers (1979) have suggested that, in the United States, methods of reimbursing doctors for services rendered should be changed so as to neutralise the financial incentives to use diagnostic tests. Rates of payment for tests, for example, might be more closely related to the investment of time required to perform the tests. This strategy would not be possible in the NHS where medical staff are paid salaries which are mostly independent of the level of services provided. A financial reward to reduce use of diagnostic tests would have to take the form of an additional payment made to the clinician. A system of personal financial rewards would however not necessarily have the desired effect on utilization.

In a controlled trial of strategies to reduce the use of diagnostic tests in a hospital in Boston (Martin et al, 1980), one group of house officers were offered a financial reward, the amount being dependent on the extent of reduction in use of diagnostic tests. The financial incentive group did not perform fewer tests (including X-rays) than a control group of house officers. This was not surprising since the maximum financial reward was only $375 and was in the form of gift certificates to be used for the purchase of medical books or journals. The authors reported that the personal financial reward caused some conflict within individuals; because of this and the poor results obtained, they considered such a system of financial rewards to be an inappropriate strategy for reducing the use of diagnostic tests. They did acknowledge, however, that a financial incentive might work under other circumstances. It is unlikely that such a system of financial reward would be acceptable in the NHS. The medical profession and the public might think that such a system would lead to the witholding of necessary investigations.

(3) Clinical budgeting

A more acceptable form of incentive to encourage clinicians to reduce their use of unnecessary investigations is clinical budgeting. This involves senior staff in clinical, diagnostic and other departments working out in some detail the clinical services to be provided in the immediate future and the expenditures required to finance these services. Each head of department is then provided with an appropriate budget and if the agreed service is provided within budget, the department is entitled to some benefit, such as the purchase of new medical equipment (out of all or part of the savings) (Wickings et al, 1983). There is thus an incentive for the clinicians to achieve a more efficient use of resources.

Several experiments in clinical budgeting have been conducted in recent years. One of the first was at the Westmimster Hospital where seven wards were allocated budgets and seven wards acted as controls. The wards with budgets all achieved savings allowing them to finance improvements in their services. Some savings were achieved by a reduction in the use of diagnostic services. For example, bacteriology costs were reduced by up to 55%, mobile X-ray equipment was used less often, chest X-ray utilization fell by 72% in the intensive care unit and by 57% in the coronary care unit, and the cost of immunological investigations was reduced by 67% (Wickings, 1977). Furthermore, the participating clinicians appeared to like the system: the opportunity to spend money saved in one sphere on requirements in another was attractive, and the cooperation and friendliness between members of staff were enhanced (Gibberd, 1982). In a geriatric unit in Cumbria, Chinn et al (1981) also found that clinical budgeting was a considerable boost to the morale of staff.

Some clinicians have however expressed reservations about clinical budgeting. Bartlett et al (1981) calculated that approximately 80% of costs were fixed in a typical neurosurgical unit; this suggested that the opportunities for reducing costs by means of clinical budgeting were minimal. Concern has been expressed that when savings are made, efficient departments may have greater reductions in their budget in the future than less efficient ones (Gibberd 1982). Another criticism of clinical budgeting is that participation requires a considerable commitment of time by consultants. However, in most studies, the time required has been shown to be minimal, accounting for about one hour per month of consultant time (Wickings et al, 1983).

In the NHS currently, the DHSS is funding several experiments in clinical budgeting; the results of these will more clearly delineate the advantages and disadvantages of such a system. However, the evidence to date would suggest that clinical budgeting as a means of providing an incentive for clinicians to be more discriminatory in their use of diagnostic tests (and other resources) is worthy of further development.

(4) Need for monitoring

Whatever strategies are employed to reduce the unnecessary use of diagnostic tests, a reliable information system is required to monitor utilization. Creating a more rational use of resources is a long term commitment and those involved need to know the success of their interventions and where to redeploy their efforts.

The complex data collection process which was necessary in this study to assemble useful information from several hospitals demonstrates the considerable variability in methods of routine data collection and storage in the NHS. Collecting information on the use of a single test (such as a pre-operative chest X-ray) may be an extremely cumbersome process. The Korner Committee (Steering Group on Health Services information, 1981) has made many recommendations for future information requirements in the NHS. The Committee recommended that radiology departments should collect information on (i) numbers of requests for examinations according to six defined groups and (ii) the source of the request (i.e. the consultant team). More detailed information on individual investigations was not considered necessary except in a small sample of departments who currently have computerised information systems.

Monitoring numbers of examinations according to only six defined groups is unlikely to be helpful to clinicians or utilization review committees monitoring the implementation of guidelines for specific investigations. On the other hand, the level of precision obtained in this study may not be required for routine monitoring. For example, simply monitoring numbers of chest X-rays requested by surgical firms may be an adequate measure of preoperative chest X-ray use because in most surgical firms over 90% of chest X-rays requested are pre-operative (Unpublished data from National Study by the Royal College of Radiologists, W P Ennis, 1979). This information could be collected quite easily because X-ray registers in most departments list individual procedures and source of requests. Monitoring would simply require regular aggregation of the data from registers. Such data is routinely entered into a computer in some hospitals (Hartley, 1982); this process is likely to be commonplace within the next few years. Expenditure on improving current recording systems would be worthwhile because, when combined with appropriate strategies to reduce the unnecessary use of tests, considerable overall financial savings might accrue.

