Medicines Management Strategies to Improve Antibiotic Prescribing

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Summary

A systematic review was conducted to explicitly identify interventions that alone, or in combination, were effective in improving antibiotic prescribing. The citation search strategy used in the present review provided a database of 365077 studies, of which only twenty-five were included in the final review ("review studies"). Analysis of the interventions used within the review studies indicated that a combination of "guidelines" and "pharmacy" interventions have the greatest potential to improve antibiotic prescribing.

Two types of qualitative research were conducted, semi-structured interviews and the collection of naturally occurring data. Semi-structured interviews were conducted in order to determine NHS managers' perceptions of current policies used to improve antibiotic prescribing within selected Primary Care Trusts and highlighted the importance of pharmacy intervention, formularies or guidelines and improved prescribing analysis (IT based intervention) on improving antibiotic prescribing. This was supported by the collection of naturally occurring data, which was used to provide further insight into interventions used to improve antibiotic prescribing.

The Specialist Antibiotic Pharmacist (HD) produced and implemented an innovative electronic antibiotic prescribing analysis tool (the Antibiotic Database) to analyse and improve antibiotic prescribing in a consistent manner. The key advantage of the Antibiotic Database was the time and money saved on producing visual electronic outputs containing an inaccurate outcome measure or time period for analysis.

The results concluded that an IT based intervention, such as the Antibiotic Database should be used, in addition to the use of antibiotic guidelines and pharmacy intervention, within all sectors of the NHS in order to improve antibiotic prescribing and its analysis.

Keywords: Antibiotics, control, Antibiotic Database, systematic review

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Glossary of terms

The use of uppercase indicates the term was being used in accordance with the definition in the glossary.

Academic Detailing – a process involving face-to-face education of prescribers by trained health care professionals

Actual Cost - is available within the Prescribing Monitoring Documents (PMDs) and can be calculated by subtracting the national average discounts from the NIC and adding add the cost of the allowance for the container from the basic price of the prescription item

Advertising – communication used to inform patients

Analytic induction – aims to identify deterministic laws and the essential character of phenomena, involving an iterative process of defining a problem, formulating and testing an hypothesis, then reformulating the hypothesis until all cases 'fit' the hypothesis

Antibacterial STAR (01)-PUs - can be calculated in terms of the number of items **(**Items per 1000 Antibacterial STAR (01)-PUs) or the net ingredient cost **(**NIC (£) per 1000 Antibacterial STAR (01)-PUs)

Antimicrobial Management Team – a team consisting of a combination of different health care professionals dedicated to improving antibiotic prescribing

Antibiotic Stewardship Program – programs developed to improve antibiotic prescribing

Audit – process of evaluating prescribing

Baseline – the period before an intervention or combination of interventions was implemented

Case studies - focus on any given situation (individual person, a group, a setting, an organisation, etc.)

Compliance - measure used in studies to demonstrate the appropriateness of prescribing (i.e. in accordance with requirements within the intervention)

Computerised Decision Support – computer based information system used to assist improvement in prescribing

Content analysis – both the content and context of documents are analysed

Conversation analysis – focuses on the structure of conversation and classifies interaction in terms of key linguistic systems

Discourse analysis – concerned with the way knowledge is produced within a particular discourse through the use of distinctive language or through the adoption of implicit theories in order to make sense of social action

Education – any intervention used to impart knowledge, skill and judgment

EPOC – Cochrane Collaboration Effective Practice and Organization of Care (EPOC) database

Ethnographic accounts – largely descriptive and detail the way of life of particular individuals, groups or organisations

Feedback - the process of current antibiotic prescribing being regulated by review of previous antibiotic prescribing

Follow-up - the period after an intervention or combinations of interventions were implemented

Formulary – a reference document used by health care professionals to influence antibiotic prescribing

Grounded theory – involves the generation of analytical categories and their dimensions, and the identification of relationships between them

Guidelines – a document used to guide decisions and criteria regarding diagnosis, management, and treatment of infections

Incentive scheme – a formal scheme for inducing prescribers to improve their antibiotic prescribing

Intervention - the period when an intervention or combination of interventions were implemented

Intranet - a private computer network using internet protocol technologies to securely share operational systems within an organisation

Lectures - an oral presentation of information to teach the audience about a particular subject

Life histories – can be analysed as single narratives, as collections of stories around common themes, or quarried to construct an argument based on comparison between different accounts

Meeting GP's - organised events with one or more prescriber in order to influence improvements in antibiotic prescribing

Minor Ailment Scheme – a scheme allowing pharmacies to provide free medication (from a selected list of products) to those patients who could receive free prescriptions

MSDi antibiotics module – computer software produced by the pharmaceutical company Merck Sharp & Dohme Ltd. to extract information regarding antibiotic prescribing from all surgeries within Sandwell PCT to a centralised computer

Narrative analysis – identifies the basic story which is being told, focusing on the way an account or narrative is constructed, the intention of the teller and the nature of the audience as well as the meaning of the story

Net Ingredient Cost – is used in ePACT.net and measures the basic price of a drug listed in the Drug Tariff or the manufacturers' price list

Newsletters – periodic publication containing topics of interest in order to establish frequent and constant communication with the target audience

Nominal group technique – method of decision making for groups of any size who want to make their decision quickly, by vote, with everyone's opinions taken into account

OTC prescription pads – an information sheet presented in the form of a prescription to provide patients with information on how to treat minor ailments without the use of antibiotics

Patient leaflets – a piece of printed information regarding antibiotic prescribing

Pharmacy intervention – the involvement of a pharmacist(s) to improve antibiotic prescribing

Pocket book – a pocket-sized paperback book used to provide guidance on antibiotic prescribing

Policy and evaluation analysis – where analysis is targeted towards providing answers about the contexts for social policies and programmes and the effectiveness of their delivery and impact

Posters – a piece of printed paper designed to be attached to a wall or vertical surface and contain information to teach the audience about a particular subject

Practice based pharmacists – pharmacists employed to work within surgeries in order to influence the prescribing decisions of prescribers

Practice profiling – the process of providing prescribing data to prescribers within any given surgery in order to influence improvements in antibiotic prescribing

Prescribing alerts – the presence of computer software that allows the visual display of warnings associated with the decision to prescribe any given antibiotic

Prescriber events – organised events with more than one prescriber in order to influence improvements in antibiotic prescribing

Prescriber meetings – organised events with one or more prescriber in order to influence improvements in antibiotic prescribing

Prescription numbers - measure used in studies to demonstrate the number of times an antibiotic was prescribed to a patient to treat any given condition

Presentations – the act of presenting information to an audience in order to improve antibiotic prescribing

Public education – the act of presenting information to members of the public in order to improve antibiotic prescribing

QoF – Quality and Outcomes Framework is a voluntary annual reward and incentive programme for all GP surgeries in England, detailing practice achievement results. It is not about performance management but resourcing and then rewarding good practice

Semi-structured interview – the interviewee has an interview guide that serves as a checklist of topics to be covered and a default wording and order for the questions, but the wording and order are often substantially modified based on the flow of the interview, and additional unplanned questions are asked to follow-up on what the interviewee says

STAR (01) – PUs - have been produced for eight leading therapeutic groups, gastrointestinal, cardiovascular, respiratory, central nervous system, infection, endocrine, musculoskeletal and skin.

Structured interviews – has predetermined questions with fixed wording, usually in a pre-set order, The use of a greater number of open-response questions is the only essential difference from an interview-based survey questionnaire

Surveillance – process of monitoring antibiotic prescribing

Unstructured interviews – the interviewer has a general area of interest and concern but lets the conversation develop within this area

Abbreviations for interventions and outcome measures

A = Audit

AD = Academic Detailing

AMT = Antimicrobial Management Team

AP = Antibiotics prescribed

ASP = Antibiotic stewardship program

C =Compliance

CDS = Computerised decision support

CDSS = CDSS

E = Education

EM = Education material

F = Feedback

G = Guidelines

L = Lectures

MB = Mail Brochures

N = Newsletters

OTC = OTC prescription pads

P = Posters

PB = Pocket book

PCE = Patient and clinical educational information

PEM = Patient educational material

PI = Pharmacy intervention

PL = Patient Leaflets

PP = Practice Profiling

PR = Presentations

S = Seminar

SG = Small groups

SM = Staff meetings

T = Training

TSPB = Teaching sessions post baseline

TSPD = Teaching sessions post-declaration

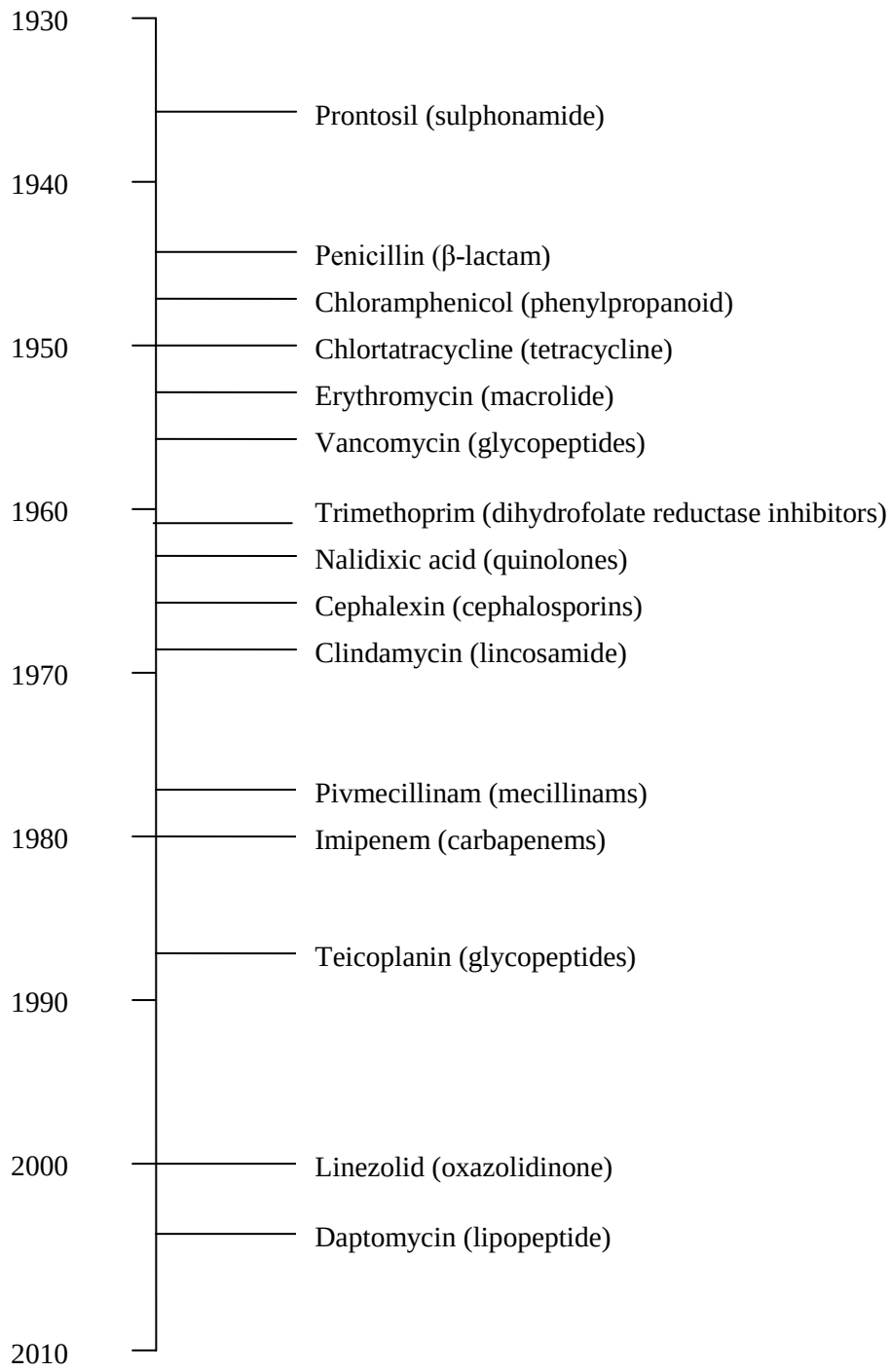
TSPRC = Teaching sessions post-refresher course

1. Introduction

1.1 Background

Excessive and inappropriate use of antibiotics is considered to be the most important reason for the development of bacterial resistance to antibiotics (Bjerrum, 2006). This has become an increasing public health issue with alarming increases in the occurrence of antibiotic resistant bacteria, including the emergence of multi-resistant Gram negative bacteria, methicillin-resistant *Staphylococcus aureus* (MRSA), and vancomycin-resistant enterococci (VRE) (Dranitsaris *et al*., 2001). The development of bacterial resistance has led to strenuous efforts to control prescribing and supply of antibiotics in order to ensure that their value as a therapeutic option is maintained. However, it is currently unclear which interventions produce the greatest impact on antibiotic usage. Figure 1 below shows a timeline of the key antibiotic classes produced.

Figure 1: **A Timeline showing the development of key antibiotic classes**



The concerns over antibiotic resistance are not new and indeed originate with the discovery of these agents. Alexander Fleming voiced concerns about resistance development in the New York Times (New York Times, 1945) stating that the misuse of antibiotics could lead to the selection of resistant strains of bacteria.

Considering that the awareness of antibiotic resistance has been a major concern since the beginning of the antibiotic era, it is relevant to ask why such a major public health issue has developed. The answer is complex and no single causative factor can be established or proven (Extending the Cure Report, 1997). However, a wide range of issues have been identified which appear to be involved with the development of antibiotic resistance.

1.2 Resistance

Antibiotics have been used to save countless lives since the introduction of penicillin by reducing the number of deaths caused by infectious diseases and facilitating the expansion of other medical interventions, such as heart transplants (Amyes, 2001). However the effectiveness of antibiotics is increasingly compromised by the growing levels of bacterial resistance (Department of Health UK, 1998). Bacteria have coped with the increasing encounters of a wide variety of antibiotics, by continually evolving through the process of natural selection to provide a genetic composition which can aid their survival by resistance. The natural selection process is also supported by other variables of antibiotic use that also impact on the selection of resistance, such as dose and duration of treatment used, as well as patients' individual factors. These include the penetration of the antibiotic into various parts of the body, and how the body absorbs, metabolises and excretes the antibiotic, resulting in differing concentrations of antibiotics remaining in various body tissues and organs (Extending the Cure Report, 1997). Therefore the main factor for driving the production of new antibiotics has been to overcome resistance caused to the previous generations of antibiotics.

The Health Protection Agency defined antibiotic resistance as microorganisms that are not susceptible to antibiotics, thus are not killed or inhibited and can continue to grow or multiply in the presence of antibiotics. Resistance can occur in three ways; innately, clinically and acquired (House of Lords, 1998). Innate resistance is the consequence of exposure to antibiotics present in the natural environment which naturally lead to resistance (Extending the Cure Report, 1997). However some organisms are more resistant than others as bacterial species differ in their susceptibility to resistance. This is an example of clinical resistance where the effectiveness of an antibiotic on an organism depends upon many factors including the precise location of the infection, the distribution of the drug in body fluids and the state of the patient's immune system (Amyes, 2001). Acquired resistance can occur by horizontal or mutation transfer of genes. Horizontal gene transfer is the movement of genetic information from one organism to another without being the offspring of that organism. Mutational resistance is exemplified by tuberculosis, where mutation occurs randomly in a small proportion of a particular bacterial population (House of Lords, 2001).

1.2.1 Mutational resistance

Bacterial infections are composed of millions of individual cells called a colony. The bacteria within these colonies contain some heterogeneity, meaning that most of them are sensitive to the antibiotic, some are super-sensitive and some are less sensitive. Therefore the dose of antibiotic has to be high enough to inhibit all of the bacteria. If the dose is insufficient, some of the bacteria will survive, grow and mutate to bacteria containing higher levels of resistance (House of Lords, 2001). Chromosomes provide the bacteria with an opportunity for mutation, either through a single chromosomal mutation, or through a series of mutations. Streptomycin resistance is an example of single chromosome mutation, where alteration in a ribosomal protein or amino acid present in the enzyme dihydropteroate synthesase results in a lower affinity for sulphonamides (Extending the Cure Report, 1997). Penicillin-resistant pneumococci occur due to a series of mutations in penicillin binding proteins. One of the highly publicised resistant strains of recent years has been methicillin-resistant staphylococcus aureus (MRSA), which has spread worldwide. In this case, the mutation enables methicillin to bind to its receptor site, as the cell wall is altered, making it resistant (Health Protection Agency, 2005).

The result of this evolutionary process is the presence of micro-organisms capable of counteracting the effects of specific antibiotics. The higher frequency exposure of bacteria to sub-therapeutic doses leading to sub-therapeutic outcomes increases the likelihood of antibiotic resistance developing through random changes. Therefore antibiotic resistance is more likely to spread to other sites in the same patient, or transfer to other patients through cross-infection. This explains why patients are required to complete a course of antibiotics, to ensure that the patient does not relapse with the resistant variant and to prevent the resistant bacteria moving onto other patients.

1.2.2 The spread of antibiotic resistance

Antibiotic resistance can spread in two ways, through the presence of the resistant genes on conjugative plasmids and the transposition of resistant DNA sequences from one cell to another (House of Lords, 2001). Plasmids are circular DNA fragments carrying additional genes. These genes contain information that can have a beneficial impact on cell survival, such as the ability to adhere to cells, or adapt better to changes in temperature. Although plasmids are unable to survive outside of their host bacterial cell, they may be transferred when conjugation occurs. Some plasmids

are promiscuous and can carry vital resistant information to many bacteria, and thus resistant genes are found in a wide variety of species. For example, TEM-1 is the most common plasmid-mediated beta-lactamase in Gram-negative bacteria found to be widespread in Escherichia coli (Department of Health UK, 1998). However it has also been responsible for penicillin resistance in *Neisseria gonorrhoeae*, and ampicillin resistance in Haemophilus influenzae (Extending the Cure Report, 1997). Transposons are smaller pieces of DNA, compared to plasmids, which are capable of integration into the chromosome or into plasmids. The chromosome provides a more secure position for the gene, however transposons moving from chromosomes to plasmids allow genes to be disseminated more rapidly, as transfer of information is slowed down by the process of bacteria dividing. Movement of resistant genes can occur via bacteriophages when they attach to a bacterial cell and transfer their DNA.

1.3 Economic impact of resistance

There have been many estimates calculated for the cost of overcoming antibiotic resistance, however it is very difficult to estimate the dose-response relationship between antimicrobial use and resistance because of the lack of time-series data to relate the two factors (Extending the Cure Report, 1997). Also there are many other factors which can impose direct or indirect costs onto the burden of treating antibiotic resistance, such as time lost at work or repeated stays at hospitals. A key factor in the cost of treating antibiotics resistance is the cost of the newer, more expensive antibiotics, which are used even if older antibiotics retain considerable effectiveness, owing to the risk of treatment failure. The new antibiotics also incur a higher cost as pharmaceutical companies obtain a patent for their production, thus increasing the cost of drugs during the patent period. Sometimes a combination of antibiotics, or sequential use of antibiotics are required to treat infections which can also increase the cost significantly.

1.4 The use of antibiotics in animals

The use of antibiotics as growth promoters, and as compensation for poor husbandry practices in food producing animals has resulted in the spread of antibiotic resistance through the food chain to humans. Antimicrobial use originated in livestock in the 1940s when chlortetracycline fermentation waste was used to enhance the growth of poultry and pigs (House of Lords, 1997-1998). Since then, antibiotics have been used as growth promoters to improve the growth rate and efficiency of feeding livestock, although their mode of action is not fully known. Growth promoters are used at low concentrations and can lead to increase daily growth and food conversion by 3-11 percent (House of Lords, 1997-1998), depending on the species. This could make the difference between profit or loss for livestock producers. Growth promoters are also seen as an option for livestock therapy as they can be bought direct from manufacturers without the need for prescription and thus further reduce costs. Poor husbandry practices have resulted from the mass oral administration of antibiotics to all livestock to reduce the spread of infection, therefore increasing the likelihood of eventual antibiotic resistance. Prophylactic antibiotic use is practical when treating predictable diseases or the outbreak of disease in livestock and is supplied as mass medication ("metaphylaxis") through medicated feed or water.

The issue of resistance in animals may become an issue of resistance in humans when agents reserved for animals are discovered to have clinical applications in humans. A Committee on the Use of Antibiotics in Animal Husbandry and Veterinary Medicine (the Swann Committee) was appointed in 1969 and produced legislation to ban the use of human therapeutic antibiotics as growth promoters for animals. However no restriction was placed on therapeutic or prophylactic antibiotic use. In 1992, the Veterinary Products Committee "discouraged" the use of prophylactic treatment on the basis of recommendations made by the Expert Group on Animal Feeding stuffs.

1.5 Controlling antibiotic use

There are a variety of professions worldwide who are able to prescribe antibiotics. Conventionally, in the UK medical practitioners have been the most prominent prescribers, however dentists, veterinary practitioners, nurses, and other independent and supplementary prescribers also frequently issue prescriptions for antibiotics (House of Lords, 2001). The term "Prescribers" will be subsequently used in this thesis to define any person who can prescribe antibiotics to a patient or animal. The factors that influence a prescriber's decision to provide antibiotics are difficult to assess, as each prescriber is likely to perceive the need for antibiotic therapy differently. However, prescribing decisions will be generally based on the practitioner's views and practice habits that are supported by numerous influences in their local environment, which include administrative, educational, economic, personal, patient, and community based factors (Extending the Cure Report, 1997).

The most effective way of slowing the spread of resistance is to reduce selection by stopping the use of antibiotics when they provide no medical benefit, however there are several reasons why antibiotics are prescribed unnecessarily. Firstly, if the prescriber is unsure of the medical diagnosis a patient presents with then they are more likely to use an antibiotic. Secondly, antibiotics are most likely to benefit a patient when started early in treatment. Thirdly, patients can demand antibiotics and thus influence the decision to prescribe antibiotics (Amyes, 2001). Another way to reduce the spread of resistance is to use narrow-spectrum antibiotics rather than the broad spectrum antibiotics. However as mentioned before, if prescribers are unsure of a diagnosis they are more likely to not only prescribe antibiotics but also prescribe broad-spectrum antibiotics as they are more likely to work against an infection with unidentified bacteria. The disadvantage of using broad-spectrum antibiotics is that they are also more likely to select for resistance in several bacterial species simultaneously (Amyes, 2001).

Rapid diagnostic testing could be used to facilitate the shift in antibiotic use from broad- to narrow-spectrum antibiotics, even in cases where broad spectrum antibiotics have been initially prescribed. However, many antibiotics that cause infections may not be easily detected with a rapid diagnostic test as they are not easily cultured and the tests that are available can take up to three days to provide results (Extending the Cure Report, 1997). This asserts more pressure on prescribers to prescribe antibiotics earlier for those patients that are perceived to require treatment. Rapid diagnostic tests could be improved with new technology, but there are no guarantees that the results will be one hundred percent accurate nor will their production be cheap.

1.6 Demographics

Antibiotic resistance is an international issue, however, the potential factors that appear to influence the patterns of development of resistance vary widely between different countries. Antibiotic use can be measured in terms of defined daily dose per 1000 population per year. Based on the use of this indicator the general antibiotic prescribing rate in an international comparison was highest in France and lowest in the Netherlands (Extending the Cure Report, 1997). The organism of great global concern is methicillin-resistant *Staphylococcus aureus* (MRSA) with the highest current incidences occurring in Romania. The USA and UK have the seventh and eleventh highest incidences of MRSA respectively (Extending the Cure Report, 1997). Countries with high antibiotic prescribing rates do not necessarily have high levels of antibiotic resistance when compared to other nations. For example Portugal has a higher antibiotic prescribing rate in terms of defined daily doses per 1000 population per year compared to the USA. However, the incidence of MRSA is actually higher in the USA when compared to Portugal. This indicates that other causal factors are involved (Extending the Cure Report, 1997).

1.6.1 Antibiotic resistance in the developing world

Resistance in the developing world results from the combination of many factors resulting in a real global threat of antibiotics resistance, much of which appears to be due to inappropriate and/or over prescribing of antibiotics and a lack of routine microbiological sensitivity testing and surveillance (Awad *et al.*, 2006). Infectious diseases in the developing world are often considered as overwhelming pathogens owing to the greater impact of diseases such as AIDS and tuberculosis in comparison to the developed world. Moreover poverty stricken areas have been associated with the increased spread of resistance owing to the poorer living conditions, prevalence of disease and closer proximity of inhabitants. Therefore more importance is placed on antibiotics to treat all illnesses and their greater availability can lead to increased resistance (Extending the Cure Report, 1997).

Antibiotics are readily available to buy without a prescription in developing countries, with the cost being equivalent to that seen in industrialised countries. Therefore the cost of antibiotics determines the length of treatment a patient receives, with many patients unable to afford the full course of treatment. Another issue with over-the-counter sale of antibiotics is the lack of involvement of qualified health professionals in diagnosing the illness and providing the correct antibiotics (Extending the Cure Report, 1997).

1.7 Secondary Care

Antibiotic resistance is of particular concern in hospitals as increased morbidity can lead to an increased length of stay. MRSA is an example of a Gram positive infection, which became an important threat to community health in the late 1990s as it was isolated in patients without recent hospital exposure or predisposing factors. However, the situation has been worsened further by the difficulty in controlling Gram negative pathogens such as *Escherichia coli*, *Acinetobacter baumannii*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa.* Currently there are few antibiotics available to treat infections caused by Gram negative pathogens. As resistance to antibiotics develops, treatment options will continue to narrow (Coia, 2006).

1.8 Primary Care

There is widespread and inappropriate use of antibiotics for viral illnesses in Primary Care, which has contributed to the emergence of bacterial resistance (Department of Health UK, 1998). Eighty percent of antibiotic prescribing in the UK occurs in Primary Care, principally in the oral form, with approximately half of these prescriptions being used to treat respiratory tract infections (Department of Health UK, 1998). Many of these RTIs are likely to be of viral origin and thus antibiotics are unlikely to offer benefit (Department of Health UK, 1998). Infections account for forty percent of consultations in Primary Care (House of Lords, 2002-2003) so to minimise inappropriate antibiotic use (for example in treating viral illnesses) greater emphasis is required in improving communication between patients and doctors.

1.9 Patients

Patients benefit from using antibiotics because they can reduce their recovery time and also help them avoid health complications. However, these positive outcomes must be balanced against problems associated with antibiotic use such as possible patient allergy to antibiotics, associated side effects and the development of resistance. Increasing resistance inevitably requires the continued development of new antibiotics to treat infections, which requires involvement of the pharmaceutical industry.

1.10 Pharmaceutical companies

The pharmaceutical industry has played a vital role in the progressive development of antibiotic agents to counter the development of antibiotic resistance. However, the cycle of developing new antibiotics in order to counter developing resistance inadvertently exacerbates the underlying problem: new antibiotics are often developed to overcome the outcomes of injudicious use of existing treatments. The pressures upon pharmaceutical companies to maintain an economic return from research and development has rendered antibiotic research unfavourable compared to other areas of therapeutics that involve lifelong therapy. In 2001, Eli Lilly and Bristol-Myers Squibb ceased to develop new antimicrobial drugs, and it would appear that many more companies have followed this approach, since the average numbers of new antibiotics reaching the market have dropped from three per year to one since 2003 (FierceBiotech Newsletter, 2007).

There is currently research being conducted by Swiss scientists into the development of a new class of antibiotics, with phase one of clinical trials started in summer of 2010. It is hoped that the new antibiotics produced will be used to treat patients infected with highly resistant forms of bacteria, such as *Pseudomonas aeruginosa and Escherichia coli (*Swiss Info, 2010).

1.11 The control of antibiotics within the UK

International and national guidance concerning the cost-effective use of antibiotics places a great emphasis on the use of a variety of interventions on prescribers and the public (Keuleyan and Gould, 2001). This has been exemplified in England by the guidance produced by the House of Lords Committee on Science and Technology published a report (House of Lords, 1998). The report included guidance on the prudent use of antibiotics in humans as well as animals. Of the many suggestions made, the key changes included the need to:

- Produce formularies/guidelines with the involvement of prescribers, including junior staff at all hospitals.
- Improve the process by which junior doctors prescribe antibiotics.
- Improve the speed of susceptibility testing as most results take roughly forty-eight hours to obtain, in which time doctors may prescribe inappropriately.
- Improve prescriber feedback by pharmacists and senior nurses.
- Modify antibiotic licensing to allow some antibiotics to be used in hospitals only, therefore ensuring they cannot be unnecessarily used by General Practitioners.

This resulted in a report published by the Department of Health (House of Lords, 1998) for antibiotic prescribing within Primary and Secondary Care. These included: recommendations for the production of local guidance in accordance with the British National Formulary (BNF) and the development of the National Institute for Clinical Excellence (NICE) guidance on appropriate antibiotic prescribing. To make these changes work more efficiently, there was also a huge drive to integrate these changes in tandem with computerised decision support systems.

In 2001, a follow up progress report (House of Lords, 2001) expressed concern over the time being taken to implement the original recommendations. This led to the publication of a further report in 2003 by the Select Committee on Science and Technology (House of Lords 2002-2003) who suggested improvements to ensure control over infectious diseases. Their recommendations included:

- Improved collaborative relationships across the services.
- Ensuring sufficient well-trained health professionals.
- The development of electronic capture, analysis and dissemination of information about infection across relevant organisations.
- The production of clear evidence-based priorities for, and facilitate development of vaccines and diagnostic tests.
- Funding research to provide an evidence base for improving diagnosis, treatment, prevention and control of infection.

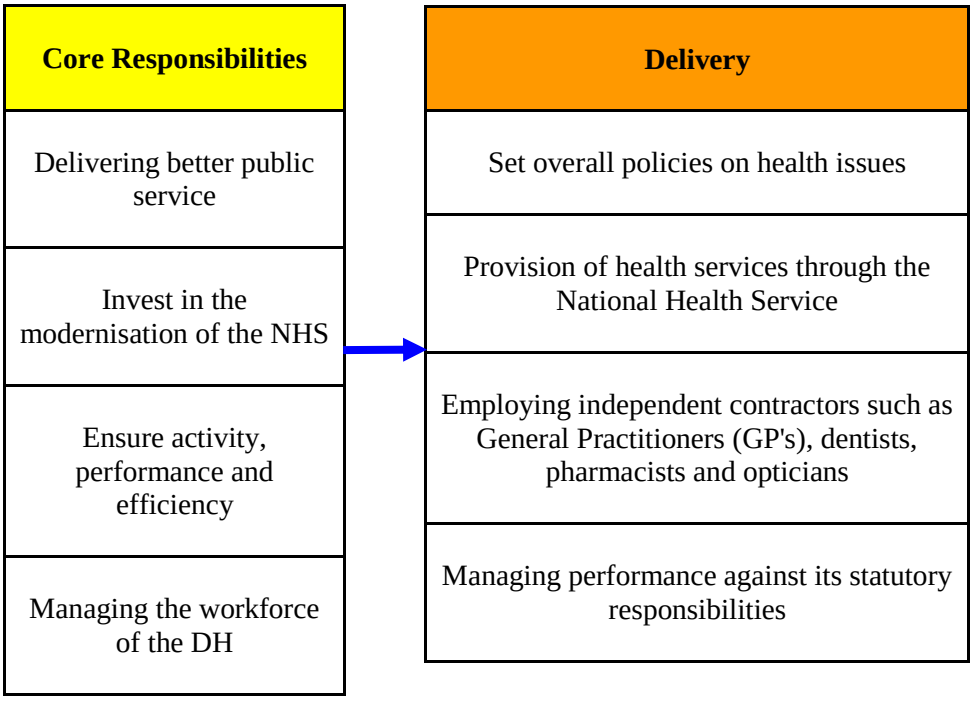
- The secure supplies of vaccines in case of epidemics.
- The provision of clear advice and information to the public.

The current NHS structure below will provide an insight into how these recommendations can be met.

1.11.1 The National Health Service (NHS)

The Department of Health is led by the Secretary of State for Health and was responsible for government policies in England covering social care, the NHS and health. The NHS was launched in 1948 and has been an ever-present service within the UK. Figure 2 provides an overview of the core responsibilities of DH and how it delivered them.

Figure 2: Overview of DH responsibilities and delivery (Department of Health, 2009)



A budget is set to deliver the core responsibilities, which in the financial year of 2004/2005 was over £79 billion public funds. As Parliament is ultimately held accountable for the use of funds, the DH advises ministers on how the objectives can be best achieved, with all reports made fully available to the public. The DH has released many policies and publications regarding antibiotics and their control, especially since the emergence of antibiotics resistance as a worldwide concern in the mid 1990's. The Policy Research Programme (PRP) sector of DH funds Primary and Secondary research to achieve the DH's strategic objectives and Public Service agreements. Figure 3 below demonstrates the impact these publications and policies may have had on antibiotic prescribing since 1994.

In July 2004, a progress report on Healthcare Associated Infections (HCAIs) was released ((National Audit Office, 2004) and concluded that the implementation of the Select Committee on Science and Technology of the House of Lords recommendations was patchy, owing to the lack of data provided on prescribing, the limited progress in implementing national mandatory surveillance programme for the NHS and the lack of evidence for the impact of intervention strategies implemented.

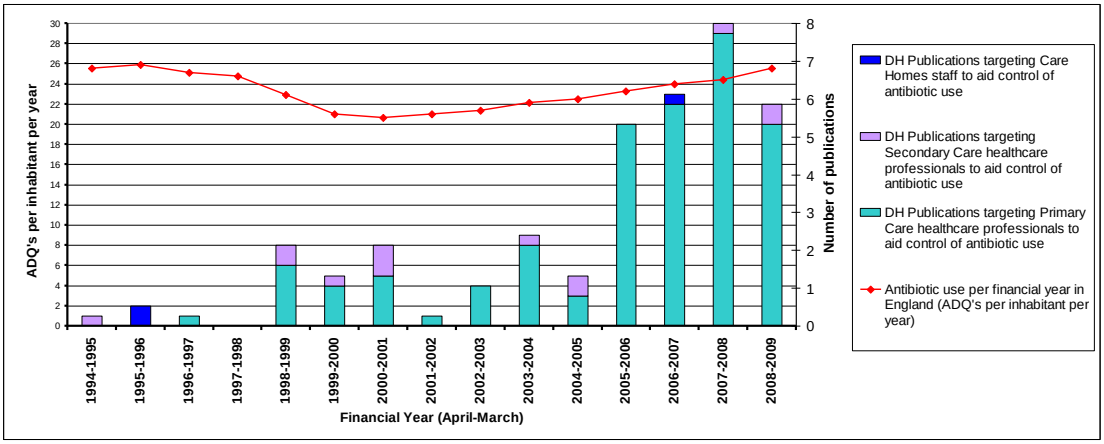
In 2006, the Department of Health produced a code of practice for the prevention and control of Healthcare Associated Infections (the Code). The purpose of this Code is to aid NHS bodies to plan and implement strategies to control Healthcare Associated Infections. The document outlines a number of criteria for NHS managers to ensure patient care is conducted in a clean environment, where the risk of HCAIs is kept as low as possible. However each NHS body is expected to have

systems in place in order to apply sufficient evidence of compliance with the Code. If the Code criteria are not met, the Healthcare Commission are provided authority to issue an Improvement Notice or place the body under "special measures". With regards to antibiotic prescribing, this Code details the need for antimicrobial prescribing policies and the production of local guidelines, containing drug, regimen and duration of antibiotics which are harmonised with that provided in the British National Formulary (BNF). The need for procedures to ensure prudent antibiotic prescribing is also stated.