(5) Role of clinical guidelines

Guidelines for the use of diagnostic tests have the potential, if correctly applied, to contribute to more effective utilization. Such guidelines may have to be based on incomplete evidence because for many diagnostic tests, particularly common tests such as full blood counts and multi-channel investigations in clinical chemistry, there have been very few studies examining their benefit to patients. However, for most tests, adequate evidence exists to allow clinicians to draw up reasonable guidelines for utilization. As has been demonstrated in Chapter 2 (Literature Review), the evidence would suggest that pre-operative chest X-rays should not be used as routine procedures but there is no evidence indicating which patients would benefit by having pre-operative chest X-rays. Despite this incomplete evidence, few would disagree with the clinical guidelines drawn up by the Royal College of Radiologists Working Party which include a sensible list of clinical situations in which pre-operative chest radiology should be considered. Indeed, the guidelines developed by the Working Party may be somewhat liberal in that in some hospitals in this study a lower level of utilization was achieved than the level in which patients were shown, at least from the medical records, to have clinical indications (15 pre-operative chest X-rays per 100 elective operations).

The format of the guidelines may indeed depend upon the precision of the evidence on which they are based. The Royal College of Radiologists guidelines on preoperative chest X-rays (Appendix I) and skull X-rays (K T Evans et al, 1983) are lists of clinical indications, but guidelines can also be constructed in a more detailed and precise format , for example, as algorithms (branching flow charts) (Editorial, Lancet, 1982). Algorithms in complex clinical situations may be almost unworkable but they have been used successfully where a limited number of clinical decisions have to be made (Grimm et al, 1975, Wirtschafter, 1978).

Guidelines in the form of a simple list of clinical indications for performing a diagnostic test do appear to be successful in creating a change in practice. For example, the Royal College of Radiologists guidelines on the use of skull X-rays in patients with head injuries led to a 50% reduction in use in one accident and emergency department (Fowkes et al, 1984). Similar guidelines used in other departments have also had a substantial effect on the use of skull X-rays (Phillips, 1979, Cummins et al, 1980; Corden, 1981). A protocol for selecting those patients with injured extremities requiring X-rays created a 5% and 17% reduction in the use of upper and lower extremity X-rays respectively (Brand et al, 1982). Finally, in a primary health care clinic in Seattle, guidelines were formulated for the use of chest X-rays in patients having routine health examinations. The guidelines simply indicated that an X-ray should be considered only in high risk groups, namely heavy smokers, patients aged 55 years or more, and certain occupational groups. Implementation of the guidelines resulted in a reduction in the use of chest X-rays by two thirds (Thompson et al, 1983). In many of these studies, the precise format of the guidelines may not be the main stimulus to change, but the more presence of the guidelines provoke more critical appraisal before requesting a test.

In addition to guidelines giving clinical advice on the use of diagnostic procedures they also assist in protecting the legal liability of clinicians. In the case of diagnostic radiology, the law does not define the circumstances under which an X-ray ought to be taken or need not be taken (Bovell, 1976) "Negligence is a failure to do what a reasonable man would have done in the circumstances" (Kloss, 1984). Thus a clinician who does not carry out a test while adhering to guidelines drawn up by an eminent group of medical specialists is unlikely to be deemed liable for any untoward consequences to a patient. In most cases of medical litigation both the employing health authority and the doctor are liable and generally come to an agreement about sharing damages. Clinical guidelines not only assist in protecting the individual doctor but also the employing authority. Health authorities may thus be more willing to encourage a discriminating use of diagnostic tests if clinical guidelines are available.

Although Pilling (1976), in reviewing cases of medical negligence over a 20 year period, did not find one case due to failure to perform an X-ray, patients are now more ready to demand inquiry into clinical judgement or demand litigation; this will undoubtedly encourage more defensive medicine on the part of doctors and lead to an ever increasing use of diagnostic tests (Editorial, Lancet, 1982). Guidelines will have an important part to play in counteracting any such increase in defensive medicine.

6.3.3 Change in medical attitudes

Implementation of guidelines on the use of diagnostic tests could be facilitated by an increase in the social and economic awareness of clinicians. Traditionally the attitude of doctors is that the best should be done for individual patients no matter what the monetary cost. The idea that the consumption of resources by one patient may deprive another patient of benefit is a relatively new concept for many doctors. However, the emphasis of the present UK government on cost efficiency, the publicity given to financial limits imposed upon the NHS, and the impact of financial cutbacks and redistribution of resources within the NHS have brought to the attention of the medical profession (and the public) that there is a limit in the finance available for the provision of medical care.