The Code was revised in 2008, and again in December 2009 to reflect the changes within healthcare regulation since the establishment of the Care Quality Commission (CQC) in 2009. The aim of the CQC is to independently regulate health and social care in England, with the provision of increased powers to enforce compliance to the Code. The revisions to the Code have also increased the detail within the criteria set for antibiotic prescribing. Local prescribing guidelines are now not only required to be harmonised with the BNF, but also observe local Primary and Secondary Care guidance. Secondly the need criterion for prudent antibiotic prescribing is now the responsibility of the Antimicrobial Management Team present within Secondary Care and includes the need for antimicrobial stewardship, with an on-going programme of audit, revision and update.

The DH set the objective of reducing the prescribing of antibiotics within their Health Protection policies, resulting in the production of 139 policies and publications released from the DH since 1994 targeting: Primary Care, Secondary Care, care homes and the public.

Figure 3: Timeline of antibiotics prescribing and publications released within the United Kingdom



All policies and publications released by the DH were searched using the Department of Health website. "Antibiotics" and "Antimicrobials" were used as the search terms to retrieve all relevant policies and publications. Figure 3 shows that 139 policies and publications have been released from the DH since 1994 to target Primary Care, Secondary Care, Care Homes and the public. The number of publications released annually has fluctuated between the years 1997 to 2005, however between 2006 and 2008 there has been an increasing number of publications released, which predominantly target Primary Care. Figure 3 also shows that the level of antibiotic prescribing in 2009 has now increased to similar levels of antibiotic prescribing recorded in 1994, with antibiotics being prescribed the least in the financial year 2000-2001. Therefore the increasing number of publications released by DH appears to have had no direct impact on national antibiotic prescribing, with the increase in publications released since 2004 actually coinciding with a period of increased national antibiotics prescribing. It is therefore important to further analyse the role of SHAs and PCTs as antibiotics prescribing may have been affected by their capabilities in implementing DH publications.

1.11.1.1 Strategic Health Authorities

The SHAs' role is to ensure that the NHS (in their region) runs effectively and that NHS services, staff and organisations are developed to meet the needs of the future without directly providing any services. In order to achieve these targets SHAs are required to work closely with local health organisations to ensure that they operate effectively and in line with government policy, whilst also helping shape national policy based on local evidence and best practice. Regulators such as the Care Quality Commission, Monitor and the Audit Commission, as well as professional bodies such as the General Medical Council also worked in collaboration with SHAs to ensure services work well and were fit for purpose. Originally twenty-eight Strategic Health Authorities were created in 2002 which were reduced to ten in 2006 (National Health System, 2009). The role and objectives of SHAs are summarised in Figure 4 below.

Figure 4: The role and objectives of the SHA (SHA and PCT structure, 2011)

Roles of SHA
Provide the strategic leadership of the NHS in their region
Building the capacity and capability of local health services for the future, creating strong commissioning to ensure clinical excellence for patients
Developing strategic partnerships with other bodies at regional level to ensure more joined up services; combining efforts to reduce health inequalities
Encouraging and supporting local innovation and reform, actively engaging clinicians in driving reform and leading service improvements for patients
Informing and supporting national policy and be accountable to the Department of Health for the delivery of high performing local services
Ensuring that patients and communities get the full benefits of investment and reform as quickly as possible
Ensure that new Primary Care Trusts are fit for purpose so that they can become 'World Class' commissioners and supports Acute (hospital) Trusts to gain foundation status
Ensuring the local NHS operates effectively and delivers improved health and healthcare performance

Objectives
Improve quality and safety of services
Get more people involved in their own healthcare
Deliver more care closer to home
Change health services to the changing needs of patients, public and staff
Ensuring capacity in the local NHS to deliver high quality and safe care
Deliver a better patient experience
Improve people's health
Reduce unfairness in health

1.11.1.2 Primary Care Trusts

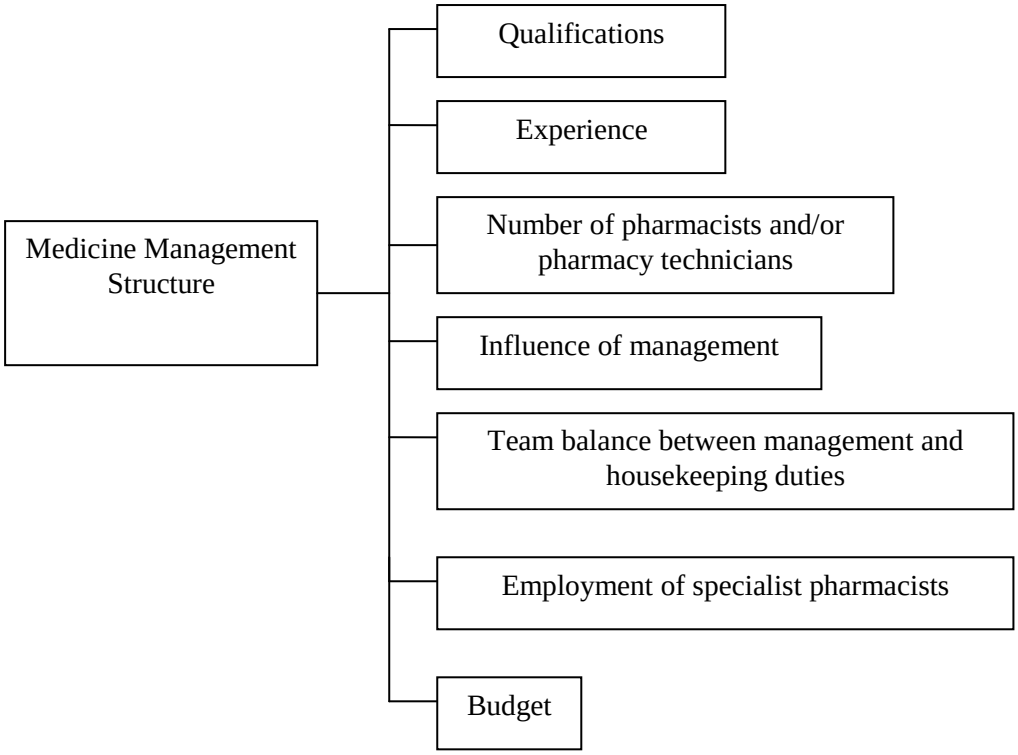
In April 2010 there were 152 PCTs which in total were responsible for working with around 37, 000 general practitioners and approximately 21, 000 NHS dentists (SHA and PCT structure, 2011). PCTs also play a major role in commissioning Secondary Care and providing Community Care Services, which in total covers eighty percent of the NHS budget. Some of the responsibilities and how they are delivered are detailed in Figure 5.

Figure 5: Roles and responsibilities of PCTs (SHA and PCT structure, 2011)

Responsibilities	How are they achieved?
Core standard of safety	Place contracts with doctors, dentists, pharmacists, opticians, community service providers and hospital services
Quality	Provide services in Primary Care and community settings
Dignity	Listen and respond to local needs and priorities
Respect	Bring openness, honesty and a caring approach
Privacy	Work in partnership with other local stakeholders to improve health and the quality of services
Cleanliness	value and recognise the individual contribution made by those who work in our local healthcare community and be committed to supporting and developing them
Increase life expectancy	offer a range of choices of different services wherever possible
Reduce health inequalities	Ensure services are provided as close to people's homes wherever possible whilst ensuring that services that are being delivered are safe and of a high quality
	Promoting creativity and innovation to drive the improvement of services for the benefits of patients and the community
	To be cognisant of the diverse needs and the aspirations of our patients, the community, our employees and stakeholders and ensure that they are taken into consideration in the way we commission and deliver our services
	Respect the confidentiality of patients and service users throughout the process of care
	Ensure services deliver value for money
	Provide enough GPs for their population and ensure they are accessible to patients
	Ensure the provision of other health services including hospitals, dentists, mental health care, Walk-In Centres, NHS Direct, patient transport (including accident and emergency), population screening, pharmacies and opticians
	Achieve close partnership with all those who have an interest in providing care and services, this includes other NHS providers, councils, private companies, the third sector and patients and carers
	Value, support and develop staff
	Promote evidence based practice
	Bring services closer to people's homes
	Commission specialist care from recognised centres of excellence
	Support people to live independently in their homes and to manage their healthcare needs
	Improve access, clinical outcomes, safety and the patient experience

A key responsibility of all Medicines Management teams present within PCTs is the control of antibiotic prescribing, with their ability to do so being affected by regional differences in demographics such as ethnicity, age, socio-economic status, average size of family and prevalence of conditions. The organisational structure of Medicines Management teams and their relationship with neighbouring Acute Trusts can also impact on their ability to control antibiotic prescribing. Acute Trusts play a significant role in controlling antibiotic resistance by employing staff to analyse antibiotic prescribing trends, resistance and sensitivity patterns in order to inform prescribers of appropriate antibiotic use. The advantages of collaboration between Medicines Management teams and their local Acute Trusts is the potential to implement cohesive strategies such as formulary implementation and maintenance, antibiotic prescribing surveillance and feedback to prescribers, although some PCTs provide no formal communication devoted to this mission. The structure of Medicines Management teams can also have a large impact on antibiotic prescribing, with possible factors affecting team structure shown below in Figure 6.

Figure 6: Possible factors affecting Medicines Management team structure



The structure of any Medicines Management team depends on the balance of management influence against budgetary constraints with Heads of Medicines Management deciding to either control antibiotic use with the appointment of an Antibiotic Pharmacist, or delegating the responsibility to all or certain members of the team. In doing so, the Head of Medicines Management may adopt a democratic, autocratic or laissez-faire style of management to maximise their team potential. The chosen approach may either motivate or de-motivate members of the team, which in turn improve or worsen antibiotic prescribing.

Budgetary constraints may determine the location of the Medicines Management team with members of the team being based at GP surgeries, and thus be called "practice pharmacists" or "practice technicians" From surgeries, pharmacists and/or technicians can complete audits and housekeeping tasks whilst providing direct feedback to prescribers. The whole Medicines Management team may also be located in a central office from where they conduct their daily tasks. This remote approach requires more influential education and feedback methods, such as formulary guidance and newsletters. Pharmacy technicians may be employed within Medicines Management teams to complete the housekeeping functions, although the number of technicians employed at any given PCT can fluctuate greatly with some Medicines Management teams' only employing pharmacists. The

decision to employ technicians may be based on their lower salaries compared with that of pharmacists, thus making their employment an attractive option.

1.11.1.3 How did SHAs and PCTs attempt to control antibiotic prescribing?

Figure 4 shows that SHAs cannot directly influence prescribers or the public and are thus reliant on PCTs to achieve DH objectives. One method by which SHAs aid PCTs are by providing analysis of current antibiotic prescribing using data provided by the NHS Prescription Services. The NHS Prescriptions Service retrieve all prescriptions dispensed in Primary Care by pharmacists, appliance contractors, dispensing doctors and items personally administered by doctors in order to produce prescribing reports. This service only covers prescriptions dispensed in England, thus those prescriptions which are written in the rest of the United Kingdom but dispensed in England are included. Conversely, prescriptions written in England but dispensed in the rest of the United Kingdom are not included, also items dispensed in hospitals or on private prescriptions are not included.

The NHS Prescription Service uses the retrieved data to produce several Prescribing Information Reports, including the Prescribing Analysis Reports and the Practice Prescribing Report. The retrieved data is also made available to PCTs, SHAs and the DH in the form of an electronic database called PACT. The Prescribing Analysis Report is produced at monthly and quarterly periods and contained analysis of the prescribing which has taken place during the reporting period. The Practice Prescribing Report is further broken down into individual prescribers with results also summarised at surgery level. The data covered within these reports include, the total level of prescribing, a breakdown of prescribing in the 6 highest cost BNF Therapeutic Groups, the top 20 leading cost drugs in the practice and the top 40 BNF Sections by cost in the practice. Examples of Prescribing Analysis Report data are shown in Figures 7 and 8.

Data supplied by the NHS Prescription Services can be used to help each SHA and PCT benchmark themselves against their peers and thus motivate an improvement or maintain success achieved. The ePACT database can also be used to find the national financial cost of antibacterial prescribing, with the latest figures from financial year 2008/2009 showing that antibacterial prescribing had cost just under £150 million. This alone highlights how much money has been spent to treat infections within Primary Care and why it is so important to control antibiotic prescribing, from just a financial

perspective. Figures 7 and 8 provide examples of the type of data provided by the NHS Prescription Services.

Figure 7: A representation of antibacterial prescribing that can be produced at a PCT and SHA (April 2008 - March 2009)

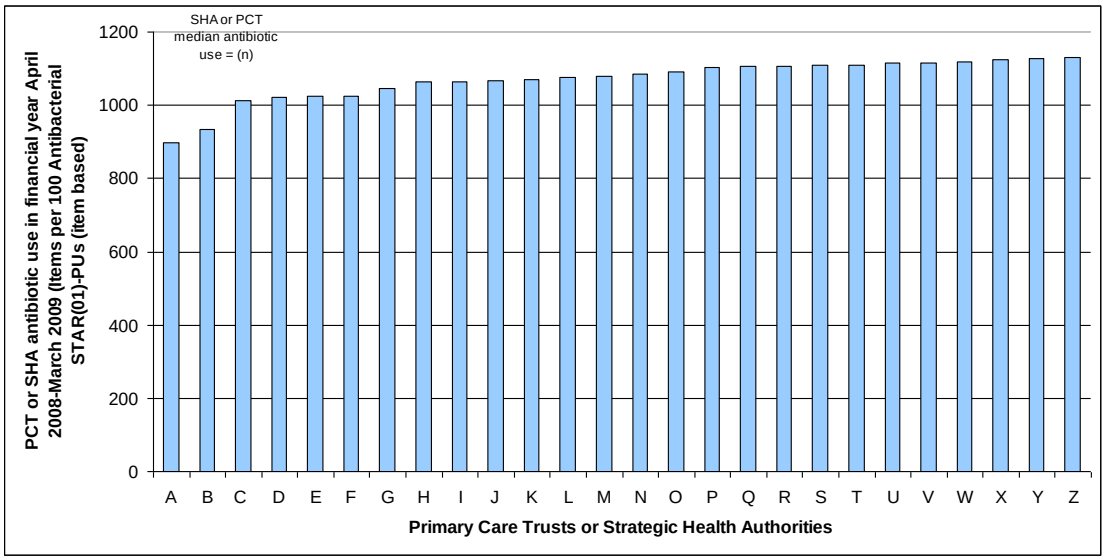


Figure 7 shows the prescribing of antibacterial drugs for all SHAs or PCTs in a league table format ascending from lowest to highest antibacterial prescribers. The outcome measure used in Figure 7 is Items per antibacterial STAR (101)-PU.

Figure 8: A representation of antibacterial prescribing spends that can be produced at a PCT and SHA (April 2008 - March 2009)

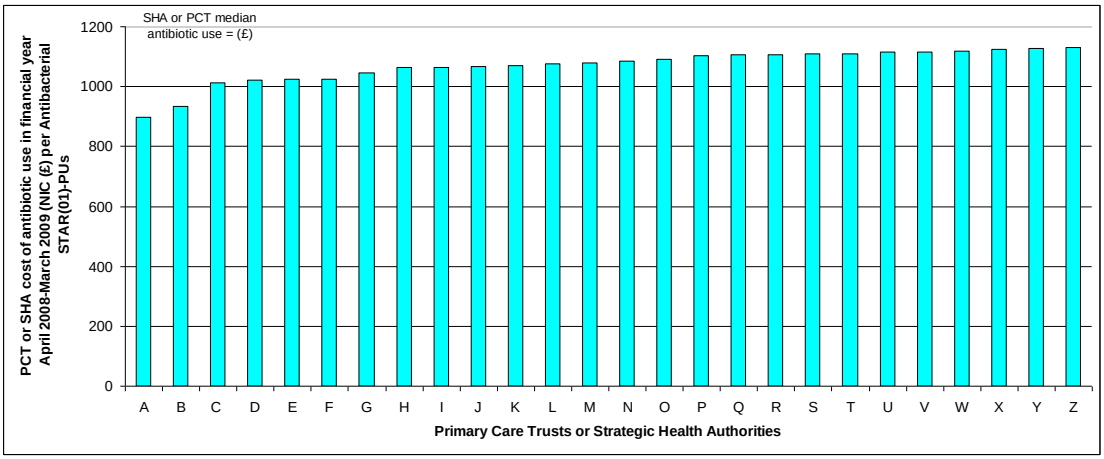


Figure 8 shows the overall spend on antibacterial drugs within SHAs or PCTs in a league table format ascending from lowest to highest antibacterial prescribers. The outcome measure used in Figure 8 is NIC (£) per 1000 antibacterial STAR-PU.