Any attempt to change the use of resources at the clinical level is perceived by many doctors as a threat to their clinical freedom, that is, to their right to do whatever in their opinion is best for their patients. But as Hampton (1983) points out, clinical freedom "at best.....was a cloak for ignorance and at worst an excuse for quackery" and he suggests that the demise of clinical freedom is upon us "crushed between the rising cost of new forms of investigation and treatment and the financial limits inevitable in an economy that cannot expand indefinitely". This notion of clinical freedom is deeply ingrained within the profession but if resources are to be used more effectively, efficiently and equitably, the medical profession must accept that complete clinical freedom is not compatible with this aim. Doctors require to perceive their clinical actions not only in terms of the benefits to the individual patient but to the population as a whole.

Another change of attitudes that may encourage more cost effective use of diagnostic tests is that more reliance is placed on the history and physical examination than tests as the means of making a diagnosis. During the last 30 years, medicine has advanced primarily as a scientific discipline with the increasing development of sophisticated diagnostic technology; this has led to diagnostic tests being considered as the most reliable and proper way to make diagnoses. Only rarely in hospital practice is a diagnosis made on the basis of a history and physical examination alone. This attitude prevails despite several studies showing that commonly used diagnostic tests do not often contribute to decisions on diagnosis (Hampton et al, 1975; Sandler, 1979). Hampton et al (1975) evaluated the relative importance of the medical history, the physical examination and laboratory investigations in the diagnosis and management of 80 new medical outpatients. Laboratory investigations were considered useful in only seven patients. In a similar study of 630 medical outpatients, Sandler (1979) found that routine haematological and urine tests contribute to less than 1% of diagnoses. Seventy three percent of diagnoses were made on the basis of the history and physical examination and only 23% on the basis of diagnostic tests.

Education at both the undergraduate and postgraduate level has an important part to play in changing attitudes towards a more discriminating use of diagnostic tests. In the United Kingdom very few, if any, medical schools run specific courses on cost effective clinical decision making. In the United States on the other hand, around one third of medical schools reported in 1978/79 that they had special programmes in which health care cost containment was taught to undergraduates and/or junior doctors (Hudson and Braslow, 1979; Russe et al, 1981).

Medical schools with cost containment programmes have instituted a variety of educational techniques such as self-instructional packages on cost effective use of the laboratory and X-ray departments (Clarke, 1981), and student peer reviews of the use of laboratory tests (Garg et al, 1979; Zeleznik and Gonnella, 1979). One course on the cost effective use of diagnostic tests employed several education techniques including seminars, simulated patient care exercises, special case presentations, newsletters and retrospective reviews of the use of diagnostic tests (Williams et al, 1984). Surprisingly, this comprehensive course had no significant effect on students knowledge, attitudes or simulated test ordering behaviour, although most students stated that they thought the programme was useful. Despite the absence of convincing evidence about short term effectiveness, the authors did not discontinue the course because they thought that a cumulative exposure to similar ideas throughout training might have an important effect on the long term attitudes and practices of the students.

Other academics in medical schools have suggested that education in cost containment should be integrated throughout the medical curriculum with emphasis on creating appropriate attitudes rather than knowledge of costs and effectiveness (Lawrence, 1979; Praiss and Gjerde, 1980). Students' attitudes are influenced to a great extent by their observations of the work and attitudes of senior clinicians and academics; it is therefore important that cost effective care is an important goal of the medical school and it's teachers (Williams et al, 1984). Given the growing interest in cost containment in medical care in the United Kingdom, it would not be surprising if some medical schools take more active steps to create clinicians who are more discriminating in their use of diagnostic tests and who are aware of costs and effectiveness.

If a shift in attitudes and practice towards more cost effective use of diagnostic services is to be sustained in the long term, clinicians require to participate in the process of creating change. Management theory suggests that, among professionals who have uncertain tasks requiring extensive problem soving, participation in making policy decisions is the most effective way of changing behaviour (Weisbord & Stoelwinder, 1979). Clinicians require to be involved in the process of change at an early stage including the identification of problems for review, development of guidelines, and planning the strategies of implementation (Eisenberg and Williams, 1981). Developments in medical education to create doctors who are more socially and economically aware may lead to a greater willingness, to participate in schemes to improve the use of diagnostic services.

CHAPTER 7.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The following conclusions are based mainly on the findings of this study considered within the context of other work in this field.

1. The pre-operative chest X-ray guidelines were readily accepted by the divisions and medical executive committees in the hospitals.

2. The strategies were successfully introduced and sustained throughout the intervention year. None had to be withdrawn because of a lack of co-operation by NHS staff.

3. Each strategy had an effect on the use of pre-operative chest X-rays in the respective hospitals. This effect was, with few exceptions, consistent within each hospital for both specialties and consultants.

4. The Utilization Review Committee achieved the lowest level of use as a result of displaying the pre-operative chest X-ray guidelines in surgical wards. Other studies have found utilization review committees to be successful in reducing the use of diagnostic tests. Much of this success may be attributed to the standing of the committee in the hospital and the scope and flexibility of interventions implemented.

5. Information feedback to consultants resulted in a consistent and gradual reduction in use of pre-operative chest X-rays throughout the year. Other studies have had variable success with feedback. Simply providing information on utilization is usually of limited value. Success is more likely if feedback is accompanied by a comment on performance, an educational intervention, or an incentive. Feedback during tutorials or medical record reviews may be more successful than providing statistical returns. In this study, feedback was accompanied by the pre-operative chest X-ray guidelines and a target level of use.

6. The new chest X-ray request form achieved a moderate reduction in use which was not sustained following a change of house staff. The results of other studies suggest that the request form is an appropriate vehicle for reminding clinicians about the use of tests, but that the effect may not persist if the reminder is withdrawn or is not accompanied by appropriate education.

7. Concurrent review of requests by radiology staff achieved a reduction in use; this was enhanced by feedback of data on use to the radiology department. Other studies have shown concurrent review to be successful in changing practice. But the process may be time consuming for staff in the diagnostic department and thus difficult to sustain over long periods of time.

8. Some strategies such as external regulation of the use of diagnostic tests and personal financial rewards have been shown

in other studies to be of limited value. It is doubtful if such strategies would be feasible or acceptable in the NHS.

9. Clinical budgeting has been shown in other studies to have an effect on the use of diagnostic tests. Giving clinicians more responsibility for the use of resources is likely to lead to long term improvements in efficiency. The results of further trials of clinical budgeting are awaited.

10. The data collection system employed in this study was too cumbersome and time consuming to be used for the routine monitoring of pre-operative chest X-rays.

11. Sustaining a reduction in utilization in the long term is difficult and may require a variety of interventions and a continuous incentive such as that offered by clinical budgeting.

12. The use of diagnostic tests, including pre-operative chest X-rays, is affected by clinical habit and medical attitudes to diagnostic testing. A more discriminating attitude to the use of tests is required among the medical profession.

Recommendations

The aim of this study was "to determine the effect of alternative strategies for implementing guidelines on pre-operative chest radiology in order to make recommendations on how the guidelines might be implemented nationally in NHS hospitals".

Given this aim, the following recommendations are made:

1. The guidelines should be distributed widely throughout the NHS. They should at least be circulated to radiologists accompanied by a summary of evidence showing the limited value of pre-operative chest X-rays. Radiologists should also be made aware of the results of this study, in particular that the pre-operative chest X-ray guidelines are acceptable to many clinicians and that utilization can be reduced.

2. Senior radiologists should be encouraged to obtain formal approval of the guidelines by cogwheel divisions and medical executive committees.

3. Given the success of utilization review committees in this and other studies, radiologists might be advised to establish such a committee in their own hospital. The committee should comprise a nominated representative from each of the divisions of surgery, obstetrics and gynaecology, anaesthesia, and radiology.

4. Radiologists should monitor the use of chest X-rays requested by surgical firms. In most departments, data may be obtained easily from the radiology register. Number of chest X-rays requested by a surgical firm is a suitable measure of pre-operative chest X-ray utilization given the difficulties in obtaining more accurate data. Statistics may be presented two or three times a year to the Utilization Review Committee.

5. The Utilization Review Committee might introduce appropriate interventions to change the use of chest X-rays. A combination of one or more of the following interventions might be worthwhile:-

(1) notices displaying guidelines in surgical wards.

(2) feedback on use to firms including copy of guideline and target level of utilization.

(3) concurrent review, especially if a system can be devised in the radiology department to sustain such a review.

(4) education of new house officers (given that utilization tends to increase with a change over of staff).

[A new chest X-ray request form is not recommended because (i) only a moderate reduction was achieved in this study, (ii) sustaining change is difficult, and (iii) the introduction on a permanent basis of a new form for only one test might not be acceptable in many hospitals.]

6. If clinical budgeting is deemed successful in the current trials, radiologists should promote this activity in their districts as long term change in the use of radiolgical investigations may be best achieved by incorporating some of the strategies examined in this study within the framework of budgeting.

7. Cost effective decision making should be given more emphasis in medical undergraduate curriculums so as to encourage a generation of clinicians with a more discriminating approach to the use of diagnostic tests including pre-operative chest X-rays.

8. The Royal College of Radiologists' Working Party on the Effective Use of Diagnostic Radiology should consider the above recommendations and take steps to implement those it considers feasible.

<u>Guideline for pre-operative chest X-ray use among patients admitted for elective non cardiopulmonary surgery</u>

"Routine" pre-operative chest X-ray is no longer justified. However pre-operative chest radiography may be clinically desirable in certain patients in the following categories:

(i) those with acute respiratory symptoms

(ii) those with possible metastases

(iii) those with suspected or established cardio-respiratory disease who have not had a chest radiograph in the previous 12 months.

(iv) recent immigrants from countries where TB is still endemic who have not had a chest radiograph within the previous 12 months.

<u>It should be noted that none of the above categories of request is routine</u> and the reasons for examination should, therefore, always be given in the usual way.