1.12 The future of antibiotics

Antibiotics have gone from a period of optimism about their ability to treat infections to a general view of pessimism owing to the development of resistance. Therefore it is important to examine the strategies used since the development of antibiotics in order to understand how this situation occurred. Antibiotics have been used readily to treat infections as there was always an assumption that new drugs would be produced to overcome the resistance caused to previous generations of antibiotics. However, very few new classes of antibiotics have been produced over the last forty years, which therefore requires the prudent use of existing antibiotics. The lack of new classes of antibiotics produced is the result of the amount of financial return achieved by pharmaceutical companies or their inability to produce new antibiotics. It has been stated that antibiotic research and development will cost any pharmaceutical company roughly 18.5% of their sales achieved (Amyes, 2001). In comparison to other drug areas this percentage is much higher. Therefore pharmaceutical companies are unwilling to invest so much into producing antibiotics, especially when there is no guarantee that they will reach the market.

2. Research question

Which strategic and operational interventions are effective in improving antibiotic prescribing practices in the UK?

2.1 Main aims and objectives

2.1.1 Aims

To identify and evaluate previously developed strategic and operational interventions designed to improve antibiotic prescribing.

To determine optimal strategies and procedures that lead to improvements in antibiotic prescribing.

To design and implement an intervention (or interventions) that lead to improvements in antibiotic prescribing.

2.1.2 Objectives

1. To undertake a systematic review designed to assess interventions aimed at improving antibiotic prescribing.
2. To compare the interventions analysed within the systematic review to the interventions implemented in the National Health System within the UK.
3. To undertake qualitative research designed to explore the impact of the method used to improve antibiotic prescribing in the National Health System within the UK.
4. To identify an intervention that can be implemented within a PCT situated in the West Midlands region.
5. To devise and implement an intervention within a PCT situated in the West Midlands region.

3. Research design and methodological considerations

The present chapter should be referred to in association with the methods provided within Chapters 4 and 5 of the present thesis in order to provide comprehensive details on the research designs and methodological considerations made regarding the systematic review and qualitative research aspects of the present research.

3.1 Research design and methodological considerations involved in the conduct of the systematic review to assess interventions aimed at improving antibiotic prescribing practices

3.1.1 The title

The title of any systematic review is important in order to provide readers with enough information to decide whether the systematic review is relevant to them. Two methods which could have been used to formulate the present systematic review title were PICO (Huang *et al*., 2006) and the Cochrane Collaboration standard format for titles (Cochrane, 2011). PICO is commonly used to develop review questions and stands for population, intervention, comparison and outcomes. The Cochrane Collaboration standard format aims at conveying information as quickly as possible by stating the intervention for any given problem in any given category.

The title (in the present review) had to remain open, in order to incorporate as many studies as possible to confirm existing hypotheses or discover new hypotheses rather than stating the intervention for any given category. The only facet that needed to be addressed was the outcomes used, as it was essential for studies to mention how antibiotic prescribing was improved. For these reasons, the method of question formulation used in the present review was PICO and the present review title was: "A systematic review to assess interventions aimed at improving antibiotic prescribing practices."

3.1.2 Methodological considerations regarding outcome measures

It is important to further analyse the use of outcome measures within the present review, given that outcome measures is the key component. There are many ways of measuring improvements in antibiotic prescribing, such as; reductions in antibiotic prescribing, compliance with prescribing guidelines, reductions in cost of prescribing, reductions in antibiotic-associated conditions, or reduced admissions to hospitals. Studies reporting improvements in antibiotic prescribing may also use a combination of these outcome measures in order to report their results. The present review will therefore require the division of study results into primary (essential) and secondary outcome measures as it is the primary results that will be addressed if sufficient studies are identified.

3.1.3 Methods of selecting study outputs

The decision on which studies should be included within the present review are based on the design of those studies and not the results achieved, therefore it is essential to produce inclusion criteria within the present review to ensure studies adhere to certain standards of publication. This will be achieved in the present review through the QUOROM statement for reporting results of a systematic review (Mother, 1999) and the use of a study quality assessment.

3.1.4 Quality assessment

Guidelines have been published by international groups, such as the International Committee of Medical Journal Editors (ICMJE) and Committee on Publication Ethics (COPE) to ensure that each type of study published contains the required information. Such guidelines, as important as they are, lack sufficient detail to ensure all important information is included. To overcome the lack of essential information contained in their respective study type, international groups have also published guidelines that allow readers to evaluate studies effectively. These include; the CONSORT (Consolidated Standards of Reporting Trials) guidelines for randomized trials (Altman, 1996; Begg *et al*., 1996; Moher *et al*., 2001), QUORUM (Quality of Reporting of Meta-analyses) (Clarke, 2001), MOOSE (Meta-analysis Of Observational Studies in Epidemiology) (Stroup *et al*., 2000) for meta-analyses, and STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) for various sorts of observational studies (the majority of clinical studies in surgical disciplines) (Von Elm *et al*., 2000).

A decision was made to use the quality assessment tool produced by the EPOC group (Cochrane Library, 2007) in the present review as their scope of work focuses on interventions designed to improve professional practice and thus relates to the present review. However, a limitation of the criteria described by the EPOC group was the focus of quality analysis in randomized controlled trials, quasi-randomised controlled trials, before and after studies and interrupted times series. Therefore an additional quality assessment tool had to be incorporated within the present review to analyse studies that may not have been accounted for by the EPOC group. This was achieved with the checklist designed by the Centre for Statistics in Medicine at Oxford University (NICE, 2005).

3.1.5 Dichotomous data

Dichotomous data are data from outcomes that can be divided into two categories, where each participant must be in one or other category and cannot be in both (Cochrane library). Dichotomous data in the present review could be exemplified by data showing antibiotics prescribed in the intervention group compared to antibiotics prescribed in the control group. However, Ritchie and Lewis (2003) stated that it is possible for the data within the studies to be not truly dichotomous and thus a decision has been made to also consider antibiotics prescribed before and after an intervention has been implemented as dichotomous data in order to improve the ease of analysis and interpretation.

3.1.5.1 Summarising dichotomous data

Summary statistics can be used for dichotomous data within the present review in order to predict the likelihood of an intervention being able to improve antibiotic prescribing. As mentioned earlier, there are many outcome measures that could be applied to the data and thus a decision has been made in the present review to define improvements in antibiotic prescribing as a reduction in antibiotic prescribing, as the impact can be measured statistically.

Four summary statistics that can be used to analyse dichotomous data are; risk ratio, odds ratio, risk difference and numbers needed to treat. Risk is the probability of having a specific event, with the event being classed as either positive or negative outcome. An alternative statistic that can be used to measure the likelihood of an event occurring is odds ratios, which is the ratio of events to no-events. In terms of antibiotic prescribing, odds ratios could be used to calculate the ratio of antibiotics prescribed against antibiotics not being prescribed.

As well as comparing the risk in one group in comparison to another, it is also possible to compare them in terms of absolute difference between the two groups that is attributable to the experimental intervention (defined as risk difference). Another way of analysing risk difference could be through the use of numbers needed to treat, where there are attempts to avoid the event.

When deciding on the summary statistic for the present systematic review it was important to consider three key factors; communication, consistency of statistics across different studies and the mathematic properties. The inclusion criteria set within the present review will lead to the presence of many different types of study designs. Therefore it is important to consider the mathematical properties of summary statistics in order to ensure variance is estimated reliably. Numbers needed to treat does not provide a useable estimate of its variance and thus cannot be used within the present review.

A direct comparison of odds and risk ratios, in terms of their ability to communicate results shows that results analysed using risk difference can be put into words easier than results analysed using odds ratios. However, odds ratios will be the summary statistic used in the present review as it most accurately measures the effectiveness of interventions in reducing antibiotic prescribing.

3.2 Research deign and methodological considerations involved in the conduct of the qualitative research to assess interventions aimed at improving antibiotic prescribing practices

There are many methods of qualitative research that could be used to collect the required data, however the choice of method could impact the results of a study. Therefore the first stage of this qualitative research required a choice of data collection method. Ritchie and Lewis (2003) divided qualitative methods into naturally occurring and generated data, with Table 1 summarising these in terms of the methods involved, the context and the detail they can obtain.

Table 1: An explanation of the data collection methods, their context and the detail they can obtain (Ritchie, J. and Lewis, J. (2003).

	Naturally Occurring Data	Generated Data
Methods Involved	- Observations - Documentary analysis - Discourse analysis	- Life stories - Narratives - Interviews - Group discussions - Focus groups
Context	Preferred if understanding is critical in the natural context i.e. by observing or experiencing	Allows interviewees to describe the personal or organisational contexts in which the research issue is located and how they relate to it
Obtaining sufficient accurate detail	- If people are unlikely to be willing to talk frankly about something - If understanding recent history is critical to making sense of an interaction so that existing data will not 'speak for themselves'	A well designed structure to generated data provides a truthful account

Table 1 shows that both naturally occurring and generated data provide many advantages to collecting qualitative data, therefore the present research will combine both methods in order to achieve understanding in the natural context and allow interviewees to provide their personal knowledge on related issues. Both generated and naturally occurring data were further analysed to determine how these methods should be used in the present research.

3.2.1 Conduct of data generation

Table 1 shows the variety of methods that can be used to obtain generated data, however interviews, focus groups and questionnaires were further evaluated as these three choices offer different opportunities for the type of data sought, the subject area and the nature of the study group (see Table 2).

Table 2: Differences between face to face interviews, focus groups and questionnaires (Ritchie, J. and Lewis, J. (2003).

	Focus groups	Interviews	Questionnaires
Nature of data	Offer less opportunity for detailed interviewee accounts	Allow depth of focus on the individual	Data are affected by the characteristics of the respondents (e.g. their memory, knowledge, experience etc.)
	Allows interaction with other interviewees and thus provides opportunities to illuminate the generation of accounts	Used to understand personal context and detailed subject coverage	Offer less opportunity for detailed interviewee accounts
	Provide opportunities for interviewees to refine what they say		
	Enhances creative thinking, solutions and strategies		
	Provide a social context		
Subject matter	Enables group discussions on abstract, intangible or conceptual topics	Addresses very complex systems, processes or experiences	Respondents may not report their beliefs, attitudes, etc. accurately
	Allow analysis of views and attitudes of interviewees	Offers opportunity to understand motivations and decisions	Care is required in the composition of questionnaires in order to retrieve the required information
	Care is required in the composition and conduct of the group, unless social norms are desired		
Research population	The need to come to a common location will inhibit the chances of the research occurring	More accessible to potential interviewees and thus best for busy study groups	Appropriate when targeting a number of respondents although low response rate is common
	Differences in status should be avoided	Appropriate if interviewees have nothing in common or if the fact they know each other restricts their contribution	They can be extremely efficient at providing large amounts of data, at relatively low cost, in a short period of time
	Appropriate for interviewees who prefer the comfort of group environment rather than on-to-one discussion		They allow anonymity which can encourage participation and involvement
	Smaller groups allow more privacy in research and allow interviewees more time to talk		

Based on the analysis of focus groups, interviews and questionnaires a decision was made to use interviews in the present research in order to promote personal context and detailed subject coverage. Focus groups were not considered owing to the potential for conflicts to occur between interviewees, and questionnaires were not considered as the interviewer/researcher would not be able to instantly expand on any specific answers provided. Further advantages of interviews are summarised below in Table 3.

Table 3: Key features and advantages of interviews (Ritchie, J. and Lewis, J. (2003).

Feature	Advantages
Combine structure with flexibility	Flexibility is sufficient enough to allow topics to be covered in a structure suitable to the interviewee
	The interviewer can fully probe and explore responses
	Allow the interviewer to respond to relevant issues raised spontaneously by the interviewee
The interview is interactive in nature	Interaction between the interviewer and interviewee generates material
	An initial question can be asked by the interviewer in order to encourage the interviewee to answer questions openly
	The interviewees answer will determine the interviewers next intervention
The interviewer uses a range of probes and other techniques to achieve penetration, exploration and explanation of answer	The interviewer will use follow-up questions to obtain a detailed understanding of the interviewees meaning to initial "surface" level answers
	Allows the interviewer to explore fully all the factors that underpin interviewee's answers
The interview is generative	The interviewee will at some point be directed (by the interviewer or themselves) to new avenues of thought
	Interviewees may also be invited to put forward ideas or propose solutions on a particular topic

Interviews can be conducted in a structured, semi-structured or unstructured format.

A decision was made to use semi-structured interviews in the present research in order to provide flexibility in the wording and order of the questions set within the checklist whilst also allowing for any additional unplanned questions to follow-up on any points made by interviewees. Structured interviews were not considered because of the strict ordering of questioning required and the lack of flexibility in asking follow-up questions to interviewees. Unstructured interviews were not considered for use as the interviews may not have maximised the information retrieved owing to the lack of question structuring (Robson, 2011).

3.2.2 Naturally Occurring Data

The second stage of qualitative research involved the retrieval of naturally occurring data on interventions used to improve antibiotic prescribing. There were many types of naturally occurring data that could be obtained, such as ethnographic accounts, narrative analysis, content analysis, conversation analysis, discourse analysis, analytic induction, grounded theory and policy and evaluation analysis. A decision was made to use a combination of naturally occurring data in the present research consisting of ethnographic accounts, content analysis, conversation analysis and policy and evaluation analysis. This approach will be subsequently referred to as the "combined approach".

3.2.2.1 Ethnographic accounts

Ethnography was a key element of the qualitative research as it allowed the research to evolve, without the need for pre-structuring the research by using sensitive methods that do not disturb the research setting (Punch, 2005). Ethnographic accounts were obtainable from naturally occurring data but not from the conduct of case studies, thus being the key reason why case studies were not used in the present research. Table 4 summarises the key differences between case studies and ethnographic accounts.

Table 4: A summary of the key characteristics needed to conduct case studies and ethnographic accounts (Punch, 2005).

Case studies	Ethnographic accounts
The case requires identification of the boundaries from the context	Shared cultural meanings of the group are crucial to understanding its behaviour
The case requires clarity on the need for the study and translates into specific purposes and research questions	Ethnographic study will be designed, and its data collection technique organised in order to elicit required knowledge from informant participants
Multiple sources of data and multiple data collection methods are likely to be used, typically in a naturalistic setting	The group will always be studied in its natural setting. Therefore, the researcher has to become part of that natural setting
	Ethnography is likely to be an unfolding, evolving study. Research questions and hypotheses will be used, but are likely to develop as the study proceeds
	Any data collection technique might be used, but fieldwork is essential
	Ethnographic data collection is typically prolonged and repetitive in order to be comprehensive and detailed

3.2.2.1.1 Observation methods

Observation is very closely associated with the conduct of an ethnographic study, where the actions and behaviour of people in a natural setting are observed, analysed and interpreted (Robson, 2011). There are two key types of observations, participant and structured, with the present research adopting the participant observation approach. The key differences between both approaches are shown below in Table 5.

Table 5: **Key differences between participant and structured observations (Robson, 2011).**

Participant observation	Structured Observation
The observer seeks to become a member of the group being observed.	The observer takes a detached "pure" observer stance.
The observer has to establish some role within the group.	The aim is to quantify behaviour.
The observer is required to conceal their role as an observer, although the observer is required to inform those in the setting about the research.	The observer might use qualitative approaches but has tended towards fixed designs and quantitative, structured methods.
The observer is more likely to use flexible designs and qualitative, unstructured approaches.	

The participant observations were conducted informally in order to allow considerable freedom in what information was gathered and how it was recorded in order to achieve a higher level of complexity and completeness in data retrieved. However, disadvantages of the informal approach included lower reliability and validity of data retrieved (Robson, 2011). The very nature of participant observations mean that data was collected opportunistically, from the questions asked and answers provided by group members. This information could then be used to describe the key information retrieved.

3.2.2.2 Content, conversation and policy analysis

In addition to ethnographic accounts, the researcher also conducted analysis of documents, conversations and policies with Table 6 summarising the sources of information used for each.

Table 6: Sources of information used for analysis of documents, conversations and policies (Robson, 2011).

Documents	Conversation	Policies
All documents produced by the Medicines Management, Public Health departments that contain the word "Antibiotic" or "Antimicrobial"	All colleagues working within the Infection Control department of Public Health and the Medicines Management department	All policies produced by the Medicines Management, Public Health departments that contain the word "Antibiotic" or "Antimicrobial"
Documents included: - Minutes of meetings - Letters - Memoranda - Diaries - Speeches - Prescribing software	Colleagues included: - Head of Medicines Management - Senior Pharmacists - Pharmacy Technicians - Practice Pharmacists - Infection Prevention Nurses - Data analysts	Policies included: - Clinical guidelines - Algorithms - Formularies

4. A systematic review to assess interventions aimed at improving antibiotic prescribing practices

4.1 Background

Traditional reviews (such as literature reviews, narrative reviews, critical reviews or commentaries) have been used by individuals to ensure they keep up-to-date with the ever increasing evidence that accumulates in their field of interest. In some instances the level of evidence has increased so much that individuals find it difficult to read and critically evaluate evidence on a regular basis. This ultimately led to literature reviews becoming unreliable sources of information, especially after Antman *et al* (1992) and Lau *et al* (1992) highlighted the inadequacies of traditional reviews. This was based on their findings that if original studies of the effects of clot busters after heart attacks had been systematically reviewed, the benefits of therapy would have been apparent as early as the mid-1970s. Secondly, narrative reviews were woefully inadequate in summarising the current state of knowledge.

To overcome the unreliability of literature reviews (as stated by Antman *et al* (1992) and Lau *et al* (1992 above), the emphasis has now been placed on conducting systematic reviews. A systematic review focuses on answering a given research question by identifying, appraising and synthesising all the empirical evidence that meets pre-specified eligibility criteria (The Cochrane Library, 2007). The conduct of systematic reviews requires the explicit explanation of methods aimed at minimizing bias, in order to produce more reliable findings that can be used to inform decision making (The Cochrane Library, 2007).