<u>Royal College of Radiologists Working Party on the Effective Use of Diagnostic Radiology</u>

DRAFT LETTER

Dear

REQUESTS FOR PRE-OPERATIVE CHEST X-RAYS

As you may know, the Committee at its meeting on approved Guidelines for the use of pre-operative chest X-rays in this hopsital. I enclose a copy of these Guidelines and you will note that in the absence of certain clinical conditions the use of routine pre-operative chest X-rays is no longer considered to be justified. I should be grateful if you would bring these Guidelines to the attention of your junior staff, as we wish to reduce the unnecessary use of this investigation as soon as possible.

APPENDIX IIb

14th June 1983

Dear

<u>Use of Pre-operative Chest X-rays</u>

The Divisions of Surgery, Gynaecology and Anaesthetics have recently given their approval to the participation of this hospital in a multi-centre study examining ways of reducing the use of pre-operative chest X-rays in hospitals. The use of pre-operative chest X-rays shall be monitored for one year from 1st May, 1983 by a committee comprising a representative of each of the three Divisions, together with Dr   from the Department of Epidemiology, Dr   and myself. The representative of the Division of Obstetrics and Gynaecology is Mr   . The level of use of pre-operative chest X-rays will remain confidential to the monitoring committee although they may inform individual consultants about the level of use by their firm.

I enclose a copy of the Guidelines on the Use of Pre-operative Chest X-rays, which have been approved by the Divisions and I should be grateful if you would bring them to the attention of your junior staff. It is to be hoped that clinicians will feel able to adhere to these guidelines as we are anxious to reduce the use of any unnecessary X-rays.

Yours sincerely

Chairman
Utilisation Review Committee

APPENDIX IIc

15th May 1983

Dear

As you may be aware, research in recent years in the UK and USA have shown that pre-operative chest X-rays are no longer justified as "routine" procedures. The Hospital Medical Executive Committee have approved guidelines on the indications for use of pre-operative chest X-rays and recommended that they be implemented in the hospital. I enclose a copy of the guidelines for your information. In order to enhance the implementation of the guidelines, special chest X-ray request forms will be introduced in the hospital at the end of May. These forms will be used for a trial period of one year and should be completed when a chest X-ray of any type is being completed.

It is hoped that this procedure will lead to a reduction in the unnecessary use of a routine, but costly procedure.

Yours sincerely

Consultant Radiologist

Enc.

Dear

During the last few years, this hospital and other hospitals in the United Kingdom have been involved in studies of the use of pre-operative chest X-rays. The results of these studies indicate that the use of pre-operative chest X-rays as a routine procedure is no longer justified, and as a consequence of this, the Royal College of Radiologists has issued some guidelines on the appropriate use of pre-operative chest X-rays (enclosed).

The King Edward VII's Hospital Fund for London has recently awarded a grant for a multicentre trial to test different methods of implementing the guidelines in hospitals in the United Kingdom. This research is being co-ordinated in the Department of Epidemiology and Community Medicine at the Welsh National School of Medicine. The Hospital has made an important contribution to previous studies and it has been suggested that it would be appropriate for this hospital to be one of the trial hospitals in the proposed study. Participation in the trial would require that the Divisions of Radiology, Surgery, Obstetrics and Gynaecology, and Anaesthetics accept in principle the guidelines on the use of pre-operative chest X-rays. This would be followed by monitoring of the use of pre-operative chest X-rays in the hospital over a period of one year. The monitoring would be carried out by a small internal committee consisting of one representative from each of the Divisions mentioned above. The results of the monitoring would be used solely for the purposes of the research and to inform some firms of their use of pre-operative chest X-rays.

Dr in the Department of Radiology has discussed the research project informally with me and my reaction was that the project, which is designed to reduce waste in the Health Service, should be supported. I should, therefore, be grateful if the Division at its next meeting would consider:-

(i) approving the project in principal;

(ii) approving the guidelines on the use of pre-operative chest X-rays and;

(iii) nominating a Divisional representative to sit on the monitoring committee.

Yours sincerely

Consultant Surgeon

Enc.

APPENDIX IIIa

Utilisation Review Committee Meeting 7th November 1983

HOSPITAL :

PERCENTAGE OF ELECTIVE SURGICAL PATIENTS

HAVING PRE-OPERATIVE CHEST X-RAYS

Consultant	Baseline Jan-Feb 83 May 82 (%)	Aug-Sept 83 (%)	Change
A	0	18	+
B	36	22	-
C	52	22	-
D	24	11	-
E	11	27	+
F	10	29	+
G	44	24	-
H	24	36	+
I	70	34	-
J	34	7	-
K	53	29	-
L	38	14	-
M	27	8	-
N	30	22	-
O	38	26	-
All Consultants	30	21	-

Utilisation Review Committee Meeting 8th March 1984

HOSPITAL:

POCR % USE (ELECTIVES OPERATIONS ONLY) 1983-84

Consultant	baseline	Aug-Sept	Dec-Jan
A	7	18	11
B	20	9	0
C	38	41	0
D	16	13	3
E	48	22	20
F	43	22	3
G	30	10	22
H	31	25	7
I	51	41	14
J	21	26	15
K	8	28	2
L	40	23	0
M	23	10	13
N	25	36	7
O	57	34	10
P	6	10	9
Q	31	7	2
R	3	8	1
S	13	2	4
T	45	29	0
U	38	14	14
V	44	8	0
W	35	33	0
X	38	22	6
Y	27	0	0
Z	42	26	-
All Consultants	30	21	7
no of POCR (elec)	429	251	92
No of elec ops	1420	1157	1254

1st November, 1983.

Dear Mr.

Use of Pre-operative Chest X-rays

Further to my letter of 29th April, 1983 I now have some information on the use of pre-operative chest X-rays in Hospital. The following table shows the proportion of elective surgical patients under your care in May - August, 1983 who had pre-operative chest X-rays.

	% elective surgical patients having pre-operative chest X-ray
Patients under your care	%
Consultant with lowest pre-op chest X-ray rate	1%
Consultant with highest pre-op chest X-ray rate	73%
Average for all consultants	25%

The results of recent research suggest that if the enclosed guidelines were adhered to, the proportion of elective patients having pre-operative chest X-rays would be about 3%.

I should be grateful if you would bring this information to the attention of your staff and encourage them where possible to adhere to the guidelines.

Yours sincerely,

Consultant Radiologist
Local Co-ordinator of Pre-op CXR Survey

IMPORTANT NOTICE

ROUTINE PRE-OPERATIVE CHEST X–RAYS ARE *NOT* JUSTIFIED

Consider only if:-

1. acute respiratory symptoms
2. possible metastases
3. chronic cardio-respiratory disease and no chest x-ray in last year.
4. immigrant from TB endemic country and no chest x-ray in last year.

Chairman, Radiology Review Committee.
November, 1983

APPENDIX Va

X-RAY AND ULTRASONIC REQUEST FORM

Date of Birth

CONSULTANT/G.P. (Block letters please)

Attach sticky label in this space. If not available, enter required information.

SURNAME .... SEX ....
FORENAMES .... WARD LEVEL ....
ADDRESS ....
.... HOSPITAL No. ....

Is patient fit to stand unaided?

Bed Stretcher Chair Walking Portable

Oxygen Req? ....
IV/Drip? ....

EXAMINATION REQUIRED

CLINCIAL DIAGNOSIS

EXAMINATION TO EXCLUDE

CLINICAL FEATURES

Signature (PRINT SURNAME) .... Date ....

Appointment made by ....

Previous X-ray and Ultrasonic Examinations ....

Time of Arrival ....

Time of Departure ....

Radiographer ....

Radiologist ....

Films Taken		
		30/40
35mm	35/43	20/40
100mm	35/35	24/30
105mm	18/24	15/30

Screening Time

Min Ma Kv

2 (21)

ORIGIN OF REQUEST — To be completed by the Clinician (only one box should be crossed)

Out-Patients	01	Level I I.T.U.	10	Level 5 Ward A	17	Level 6 Ward A	23	Level 7 Ward A	29
Accident Service	02	Level I C.C.U.	11	Level 5 Ward B	18	Level 6 Ward B	24	Level 7 Ward B	30
Emerg Admission Unit	03	Level I Admission Unit	12	Level 5 Ward C	19	Level 6 Ward C	25	Level 7 Ward C	31
Radcliffe Infirmary	04	Level 4 Ward B	13	Level 5 Ward D	20	Level 6 Ward D	26	Level 7 Ward D	32
John Radcliffe (Mat)	05	Level 4 Ward C	14	Level 5 Ward E	21	Level 6 Ward E	27	Level 7 Ward E	33
Eye Hospital	06	Level 4 Ward D	15	Level 5 Ward F	22	Level 6 Ward F	28	Level 7 Ward F	34
Cowley Road Hospital	07	Level 4 Ward E	16						
Churchill Hospital	08							General Practitioner	40
J.R. Hospital (Main)	09							Other Hospital	50
								Other Sources	51

The remaining sections to be completed in the X-ray Department

PATIENT SEX (col. 4) — Male 1; Female 2

PATIENT TYPE (col. 5) — Private 1; N.H.S. 2

DATE OF X-RAY — day 6 7, month 8 9, year 10 11 12

CONSULTANT or G.P. 13 14 15

PLACE X-RAY PERFORMED (Col. 16) — X-ray Department 1; Theatre 2; Ward 3; Intensive Unit 4; Domiciliary 5

EVENING or NIGHT 17

WEEKEND 18

DATE OF BIRTH — day 19 20, month 21 22, year 23 24 25

DAYSHEET NUMBER

Put a 1 (one) in the appropriate box if condition applies to the patient.