The research question set in section 2 of the thesis was to identify interventions to improve antibiotic prescribing practices. In total there have been four systematic reviews conducted regarding interventions to improve antibiotic prescribing practices (Arnold and Straus, 2005; Davey *et al*., 2005; Steinman *et al*., 2006; Ranji *et al*., 2008). Table 7 summaries the key differences in the conduct of these four systematic reviews.

Table 7: Analysis summary for the four systematic reviews published regarding interventions to improve prescribing practices

	Interventions to improve prescribing practices in ambulatory care (Arnold, S. R. and S. E. Straus, 2005)	**Interventions to improve prescribing practices for hospital inpatients (Davey, P., E. Brown, *et al*., 2005)**	**Improving antibiotic selection - a systematic review and quantitative analysis of quality improvement strategies (Steinman, M., S. Ranji, *et al*., 2006)**	**Interventions to reduce unnecessary antibiotic prescribing a systematic review and quantitative analysis (Ranji, S., M. Steinman, *et al*., 2008)**
Types of studies included within the systematic review	Randomised Controlled Trials, Quasi Randomised Controlled Trials, Controlled Before and After Studies and Interrupted Time Series Studies	Randomised Controlled Trials, Quasi Randomised Controlled Trials, Controlled before and after studies and Interrupted Time Series (with at least 3 data points before and after implementation of the intervention)	Patient- and Cluster-Randomised Controlled Trials, Controlled Before-after Studies and Interrupted Time Series (with at least 3 data points before and after implementation of the intervention)	Randomised Controlled Trials, Controlled Before and After Studies and Interrupted Time Series Designs
Participants included within the systematic review	Studies of healthcare consumers, qualified physicians of all ages and level of experience and physician extenders who prescribe antibiotics and provide primary care in community or academic ambulatory settings were included	Health care professionals who prescribe antibiotics to hospital in-patients receiving acute care.	Treatment of patients presenting with acute infections in the outpatient setting	Antibiotic prescribing for acute outpatient illnesses for which antibiotics are inappropriately prescribed
Excluded participants	Studies including only medical trainees	The review excluded interventions targeted at residents in nursing homes or other long term healthcare settings.		
Exclusion criteria	Studies published in languages other than English	Descriptions of interventions to change antibiotic prescribing without measurement of the effect of these interventions on prescribing or other outcome measures	Studies published in languages other than English	Studies published in languages other than English
		Surveys of hospitals to establish the range of measures used to control or optimise antibiotic prescribing		
Inclusions		Studies in all languages		
Search method for study identification	Embase and Medline OVID and EPOC	Cochrane, Medline, EMBASE, EPOC, Personal file and contacting authors	EPOC, MEDLINE, EMBASE, CINAHL, manual review of article bibliographies	EPOC, Medline, EMBASE, CINAHL, manual review of article bibliographies
Data collection & analysis	Assessed by both authors according to the criteria described by the EPOC group	Criteria described by EPOC group	Criteria described by EPOC group	Criteria described by EPOC group

Table 7 highlights a number of key areas within each systematic review and the differences and comparisons that were used to achieve the set aims and objectives for each study. The results of these systematic reviews also provided an insight into which interventions have been reviewed previously and how effective they have been in improving antibiotic prescribing, these will be discussed below.

The two systematic reviews conducted by Steinman and Ranji both produced three key conclusions. Firstly more "active" interventions (one-to-one or small group interactions) were superior to less active interventions (lectures, distribution of printed materials) within the same study. Secondly trials using clinician education alone produced superior performance in trials compared with trials that combined clinician education with audit and feedback. Finally they did not find interactive, multifaceted, or sustained interventions to be more effective than their counterparts.

A further conclusion made in the review: Interventions to reduce unnecessary antibiotic prescribing a systematic review and quantitative analysis (Ranji and Steinman, 2008) was that broad campaigns using mass media campaigns and active clinician education produced significant reductions in overall antibiotic prescribing.

Arnold and Straus (2005) also agreed with the conclusions made by Steinman and Ranji however elaborated further to suggest that many of these studies failed to provide information on the durability of the effect of the intervention and the cost-effectiveness of such interventions have not been assessed. Arnold and Straus (2005) also stated that the most effective interventions to improve antibiotic prescribing appear to be condition and situation specific and thus the ultimate goal of any intervention is to overcome barriers to change. An example of this is the use of delayed prescriptions to allow prescribers to overcome patient demand for antibiotics.

The systematic review conducted by Davey and Brown (2005) provided a different insight into the impact of interventions as they broadly categorised all interventions as either being "persuasive", "restrictive" or "structural". Persuasive interventions were seen as those that could influence prescribers into changing their behaviour, such as educational material, educational meetings, audit and feedback. Restrictive interventions were interventions that do not allow prescribers to influence prescribing, such as formulary restriction and automatic stop dates. Structural interventions were seen as changes within processes or organisations that may influence prescribing, such as changing from paper to computer records.

The main conclusion within this review was that restrictive interventions were more effective than persuasive interventions in improving antibiotic prescribing. This conclusion therefore contradicts with the findings of the other systematic reviews discussed as they all focused on persuasive interventions to improve antibiotic prescribing.

The review of these four key systematic reviews has highlighted the need for a further systematic review to be conducted to assess interventions aimed at improving antibiotic prescribing practices in order to overcome the exclusion criterion applied in the respective studies. In doing so, a comprehensive systematic review can be completed which analyses studies that may have been missed within previous systematic reviews. Therefore the present review will apply no restrictions on the type of studies and participants included, and will not exclude studies written in other languages. Section 4.4 to section 4.9 will provide further details of the methods used within the present review that will achieve the set aims and objectives as shown below.

4.2 Aims

- To explicitly identify interventions that alone, or in combination, are effective in improving antibiotic prescribing, in a reproducible manner.
- To systematically review the literature and, where appropriate, meta-analyse studies investigating methods to improve antibiotic prescribing.

4.3 Objectives

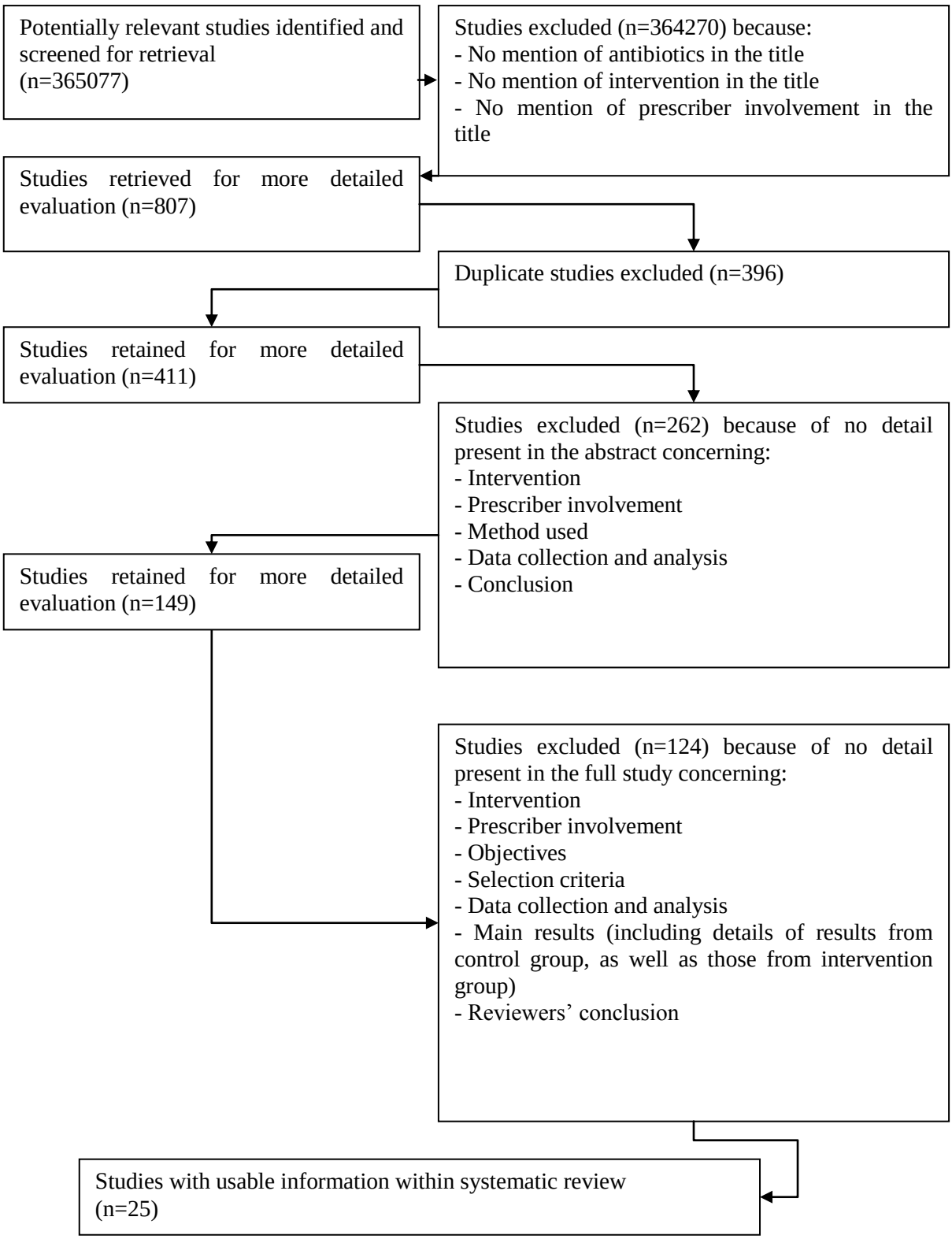
1. To undertake a systematic review designed to assess interventions aimed at improving antibiotic prescribing and use, through:

a) Development of citation terms.
b) Selection of relevant databases to search.
c) Development and application of specific inclusion and exclusion criteria to retrieved studies.
d) Development of quality assessment checklists.
e) Tabulating information from studies included in the systematic review.
f) Summarise effects observed in studies included in a systematic review.
g) Determining whether meta-analysis is possible and/or appropriate based on the study effects observed.
h) The use of a funnel plot to explore the possibility of publication and related biases of studies included in the systematic review.
i) The use of an L'Abbe plot to compare the significance in results, with respect to the intervention versus control result comparisons.
j) The analysis of results to determine the effectiveness of strategies in improving antibiotic use.

4.4 Criteria for considering studies for this review

No exclusion criteria were placed on the type of study, participants, interventions, or outcome measures within this systematic review. Instead a flow chart was used to determine whether studies contained the required criteria for inclusion, as recommended by the QUOROM statement for reporting results of a systematic review within the systematic review (Mother, 1999), see Figure 9.

Figure 9: Flow chart showing the method to select outputs from the review citation search strategy as recommended by the QUOROM (Mother, 1999) statement for reporting results of a systematic review



4.5 Search methods for identification of studies

The mind mapping technique (Buzan, 2000) (Appendix 1) was used in order to compile a comprehensive catalogue of concepts relevant to the issues surrounding the management of antibiotic prescribing and usage. A number of sources were used to aid the development of the mind map including; broadsheet newspaper articles, the internet (Google), and personal communication from other individuals. Newspaper articles were searched using Lexis-Nexis Executive. This site contained not only national newspapers, but also international papers, which were translated to English if necessary.

The aim of the literature search was to retrieve all relevant studies with high sensitivity and specificity. Sensitivity is defined as the proportion of high quality studies that are retrieved for this present review and specificity is defined as the proportion of low quality articles not retrieved (Sackett and Straus *et al*., 2000). In order to achieve this aim, the present review searches used fifty-one different combinations of terms (shown in Appendix 2) in the literature search.

Boolean search strategy combinations "AND", "OR" and "NOT" were used in the present study. No limitations were imposed on the initial searches (such as a starting date of articles) in order to retrieve as comprehensive array of outputs as possible. Medline allowed study searches from 1945 (the year when Fleming first mentioned antibiotic resistance as an issue). Any articles which were not available in English were translated in as much detail as possible by volunteers from Aston University in order to determine whether their inclusion was justified.

Basic key search terms were derived from the mind mapping exercise. Concepts generated were filtered and prioritised by collaboration with a leading academic research microbiologist in the autumn 2006. Search terms and term combinations for the literature search strategy were then generated using a nominal group technique, which included a leading academic research microbiologist and two professors of clinical pharmacy. This whole process produced fifty-one different combinations of terms (shown in Appendix 2), all of which were considered relevant to this systematic review.

Key references cited in retrieved studies were used to widen the search. This was achieved by using the search engine Medline, which provided a facility to search for related studies. The index terms of retrieved studies were also used to widen the search. This was achieved by using the index terms of retrieved studies as search terms within the chosen search engines.

In order to develop a comprehensive search strategy, mindful of bias reduction, the search strategies included Medline (Med-line, 2007) as a high yielding medically based database, Pharm-Line (Pharm-line, 2007) for a pharmaceutical perspective and The Cochrane Library (The Cochrane Library, 2007) as a speciality in systematic review studies. Retrieved articles were stored and manipulated using reference management software (Endnote 9).

4.6 Data Collection and analysis

Two reviewers independently applied pre-determined exclusion criteria to identify only those studies of relevance, with a plan to resolve disagreements in chosen studies by discussion between the reviewers. However, the present review provided no discrepancy in the choice of relevant studies. The stages of the exclusion process are shown in Figure 9 as some abstracts were subject to word limits, the key requirement of the presence of a control group was only assessed when reviewing full papers.

Quality assessment involves the appraisal of the individual aspects of a study's design, conduct and analysis (quality items). As many study designs were found in review studies, it was important to quantify quality items based on each paper's own merits. For example, papers using randomised controlled trials were assessed through the use of different quality items to those for systematic reviews. The decision of what quality items to use for each study design was aided with the use of two quality assessments (NICE, 2005; The Cochrane Library, 2007).

Appendix 3 provides the details of the quality assessments used for each study design in this present review. Each review study was analysed in order to extract the required information in order to determine whether the required criteria were met.

Any criteria highlighted in red in the quality assessment checklist indicated an aspect of the study design that was of high importance, and thus its inclusion within an article was considered essential. All quality criteria were placed in a table, and the results of their inclusion in each article in terms of sufficiency of detail were rated as either "met", or "not met", or "not stated".

A weighting system was used for this systematic review which favoured the inclusion of specific quality indicators for different study designs (NICE, 2005). On this basis, a score of four was given to the presence of a required quality item within a given study. For example,

if the type of randomisation was stated in a randomised controlled trial, then a score of four was obtained. For any other quality item present in a study, a score of two, rather than three, was set in order to add more value to the presence of the specific quality items required with any study design. For example, if a randomised controlled trial contained details on the completeness of follow-up within the study, then a score of two was given.

The score was then totalled and divided by the number of required quality items. For example, randomised controlled trials required the presence of six quality items, so the total score of a study was divided by six. This equates to the weighting score, which would be compared to all other scores in order to provide their ranking.

4.7 Statistical heterogeneity

The level of Statistical heterogeneity determines whether studies are similar enough to use statistical analyses such as the use of Forest plots, an L'Abbe plot and a Funnel plot. The present review incorporated all of these three types of statistical analysis.

4.7.1 The Forest plot

Forest plots were used in the present review to display estimated results, summary estimates and confidence intervals of each quantitative study. The order of the data could be changed (chronologically or by country in which the study was conducted) in the present review to reveal patterns in the data. The following statistical tests were required to produce Forest plots in the present review.

4.7.1.1 Fixed Effects (Mantel-Haenszel, Robins-Breslow-Greenland)

The Mantel-Haenszel method was used to analyse the relationship between a dichotomous outcome and risk factors. This was achieved by assuming a fixed effect model to estimate the pooled odds ratio for all strata. The Robin, Breslow and Greenland variance formula was used to calculate the confidence interval for the Mantel-Haenszel odds ratio.

4.7.1.2 Fixed Effects (Conditional Maximum Likelihood)

Consistent estimators of panel data models were constructed using Conditional Maximum Likelihood in the presence of individual specific effects. The Fisher Exact test was used for evaluating two-by-two contingency tables.

4.7.1.3 Non-Compatibility of Studies

Breslow-Day and Cochrane Q tests were used to test non-compatibility. The Cochran Q test was used to test differences between three or more matched sets of frequencies between related samples.

4.7.1.4 Random Effects (DerSimonian-Laird)

Heterogeneity was calculated using the Cochrane Q test by weighting the sum of squared differences between individual study and pooled effects across studies. Q was included in each StatsDirect meta-analysis function as it formed part of the DerSimonian-Laird random effects pooling method.

4.7.2 The funnel plot

Funnel plots were used in the present review to investigate the presence of publication and small study bias within review studies. The funnel plot itself is a scatter plot of study precision versus effect size. It is assumed that as the study size increases the level of precision will increase.

4.7.3 The L'Abbe plot

An L'Abbe plot was produced by plotting the proportion of events in a control group against the proportion of events in the intervention group. This analysis was then used to determine the risk or benefits of using a particular intervention.

4.7.4 Statistical Methods

Heterogeneity was analysed with the use of computer software (StatsDirect, manufactured by StatsDirect Ltd). P values of <0.05 are considered significant, P values of <0.01 are considered very significant and P values of <0.001 are considered highly significant in the present study.