BLIND	26	CHILD (under 6)	28	MENTAL HANDICAP	30	PHYSICAL HANDICAP	32		
DEAF	27	INTOXICATED	29	MENTAL ILLNESS	31	LANGUAGE DIFFICULTY	33	UNCONSCIOUS (not anaesthetised)	34

DETAILS OF X-RAYS PERFORMED (to be completed by the Radiographer performing the examinations)

HEAD		HEAD (contd.)		CHEST	
Skull cephalometry	001	Occlusal, per film	016	Larynx	031
Skull	002	Teeth (up to 7 films)	017	Laryngography	032
Nasal sinuses (one view)	003	Teeth (over 7 films)	018	Thoracic Inlet or Outlet	033
Nasal sinuses (full series)	004	Panoral; Orthopantomogram	019	Chest (number of films taken)	034
Optic foramina; Orbits	005	Salivary glands	020	Chest, with screening (films taken)	035
Nasal bones; Post nasal space	006	Sialography (per side)	021	Pacemaker insertion	036
Nasal passages, with contrast	007	Dacrocystography	022	Chest, miniature	037
Facial bones (routine)	008	Cerebral Angiography (per side)	023	Diagnostic Pneumothorax	038
Facial Bones (external fixation)	009	Encephalography	024	Ribs	039
Mastoids	010	Ventriculography	025	Bronchography	040
Petrous temporal bones (routine)	011	Pituitary implant	026	Cardiac catheterisation	041
Petrous temporal bones (C views)	012	Sterotactic Procedures	027	Angiocardiography	042
Jaw (one side)	013	Trigeminal inject. under X-ray control	028	Mammography (single or bilateral)	043
Jaw (both sides)	014	Screening (head)	029	Mammary Ductography	044
Temporo-mandibular joint (both)	015	Computerised Axial Tomography	030		

REQUEST FOR CHEST X-RAY (To be completed by the Clinician).

Attach sticky lable in this space. If not available, enter required information.

SURNAME .... SEX ....

FORENAMES .... WARD LEVEL ....

ADDRESS ....

.... HOSPITAL No. ....

DATE OF REQUEST ☐☐ ☐☐ ☐☐

AGE (years) ☐☐

CONSULTANT (...........................) ☐☐

IS THIS A PRE-OPERATIVE CHEST X-RAY ? YES ☐ NO ☐

IF PRE-OPERATIVE CHEST X-RAY, DOSE PATIENT HAVE:

Chronic cardio-respiratory disease and NO CXR within last year.	YES ☐	NO ☐
Recent immigrant from TB endemic country and NO CXR within last year	YES ☐	NO ☐
Possible pulmonary metastases	YES ☐	NO ☐
Acute respiratory symptoms Other (State ....)	YES ☐	NO ☐

APPENDIX Vb

THE DEPARTMENT OF EPIDEMIOLOGY AND COMMUNITY MEDICINE, W.N.S.H.

PROJECT PRE-OPERATIVE CHEST X-RAY ....

NAME	HOSPITAL NO.	OPERATION

HOSPITAL.................. 1 ☐

DATE OF OPERATION ...... 2 ☐☐☐☐☐☐

AGE ___.___

CONS.SURGEON ....

ANAESTHETIST

ELEC/EMER. OP

POCR

3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								

APPENDIX VIa

PRE-OPERATIVE CHEST X-RAY PROJECT

CODES

Age	:	enter 2 digits, in the range 01-99, a digit in each box.
Consultant	:	enter 2 digits, in the range 01-99, a digit in each box.
Anaesthetist	:	enter 2 digits, in the range 01-99, a digit in each bos. After 99, enter A1-A9 B1-B9 and so on for the letters of the alphabet.
Elective	:	Code 1
Emergency	:	Code 2
POCR	:	If the patient had a chest X-ray either on the day of operation or on one of the preceding six days, enter Code 1. If the patient did not have a chest X-ray during this period of time, leave the box blank.

NB Consultant and anaesthetist code numbers to be allocated sequentially to individuals as they are mentioned in the theatre registers.

CONSULTANT & JUNIOR SURGICAL STAFF

OPERATING THEATRE	MONDAY		TUESDAY		WEDNESDAY		THURSDAY		FRIDAY	
	AM	PM	AM	PM	AM	PM	AM	PM	AM	PM
1	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....
2	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....
3	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....
4	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....
5	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....
6	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....
7	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....
8	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO	CONS: .... S/REG/SHO ....

APPENDIX VIc

REF: DEPARTMENT OF EPIDEMIOLOGY AND COMMUNITY MEDICINE

PRE-OPERATIVE CHEST X-RAY PROJECT

RECORDING FORM : ADHERENCE TO POCR GUIDELINES.

HOSPITAL (UHW = 1 SINGLETON = 2 BRI = 3 OXFORD = 4 STOKE = 5) ☐

STUDY NUMBER (4 DIGITS) ☐☐☐☐

SURNAME .... FIRST NAME ....

SEX (MALE = 1 FEMALE = 2) ☐

HOSPITAL NUMBER ☐☐☐☐☐☐

OPERATION ....

DATE OF OPERATION ☐☐☐☐☐☐

AGE (ON ADMISSION) ☐☐

CONSULTANT SURGEON .... ☐☐

MENTION OF THE FOLLOWING IN ADMISSION NOTES (YES = 1 NO = 2)

ACUTE RESPIRATORY SYMPTOMS ☐

POSSIBLE METASTASES ☐

CHRONIC CARDIO-RESPIRATORY DISEASE ☐

RECENT IMMIGRANT ☐

SMOKER ☐

CHEST X-RAY REPORT IN PREVIOUS 12 MONTHS (YES = 1 NO = 2) ☐

Notes for completion of recording form on adherence to the POCR guidelines

A Information to be obtained only from the house officer's admission notes for the admission in question.