4.7.4.1 Summary Statistics

Data from two groups within a study (the intervention and control group) can be compared using several summary statistics, such as, a risk ratio, the risk difference and the odds ratio. For the present study a decision was made to use odds ratio because this statistic provided a straightforward and clinically useful interpretation, while providing consistency of the statistic across different studies. An odds ratio could easily be calculated by dividing the odds of the event in the intervention group by the odds of the event in the control group.

All of the studies in the present review were required to contain details of not only the intervention, but also control group or baseline results, therefore this data was extracted from each study and recorded in a table (see Appendix 4). If more than one outcome measure was used to calculate results, a decision was made to use the primary outcome measure results.

The data on intervention and control groups were entered into the StatsDirect package to calculate the odds ratio score and the corresponding confidence intervals (set at 95%).

The required data for odds ratio calculation were: total number of patients in the intervention group, total number of patients in intervention group with the specified outcome, total number of patients in the control group, and total number of patients in control group with the specified outcome.

4.8 Sensitivity analysis

Sensitivity analysis analyses the association between study differences and outcomes. This was achieved in the present review by evaluating different sub groups of studies and systematically excluding studies to determine how this affects the conclusions reached. For

example, the researcher could exclude all before and after studies to determine how the results would change.

4.9 Moderator variables

A moderator variable can be a quantitative or qualitative factor which affects the relationship of independent or dependent variables. Sub group analysis and moderator variables were used to analyse the impact of moderator variables on major variables within the present review. This was achieved at study level by examining varying study characteristics, such as the settings, groups of outcomes or patients.

4.10 Results

4.10.1 Implementation of selection processes

The citation search strategy used in the present review provided a database of 365077 studies from Medline, Pharm-Line and the Cochrane databases. However, of the 365077 studies retrieved, only twenty-five were included in the final review after the exclusion criteria were applied (as shown in Figure 9) and their quality assessment scores are shown in Table 8 below. These twenty-five outputs will be subsequently referred to as "the review studies".

Table 8: Quality assessment scores achieved by each review study

Study	Weighting score	
Briel (2006)	6	
Walker (1998)	5	
Melander (1999)	4.7	
Paul (2006)	4.6	
Van Driel (2007)	4.6	
Seager (2005)	4	
Monette (2007)	3.8	
Altiner (2007)	3.3	
Dranitsaris (2001)	3.3	
McGregor (2005)	3.3	
Rautakorpi (2006)	3.3	
Hadi (2008)	3	
Schwartz (2007)	3	
Arnold (2006)	2.3	
Smabrekke (2002)	2.3	
Buising (2008)	2	
De Santis (1994)	2	
Mainous (2000)	2	
Molstad (1989)	2	
Ng (2008)	2	
Bjerrum (2006)	1.6	
Gonzales (1999)	1.6	
Hickman (2003)	1.6	
Pastel (1992)	1.6	
Angunawela (1991)	1.3	
	3.0	**Average weighting score**

Table 8 shows that the weighting achieved by the review studies varied between 6 (achieved by Briel, 2006) and 1.3 (achieved by Angunawela, 1991). Four studies produced a weighting score of 3.3 and 1.6 with the average weighting score being 3. Figure 10 below analyses the range and frequency of study designs reported in the review studies.

Figure 10: A representation of the range and frequency of study designs reported in the review studies

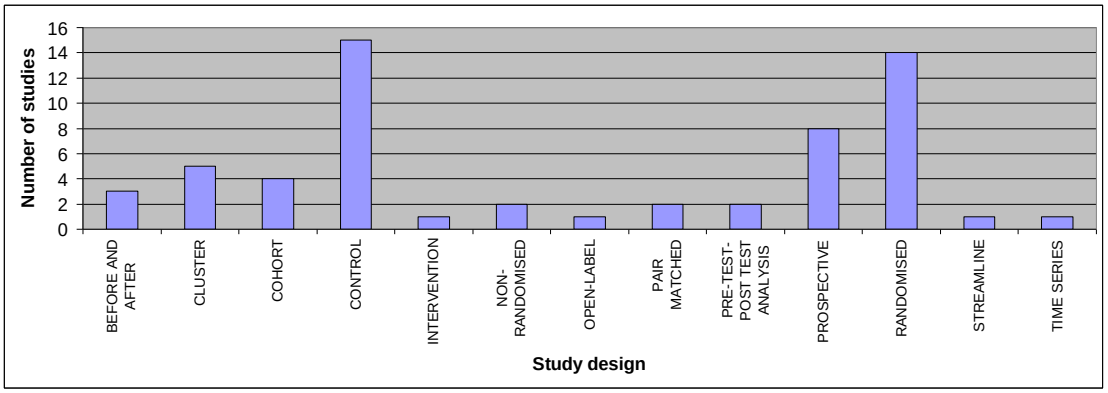


Figure 10 shows the range and frequency of experimental designs reported in the review studies. A total of thirteen different study designs were used within the 25 review studies meaning that some studies utilised more than one method of study design. "Control" and "randomised" were the most popular terms used to describe study designs. One review study mentioned the use of "streamline" as a study design, however the definition of "streamline" was not included within the study text. Only three of the review studies mentioned the use of blinding (Briel *et al*., 2006; Dranitsaris *et al*., 2001; McGregor *et al*., 2006).

4.10.2 Primary outcome measures used in the review studies

Twenty-three of the twenty-five review studies used more than one outcome measure, although there were only two primary outcome measures used in the twenty-five review studies. Nine studies used a measure of "compliance" and sixteen studies used an evaluation of the "prescription numbers". "Compliance" is used in the present study to describe an outcome measure which demonstrates the appropriateness of prescribing (i.e. in accordance with requirements within the intervention), whereas, "prescription numbers" describes measures used as a simple evaluation of changes in volume measures of prescribing before and after an intervention. Table 9 below shows other outcome measures recorded within the review studies.

Table 9: Outcome measures recorded within review studies

Outcome measures	Number of times recorded within review studies
Adverse events	1
Antibiotic costs	1
Antibiotic sales	1
Antibiotics prescribed	1
Characteristics of participating physicians	1
Clinical response	1
Compliance	9
Costs related to antibiotics stewardship program	1
Demographic characteristics of patients	1
Distribution of focus for infections	1
Frequency of testing for Clostridium difficile	1
Hospital antimicrobial costs	1
Indication for antibiotic prescriptions	1
Length of hospital stay	1
Length of hospitalization	1
Measurement of severe disease	1
Mortality	1
Number of prescriptions	16
Patient mortality	1
Patient satisfaction	1
Percentage of consultations with antibiotic prescribing in relation to focus for respiratory tract infections	1
Percentage of patients with specified or presumed types of infections	1
Quality of antibiotic use	1
Rate of subsequent physician visits	1
Relation to allergies documented	1
Time spent by team managing antimicrobial utilisation	1
Types of antibiotics used for respiratory tract infections	1

Table 9 shows that there were a total of 27 outcome measures recorded within the review studies. The two outcome measures highlighted in yellow were the primary outcomes and the only measures to be recorded more than once within review studies. Nine studies used a measure of "compliance" and sixteen studies used an evaluation of the "prescription numbers".

4.10.3 Measure of systematic review bias (Funnel Plot)

Funnel plots were constructed for the review studies' data in order to assess the presence of bias. The funnel plot should resemble a symmetrical inverted funnel where the precision of the estimated intervention effect increases as the size of the study increases.

Figure 11: A funnel plot of review study outputs comparing the effectiveness of the intervention(s) in controlling antibiotic use

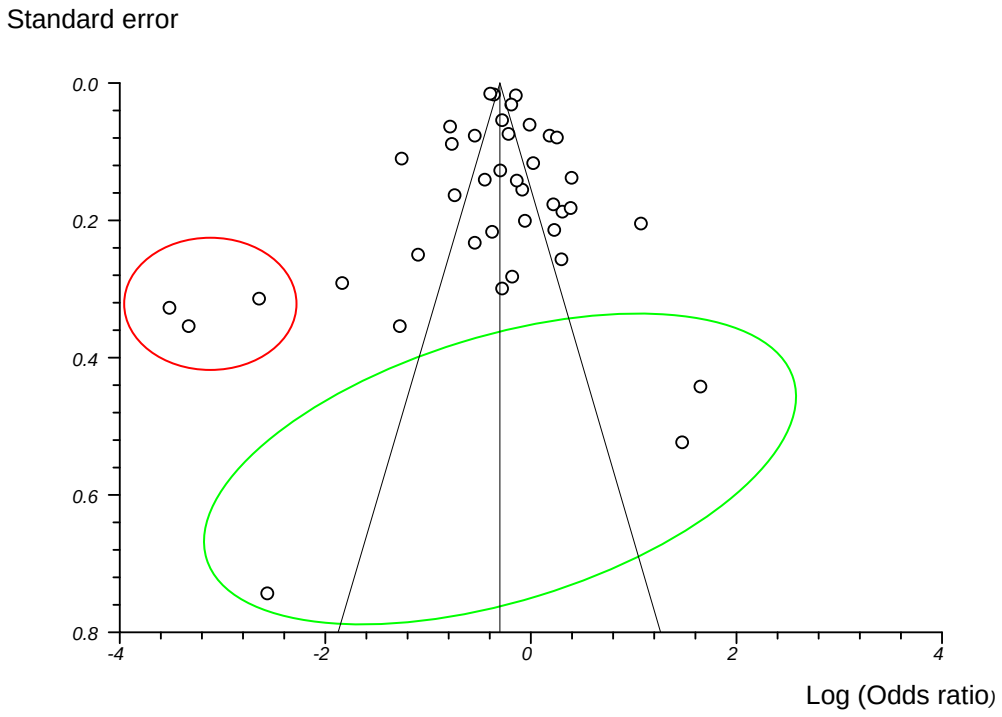


Figure 11 shows that only three studies produced standard error scores greater than 0.4 (circled green, Figure 11), indicating that most review studies produced precise outcomes.

With the exception of three studies (circled red, Figure 11) there is an indication of funnel symmetry between results presented in Figure 11. The reasons for any asymmetry could include studies being of lesser/poorer quality compared to other review studies or having been conducted in an atypical population/situation.

4.10.4 Assessment of study data heterogeneity (L'Abbe plot)

Analysis of sources of heterogeneity in a meta-analysis is imperative and can be achieved using an L'Abbe plot. The sizes of each symbol in Figure 12 represent the sample size within the study (larger symbols represent larger sample sizes). The experimental (y-axis) and control percent (x-axis) represent the proportion of patients which improved with the control or experimental intervention(s) implemented.

Figure 12: An L'Abbe plot of the review study outcomes

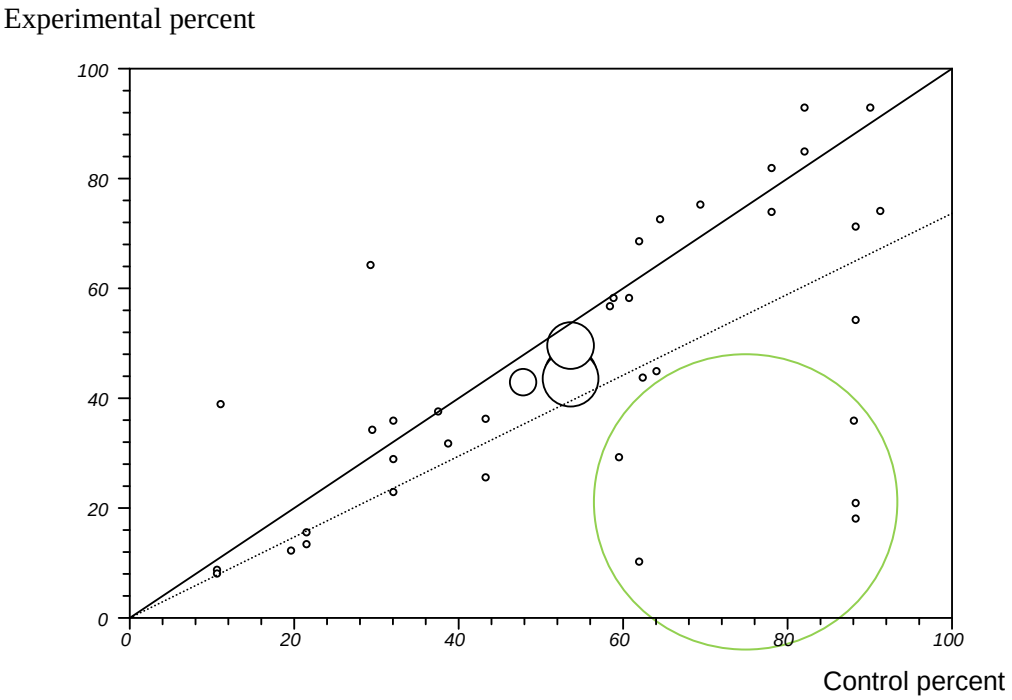


Figure 12 shows an L'Abbe plot showing the comparative success of interventions and controls within the review studies.

The heavy diagonal line in Figure 12 is the line of equality and study results lying on this line would have equally successful interventions and controls. Symbols lying to the right of the line of equality indicate that the control group had more successful results compared to the intervention group and *vice versa* for symbols to the left of the line of equality.

The lighter dashed line in the L'Abbe plot (Figure 12) represents the overall success of the control or interventions. If the dashed line is present to the right of the line of equality, the control groups are likely to be more successful than interventions. Figure 12 indicates that this is the case, implying that most interventions used have had no effect (or even a detrimental effect in some cases) in beneficially influencing antibiotic use. This is further supported by the five studies circled in green, which indicate that the control groups are much more successful than their corresponding intervention groups in influencing antibiotic use.

4.10.5 Forest Plot

The Forest Plot is a visual output used to show information from individual studies, allowing demonstration of the relative effectiveness of interventions in comparisons of multiple quantitative scientific studies. Forest Plots will be used in this review to determine the success of intervention methods on controlling antibiotic use.

The Forest Plot is presented in two columns. The left-hand column lists the names of the studies in alphabetical order. Some studies are presented more than once depending on whether they present results for multiple interventions. The second column is a plot of the log odds ratio results for each study (and each intervention used within studies) incorporating horizontal bars which represent the associated 95% confidence intervals. The relative weight of a study is represented by the size of the black square symbol, with studies containing a comparatively higher number of participants being represented with a larger black square symbol.

The vertical heavy solid line presents a log odds ratio score of 1. For an intervention to be deemed successful it has to achieve a log odds ratio score of greater than 1. The unfilled diamond and dotted vertical line represents the summary effect of all the interventions. This also needs to be greater than 1 in order for the overall effect of interventions to be proven successful for controlling antibiotic use.

The following three Forest Plots (Figure 13, 14 and 15) display results from the review studies highlighting BASELINE, INTERVENTION and FOLLOW-UP periods. In the present systematic review, BASELINE periods are those set before interventions are conducted. INTERVENTION results are classed as those produced once the interventions are complete and the FOLLOW-UP plots are derived from post-intervention results intended to determine

the long term success of the interventions implemented. The interventions and outcome measures have been abbreviated but are described in the abbreviations section on page 19.

Figure 13: Forest Plot of review studies' BASELINE data

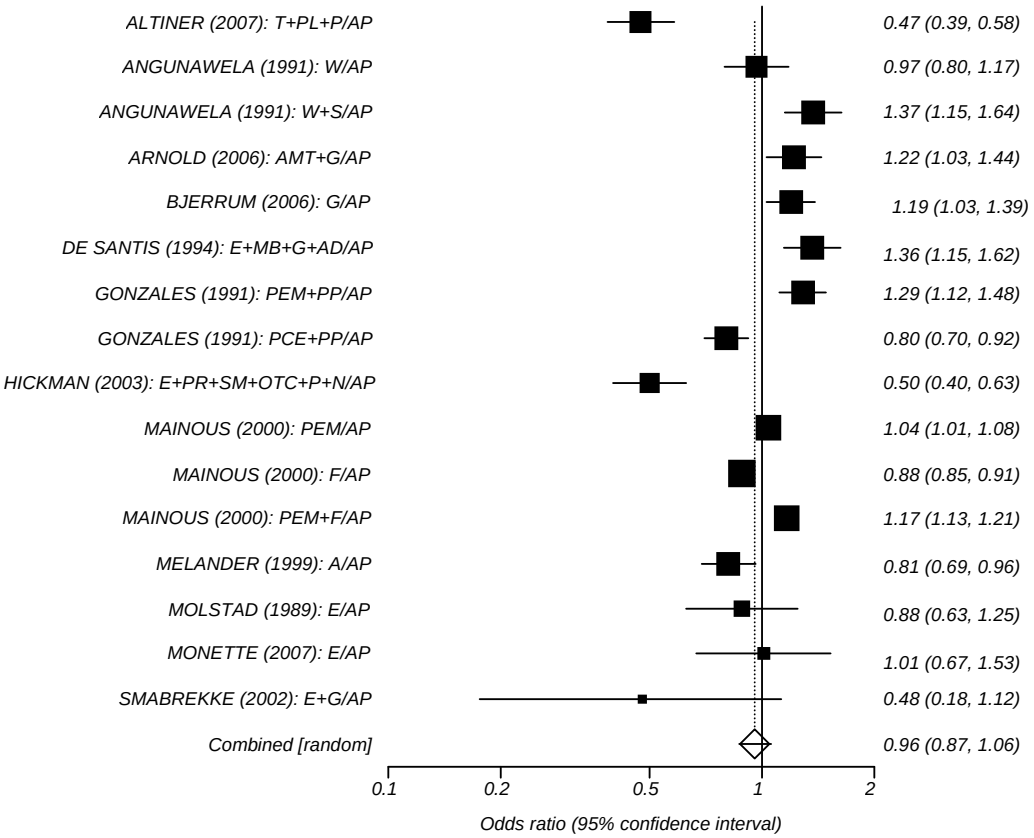


Figure 13 shows that only eleven of the twenty-five review studies recorded BASELINE results. The overall log odds ratio score was 0.96 which unsurprisingly confirms that control of antibiotic use had not been successful before any interventions were implemented.

Figure 14: Forest Plot of review studies' INTERVENTION data

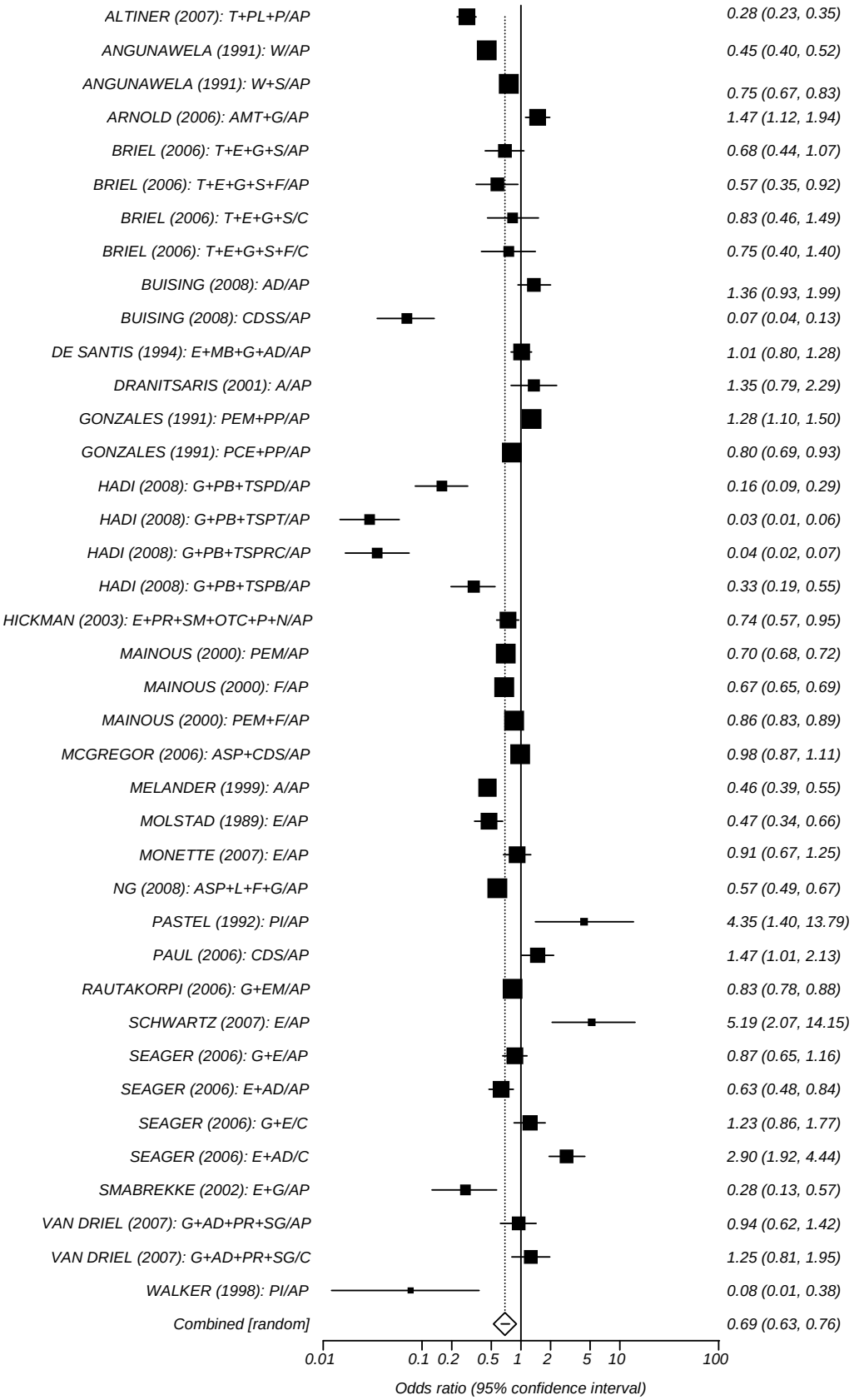


Figure 14 shows that 24 of the 25 studies recorded results immediately after the INTERVENTION period. Bjerrum (2006) was the only study failing to state INTERVENTION results; however this study included both BASELINE AND FOLLOW-UP results. From Figure 14 the overall log odds ratio score was 0.69, which indicates that the interventions were generally unsuccessful in reducing antibiotic use.

Figure 15: Forest Plot of review studies' FOLLOW-UP data

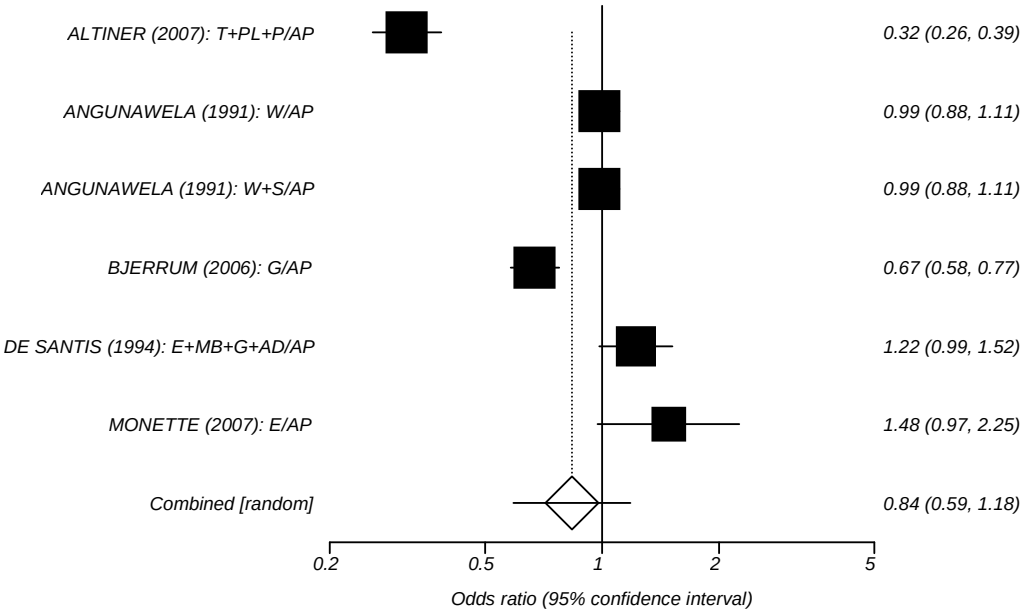
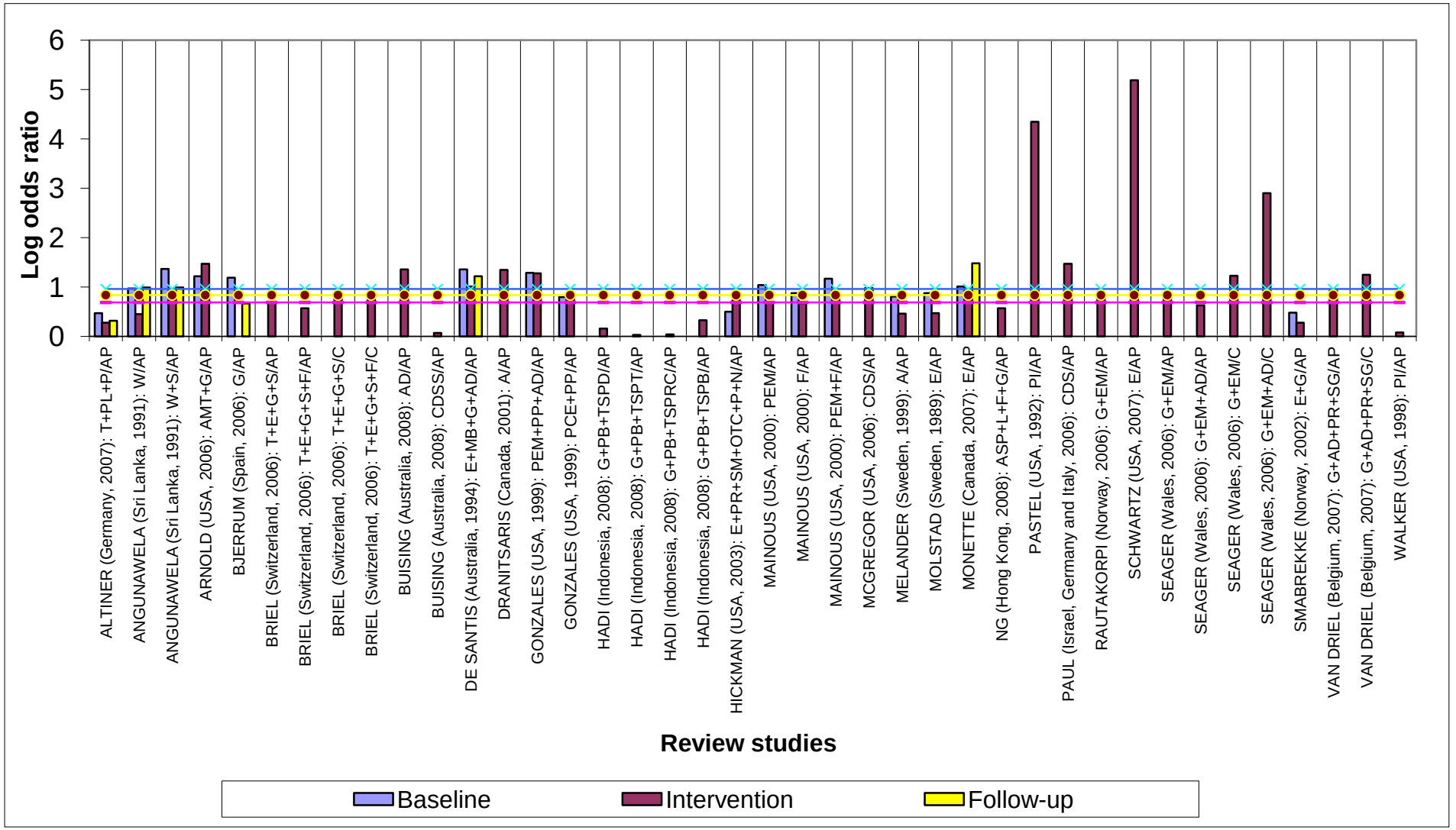


Figure 15 shows that only five of the twenty-five studies recorded FOLLOW-UP results. The overall FOLLOW-UP log odds ratio score of 0.84 indicates that these intervention methods were also unsuccessful in reducing antibiotic use in the long term.

The results of the three previous Forest Plots (Figures 13, 14 and 15) have been summarised in Figure 16 in order to show comparisons for the intervention(s) used in review studies. Figure 16 also indicates the countries where the review studies were conducted.

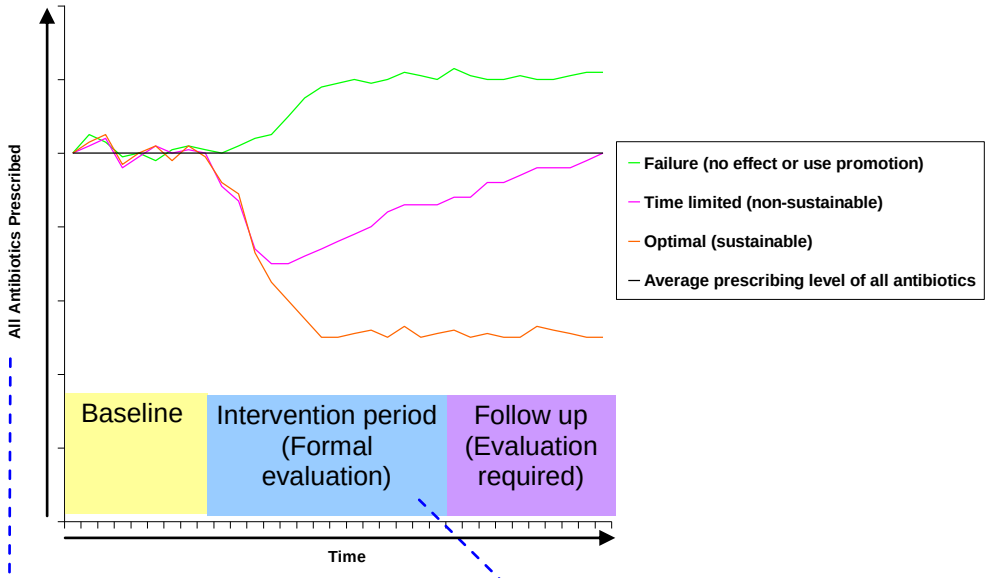
Figure 16: Histogram showing the log odds ratio scores achieved by review studies for each intervention period, including the corresponding overall log odds ratio score for comparison



4.10.6 Determination of the "ideal" intervention

Figure 17 shows three outcomes possible when an intervention(s) is implemented.

Figure 17: Modelled data for antibiotic use with control interventions



Outcome measure used in review studies	Definition
COMPLIANCE	Measure used in studies to demonstrate the appropriateness of prescribing (i.e. in accordance with requirements within the intervention)
PRESCRIPTION NUMBERS	Measure used in studies to demonstrate the number of times an antibiotic was prescribed to a patient to treat any given condition

Summary of interventions used in review studies
Audit
Academic detailing
Antimicrobial Management Team
Antibiotic Stewardship Program
Computerised Decision Support
Education
Feedback
Guidelines
Lectures
Mail Brochures
Newsletters
OTC prescription pads
Posters
Pocket Book
Pharmacy Intervention
Patient Leaflets
Practice Profiling
Presentations

Figure 17 shows that there is generally a period of "noise" before any intervention is implemented where prescribing fluctuates slightly above and below a "normal average" value, followed by three possible effects that the interventions could have on prescribing. The optimal line is the desired result with antibiotic prescribing reducing when an intervention is introduced and remaining low once the intervention is complete (if reduction is desirable i.e. not cases where you want to promote appropriate use). However Figure 17 shows that no study displayed these desired characteristics. A time limited result involves the reduction of antibiotic prescribing when an intervention is implemented, however unlike an optimal intervention(s), prescribing subsequently increases moving towards "normal average" levels. A failing intervention never results in a reduction in antibiotic prescribing below "normal" levels and may even lead to an increase (promotion) in antibiotic prescribing.

The interventions implemented in the review studies varied markedly. However, the present study has categorised all of the interventions used into sub-sets, within which similar approaches and methods were taken. Table 10 summarises each intervention categorised using key areas of analysis; the influence of intervention, the general type of intervention used and the target audience.

Table 10: Classification of intervention definitions used within review studies

Intervention mentioned in review study	Abbreviated term	Intended influence on prescribing	Type of intervention	Target audience
Audit	AUDIT	Long term	Education & Feedback & Surveillance	Prescribers
Academic Detailing	ACADEMIC	Long term	Education & Feedback	Prescribers
Antimicrobial Management Team	MANAGEMENT TEAM	Long term	Education & Feedback & Surveillance	Prescribers & Patients
Antibiotic Stewardship Program	STEWARDSHIP	Long term	Education	Prescribers & Patients
Computerised Decision Support	IT	Long term	Education & Feedback	Prescribers
Education	EDUCATION	Long term	Education	Prescribers & Patients
Education Material	MATERIAL	Long term	Education	Prescribers & Patients
Feedback	FEEDBACK	Long term	Education & Feedback	Prescribers & Patients
Guidelines	GUIDELINES	Long term	Education	Prescribers
Lectures	LECTURE	Long term	Education	Prescribers
Mail Brochures	BROCHURE	Long term	Education	Prescribers
Newsletters	NEWSLETTER	Long term	Education	Prescribers
Prescription Pads	PADS	Long term	Education & Feedback	Patients
Posters	POSTER	Long term	Education	Patients
Pocket books	POCKET BOOK	Long term	Education	Prescribers
Pharmacy Intervention	PHARMACY	Long term	Education & Feedback & Surveillance	Prescribers & Patients
Patient Leaflets	LEAFLET	Long term	Education	Prescribers
Practice Profiling	PROFILING	Long term	Education & Feedback & Surveillance	Prescribers
Presentations	PRESENTATION	Long term	Education	Prescribers
Seminar	SEMINAR	Long term	Education	Prescribers
Staff Meetings	MEETING	Long term	Education & Feedback	Prescribers
Training	TRAINING	Long term	Education	Prescribers
Teaching sessions	TEACHING	Long term	Education	Prescribers

4.10.7 INTERVENTION results

Analysis of INTERVENTION results from Figure 16 show that eleven studies achieved a log odds ratio score greater than 1. However it is also important to consider the log odds ratio scores of corresponding BASELINE and FOLLOW-UP period from each study (if recorded), as they could also indicate whether an intervention was successful.

Figure 16 shows that eight studies produced log odds ratio greater than 1 with an INTERVENTION log odds ratio score greater than that of the corresponding BASELINE periods. Table 11 below summarises the interventions used in these eight studies (Arnold *et al*., 2006; Buising *et al*., 2008; Dranitsaris *et al*., 2001; Pastel *et al*., 1992; Paul *et al*., 2006; Schwartz *et al*., 2007; Seager *et al*., 2006; Van Driel *et al*., 2007) in order to determine any patterns of interventions used.