1. Acute respiratory symptoms

   e.g. present history of cold, coryza, cough, sputum of short duration.

2. Possible metastases

   e.g. past history or possible diagnosis of cancer, neoplasm.

3. Chronic cardio-respiratory disease

   (i) diagnosis or past history of
   e.g. bronchitis, emphysema, chronic obstructive airways disease, pneumoconiosis

   e.g. ischaemic heart disease (IHD), myocardial infarction (MI), angina, cardiac failure, congenital heart disease.

   or (ii) chronic symptoms
   e.g. cough, sputum, breathlessness, short of breath (SOB), chest pain, angina).

   or (iii) abnormal physical signs in cardio-respiratory system (CVS = cardio vascular system; RS = respiratory system)

   e.g. CVS: pulse irregular, atrial fibrillation, cardiac failure, JVP ↑, oedema, apex beat displaced, cardiac murmurs).

   e.g. RS: resp rate↑ > 20, trachea not central, chest movement irregular, percussion dull, added breath sounds, rhonchi, creps, râles).

4. Recent immigrant

   Immigrant from TB endemic country only if states that entered U.K. within 12 months prior to operation.

5. Smoker

   A person who has smoked any amount within the last 5 years.

B Report available in notes of chest x-ray performed within 12 months prior to operation (excluding current pre-operative chest x-ray).

SOURCES OF DATA

(a) HOSPITAL A: Utilisation Review Committee.

Site	Filing system	Entry into System	Data collected
Theatre	Computer Recording Form	Date	Patient's Name, Hospital Number, Operation, Date of Operation, Age, Consultant Surgeon, Anaesthetist, Elective/Emergency.
↓			
X-ray	Master Card Index	Patient's Name and Hospital Number	Pre-operative Chest X-ray.

(b) HOSPITAL B: Information Feedback to Consultants

Site	Filing System	Entry into System	Data collected
Theatre	Register	Date	Patient's Name, Hospital Number, Address, Operation, Date of Operation, Age, Anaesthetist.
↓			
Admissions Area	Interim Master Patient index ↓ or Main Master Patient index	Patient's Name and Hospital Number	Consultant Surgeon, Elective/Emergency.
↓			
X-ray	Master Card Index	Patient's Name and Address	Pre-operative Chest X-ray.

SOURCES OF DATA (Continued)

(c) HOSPITAL C: New Chest X-ray Request Form.

Site	Filing System	Entry into System	Data Collected
Theatre	Register	Date	Patient's Name, Hospital Number, Operation, Date of Operation, Anaesthetist, Elective/Emergency.
↓			
Medical Records	Patient Administration System : Computer	Patient's Name, hospital number, date of operation via Visual Display Unit	Consultant surgeon.
↓			
X-ray	Master Card Index	Patient's Name, hospital number	Pre-operative chest X-ray.

(d) HOSPITAL D: Concurrent review by radiology department

Site	Filing System	Entry into System	Data Collected
Theatre	Register	Date	Patient's name, hospital number, operation, date of operation, Anaesthetist.
↓			
Admissions Area	Patient Administration System : Computer	Hospital number via Visual Display Unit	Consultant : Date of Admission.
	↓		
↓	Master Patient Index	Date of Admission	Elective/Emergency.
X-ray	File of X-ray request form	Patient's Name Hospital Number	Pre-operative chest X-ray

SOURCES OF DATA (Continued)

(e) HOSPITAL E: Control

Site	Filing System	Entry into System	Data Collected
Theatre ↓	Register	Date	Patient's name, Hospital number, operation, date of operation, age, consultant surgeon (via operating surgeon), anaesthetist, elective/emergency.
X-ray	Master Card Index	Patient's Name and Hospital Number	Pre-operative Chest X-ray.

APPENDIX VIIe

PRE-OPERATIVE CHEST X-RAY PROJECT

DATA COLLECTION PROCESS

HOSPITAL D:

Theatres Nos. 1 - 4

Collect patient's name, hospital number, name of operation, age, consultant where provided and anaesthetist.

X-ray Records Library

Note if patient received a chest x-ray, either on the day of operation or on one of the preceding six days.

Admissions Area

Using the VDU, type in the patient's hospital number. Collect the consultant and the date of admission.

Master Index

Use the date of admission to find out whether the admission was elective, (booked, waiting list) or an emergency.

COSTS OF PRE-OPERATIVE CHEST X-RAY STUDY

	2 year costs
SALARIES*	
Research Headquarters:	
Data Co-ordinator	£18616
Secretary (half time)	£5813
Hospitals:	
Clerical Assistants (hourly paid)	£2284
TRAVEL	
Visits by Research Headquarters Staff to Participating Hospitals	£1800
COMPUTING	£950
OFFICE CONSUMABLES/PRINTING	£1000
UNIVERSITY ADMINISTRATION/OVERHEADS	£3477
TOTAL COST OF STUDY:	£33940

* Salaries of Principal Investigator and Local Co-ordinators not included.

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