Table 11: Comparison of the interventions used in the review studies that achieved a log odds ratio score of greater than 1

	REVIEW STUDIES (INTERVENTION LOG ODDS SCORE ACHIEVED)								
INTERVENTION	SCHWARTZ (2007) (5.19)	PASTEL (1992) (4.35)	ARNOLD (2006) (1.47)	PAUL (2006) (1.47)	BUISING (2008) (1.36)	DRANITSARIS (2001) (1.35)	VAN DRIEL (2007) (1.25)	SEAGER (2006) (1.23)	***TOTAL NUMBER OF TIMES INTERVENTION USED***
ALGORITHM	X						X		**2**
ANTIMICROBIAL MANAGEMENT TEAM			X						**1**
AUDIT	X					X			**2**
CHOICE RESTRICTION					X				**1**
CLINICAL CASE VIGNETTES							X		**1**
COMPUTERISED DECISION SUPPORT				X					**1**
GUIDELINES	X		X		X	X	X	X	**6**
LAMINATED CARDS					X			X	**2**
MONTHLY NEWSLETTER			X						**1**
NATIONAL ABX PRESCRIBING					X				**1**
PATIENT INFORMATION LEAFLET							X	X	**2**
PHARMACIST INTERVENTION		X				X		X	**3**
POCKET SIZED BOOKLETS	X								**1**
POSTERS					X				**1**
PRESENTATIONS	X						X		**2**
QUARTERLY SPECIFIC REPORTS			X						**1**
RESEARCH EVIDENCE							X		**1**
WEEKLY AGGREGATED REPORTS			X						**1**
TOTAL NUMBER OF INTERVENTIONS	**5**	**1**	**5**	**1**	**5**	**3**	**6**	**4**	

Table 11 shows the combination and range of interventions used in those studies producing a log odds ratio score of greater than 1 in the INTERVENTION period.

From Table 11 eight studies (Arnold *et al*., 2006; Buising *et al*., 2008; Dranitsaris *et al.*, 2001; Pastel *et al*., 1992; Paul *et al*., 2006; Schwartz *et al*., 2007; Seager *et al*., 2006; Van Driel *et al*., 2007) used a combined total of eighteen interventions, eleven of which were only used once. "Guidelines" was the most frequently used intervention in the successful review studies.

The study with the highest log odds ratio score was conducted by Schwartz (2007) which used a combination of 5 different interventions. However, overall the number of interventions employed does not appear to correlate with the success of a study, since the next most successful review study (Pastel, 1992) only used a single intervention. This latter measure involved the intervention of pharmacists to monitor and highlight antibiotic prescribing inconsistencies, which was also used in two other successful review studies (Dranitsaris, 2001 and Seager, 2006).

4.11 Discussion

A systematic review has been conducted on literature describing interventions to improve prescribing practices with the aim of providing possible solutions to the escalating issue of bacterial resistance. The selection criteria used in this systematic review (Figure 9) resulted in the omission of 365,052 studies, with twenty-five containing information which met the study criteria and thus being categorised as the review studies.

The review studies were conducted worldwide, including work conducted in developing countries, resulting in the use of markedly differing layout and content, however none of the review studies required English translation. One possible limitation of systematic reviews revolves around the risk of failing to identify all crucial published work. However, the chances of studies being missed were minimised by employing rigorous search terms, using a range of databases and conducting reverse searches using citation and hand searching techniques. A limitation of the present review may have been the limited databases searched in comparison to other key systematic review. However the present review's study retrieval process was applied to other key databases such as EMBASE, OVID or CINAHL and found to produce no extra studies that may have been missed within the present review.

4.11.1 Overall results

Forest Plots were used to calculate the log odds ratio scores of BASELINE, INTERVENTION and FOLLOW-UP periods. The overall log odds ratio score for the INTERVENTION period was 0.69 whilst the BASELINE and FOLLOW-UP scores for interventions were 0.96 and 0.84 respectively, which indicate increased antibiotic use during the INTERVENTION period. However, it also has to be noted that out of the twenty-five review studies only eleven presented BASELINE and five presented FOLLOW-UP results.

The lack of studies including BASELINE and FOLLOW-UP results may have had a significant impact on the results obtained in the present review as the absence of these results may have skewed overall averages. Therefore, study designs requiring the reporting of BASELINE and FOLLOW-UP results should be fundamental to all future research conducted in controlling antibiotic use to determine the actual impact and time course of any intervention(s).

4.11.2 Results in terms of review studies

The log odds ratio results were used to construct Forest Plots for individual studies. More in-depth analysis of interventions, however, demonstrated a lack of detail necessary to explain how interventions were conducted. For example "guidelines" were used nine times in review studies with most failing to detail the target audience, the duration of implementation and the "guideline" format and content.

It is possible that a study producing a low log odds ratio score actually used poor "guidelines" and/or failed to implement "guidelines" effectively during the INTERVENTION period. Therefore, the variability within studies cannot be precisely accounted for, which is a limiting factor of the present systematic review.

In cases where there have been multiple interventions adopted, little information was provided on how interventions were combined, why certain combinations were chosen and who exactly implemented them.

4.11.3 Study design of review studies

A quality assessment tool was used to determine the robustness of review study methods based on NICE (2005) and The Cochrane Library (2007). Both the present systematic review and the systematic reviews summarised in Table 7 have used the criteria described by the EPOC group, as described in the Cochrane Library.

A key difference between the present review and the reviews analysed in Table 7 was the inclusion of all types of studies in the review. The criteria described by the EPOC group only allowed quality analysis of randomized controlled trials, quasi-randomised controlled trials, before and after studies and interrupted times series. Therefore an additional quality assessment tool had to be incorporated within the present systematic review to analyse studies that may not have been accounted for by the EPOC group. This was achieved with the checklist designed by the Centre for Statistics in Medicine at Oxford University (NICE, 2005).

A key limitation of the present systematic review was the ability to meta-analyse such possibly heterogeneous results. This was minimized by the requirement for all studies to contain control group results, however results should also have been qualitatively analysed. In doing so, the differences in study design, participants, and outcome measure used may have been accounted for more suitably.

4.11.4 Weighting system

The present systematic review did not place any exclusion criteria on the type of studies included. In doing so the probability of heterogeneity was increased, and encouraged within the present systematic review. In doing so the likelihood of including important studies in the present review was increased, in comparison to previous systematic reviews.

A limitation of the present systematic review was the implementation of a personalized weighting system. An alternative method to calculate study weighting could have been adopted to reduce the value of specific quality items included within studies by using a score of three, instead of two for those quality items not considered essential for inclusion within any given study design. However the results achieved by using this alternative method produced no differences in the ranking of review studies (in terms of study quality) in comparison to the personalized weighting system used in the present review.

Regardless of the several weighting system adopted, the quality assessment process highlighted the lack of explanation and detail for the methods used, making overall analysis of interventions difficult to achieve. Therefore, interventions were grouped and classified pragmatically.

4.11.5 Control groups

One methodological area regularly described inadequately was the use of control groups. This may have occurred owing to the circumstances faced when conducting research on prescribing, with some studies using retrospective control groups. The main limitation for studies using retrospective control groups was the unknown influence on results of factors other than the interventions used.

One flaw within some review studies which cannot be explained was the use of control group results without previously mentioning their involvement in the methods description. Overall there were thirteen study designs mentioned in the review studies, proving researchers used many different study methods in attempts to achieve intervention(s) success. "Control" was the most used term as the use of control groups were a requirement for inclusion in the

present systematic review. This is an example of poor methodological description and is an area that can be improved in future research.

The inadequacy of the review studies in reporting control group data could be explained by the inclusion of all study designs within the present review. The systematic reviews analysed in Table 7 shows that those key reviews only included randomized controlled trials, quasi-randomised controlled trials, before and after studies and interrupted times series. In doing so, the reviews ensured the presence of control groups within the data as they are an essential requirement within these study designs.

4.11.6 Primary outcome measure

It was striking that a wide range of outcome measures were used in the review studies and these were often employed in a range of complex combinations. The detail of descriptions of these measures was frequently limited and also there was little clear rationale for the use of any given intervention or combination.

The two outcome measures most commonly mentioned by the review studies have been "prescription numbers" and "compliance". Studies using "prescription numbers" analysed how many prescriptions of antibiotics were issued by prescribers to patients. Conversely, the outcome measure "compliance" involved how prescribers adhered to prescribing recommendations and was relatively subjective since there was limited consistency in measuring adherence within the review studies.

4.11.6.1 Review studies using both "compliance" and "prescription numbers"

The studies by Van Driel (2007) and Briel (2006) highlight the impact of the chosen outcome measures on the apparent effectiveness of interventions: the outcome measure "compliance" resulted in a larger log odds ratio score when compared to the corresponding score achieved using the outcome measure "prescription numbers". This raises the question of which

outcome measure should be used to assess the impact of interventions in controlling antibiotic use.

If minimising the spread of antibiotic resistance is merely a question of reducing antibiotic use then "prescription numbers" is appropriate, however "compliance" would be the ideal outcome measure if the primary aim was the measurement of improvement in antibiotic use. When using "compliance" as an outcome measure it is essential for studies to detail the "guidelines" implemented to determine whether leniency in adherence resulted in higher log odds ratio scores.

In light of the differences in results achieved by studies reporting either of these outcome measures, a limitation of the present review was the meta-analysis of studies reporting either "compliance" and "prescription numbers". This provides further support for the use of qualitative analysis to analyse the review studies rather than meta-analysis.

4.11.7 Limitations and strengths of this systematic review

The present systematic review has highlighted a number of limitations which have restricted the quality of the results obtained. These limitations must be juxtaposed with the potential significance of the results achieved: this systematic review has successfully reviewed all international studies reporting an intervention intended to control antibiotic use. This has not been previously completed and the results can be used to influence future work and improve not only how research in this area is conducted but also how the findings are presented.

4.12 Conclusion

In conclusion most research conducted on the control of antibiotic use has not been of the quality required to provide robust results, therefore more appropriate research is required in the future.

The outcome measures used to assess the impact of an intervention in controlling antibiotic use also need to be validated and refined. Using "prescription numbers" is an easy way of gathering results but does not truly reflect "control" of antibiotic use.

Antibiotic prescribing can fluctuate depending on seasons, with more prescriptions issued in cooler seasons, because of the rise in associated respiratory tract infections. If "prescription numbers" is used as an outcome measure, careful consideration of the intervention period is required to reflect the natural fluctuations that occur. This issue should however also be supported by the use of appropriate control groups.

The analytical research carried out raises the question of how success in controlling antibiotic use is defined. This review has highlighted many limitations in review studies which may have hindered the precise determination of which interventions improve antibiotic use. Therefore if this systematic review is to be repeated in the future, it is essential to qualitatively analyse results.

Ideally future research would provide an accurate, complete definition of any intervention(s) with an appropriate log odds ratio score that reflects success; the latter should be greater than 1, greater than all other intervention(s) in the review, and show optimal success (as defined in Figure 17) in reducing antibiotic use, thus demonstrating sustained success. The present systematic review has failed to highlight any study showing this pattern of success.

In order to identify a successful intervention able to improve antibiotic prescribing practices, future research must define and document intervention(s) and record the effects of BASELINE, FOLLOW-UP and INTERVENTION scores. This would require long term analysis of the effects of any interventions implemented. This is in addition to the inclusion criteria set within the QUOROM flow chart in Figure 9.

Regardless of the improvements that need to be made with future research, the results of the present systematic review do indicate that a combination of "guidelines" and "pharmacy"

intervention have the greatest potential to improve antibiotic use. Therefore pharmacists should be employed within healthcare systems to achieve appropriate prescribing by educating prescribers with the use of antibiotic guidelines as an initial best guess before categorical evidence based data is obtained.

5. Exploration of the current policies to improve antibiotic prescribing with NHS managers

5.1 Introduction

The systematic review described in Chapter 4 reported a number of interventions used to improve antibiotic prescribing practices, with pharmacists being a key intervention to improve antibiotic prescribing. Therefore this chapter will focus on exploring the impact of methods used by pharmacists working within the National Health System (National Health System managers) to improve antibiotic prescribing.

5.2 Aim

- To explore, examine and gain a detailed understanding of the optimal strategies and procedures used by National Health System managers to improve antibiotic prescribing.

5.3Objectives

1. To conduct semi-structured interviews with NHS managers working in selected Primary Care Trusts to determine what interventions are, and have been, used to improve antibiotic prescribing and how antibiotic use is analysed, through:
    a. Attainment of ethical approval.
    b. The selection of sampling strategy.
    c. The development of an interview guide.
    d. The conduct of a pilot interview.
    e. Digitally recording semi-structured interviews conducted.
    f. Transcription of semi-structured interviews conducted.
    g. Thematic analysis of semi-structured interviews conducted.

2. To collect naturally occurring data from a selected PCT to determine what interventions are, and have been, used to improve antibiotic prescribing and how antibiotic use is analysed, through:
    a. The selection of sampling strategy.
    b. The selection of storage method for data collected.
    c. Identification of themes and concepts.
    d. Generalisation of data.

5.4 Choosing data collection methods for qualitative research

The aims and objectives of the present research heavily influence how qualitative research is used to obtain the required information (Ritchie and Lewis, 2003). Qualitative research itself, can be divided into naturally occurring data and generated data (Ritchie and Lewis, 2003), with the present research combining both naturally occurring and generated data in order to achieve the set aims and objectives.

5.5 Sampling strategies for the present qualitative research

Qualitative research uses non-probability sampling to select the population for study, where units are deliberately selected to reflect particular group. Therefore, a decision was made in the present research to purposively sample NHS managers within Medicines Management teams in order to generate data, and obtain naturally occurring data within one of these Medicines Management teams on the basis of their previous ability to improve antibiotic prescribing.

The first advantage of using a purposive sample was to ensure that the chosen participants were relevant to the research aims of identifying and examining previously developed strategic and operational interventions designed to decrease the development of antibiotic resistance through improved antibiotic prescribing practices. The second advantage of using

a purposive sample was the ability to ensure the chosen participants provide enough diversity to explore the impact of the characteristic concerned. The stages of purposive sampling will be discussed in further detail below.

5.5.1 Identifying the population for study

The key population within this present research are NHS managers working within Medicines Management departments, who are all situated within Primary Care Trusts and are involved in improving antibiotic prescribing within their given region. Therefore an assumption can be made that the required population is homogenous, with a small sample providing the internal diversity required. As a result, a sample of four NHS managers was considered appropriate in order to provide the internal diversity required to generate data and one Medicines Management department required appropriate to obtain naturally occurring data.

5.5.1.1 The choice of purposive selection criteria

The choice of the four NHS managers required for the data generation process will be based upon their PCT's current and previous antibiotic prescribing figures (over the past ten years) in order to provide the internal diversity required. The first PCT was chosen as they had gone from being one of the highest prescribers of antibiotics to one of the lowest in comparison to all other PCTs across the country. The second PCT was chosen because their antibiotic prescribing had risen from being one of the lowest to one of the highest prescribers in comparison to all other PCTs across the country. The final two PCTs were chosen as they were either consistently high or low prescribers of antibiotics in comparison to all other PCTs across the country. The participating NHS managers have to be the Heads of Medicines Management within their respective PCTs.

5.5.1.2 Deciding on the locations for the study

The chosen location for the qualitative research was the West Midlands Strategic Health Authority as this region contained PCTs that achieved the desired selection criteria set in the previous section and thus maximises the financial resources available.

5.6 The conduct of semi-structured interviews

An interview guide was produced and consisted of semi-structured questions required to yield relevant responses from interviewees. All interviewees were sent the study topics prior to the set meeting with explanations of why they had been incorporated within the interview to maximise the retrieval of information (see Table 12). Also interviewees were instructed that the interview would be conducted over an hour period.

5.6.1 Ethical considerations

Ethical approval was sought from all interviewees' Primary Care Trusts, who concluded that no ethical approval was required as the research was considered as feedback from clients on professional practice. However, all interviewees were provided with information about the purpose of the study, the funder, how the data was going to be used and what participation was required from them prior to their consent to participate in the interview. Table 12 below shows the study topics that were discussed with all interviewees and thus provide an idea of how much time would be required. Also all interviews were conducted out of work hours to ensure interviewees did not commit any of their work time to the interviews.

Table 12: Justification for the use of the chosen study topics.

Study topics	Decision for use
Antimicrobial Specialist/role of the Primary Care Trust	Used to determine the employee(s) responsible for devising strategies to control antibiotic use within their Primary Care Trust level
Government Involvement	To clarify the perceived support Primary Care Trusts receive from the government.
Present policies	Used to determine what interventions have been put in place to control antibiotic use, and why they have been used
Antibiotic data	Used to analyse how Primary Care Trusts deal with antibiotic data, and how they determine whether antibiotic use is reaching levels that require control
Outcome measures	There are many different outcome measures that can be used to present data, therefore this area of analysis was used to determine what outcome measure was chosen and why
Previous policies	Used to assess the representatives knowledge of what interventions had been used previously to control antimicrobial use, and deem whether they were successful or not
	It was also important to determine whether these interventions were continued to be used, or discarded, and why
Time frame	Used to determine how long it takes to introduce an intervention and how long they are utilised
Follow-up	It was essential to find out how interviewees decide on how effective an intervention has been, do they use audits to analyse?
Final comments	Used to conclude the interview and obtain any final pieces of information that the interviewees want to disclose

5.6.2 Pilot

A pilot semi-structured interview was conducted in order to analyse the quality of responses achieved from the questions posed.

5.6.3 Purposive sampling

A purposive sample of four current Heads of Medicines Management were selected and approached to participate in the semi-structured interviews. They were chosen as their respective PCTs showed marked differences in antibiotic prescribing over the past ten years. Therefore the heterogeneous sample would maximise differences and facilitate the collection of diverse data and uncover similarities in approaches used to improve antibiotic prescribing

and opinions on how antibiotic prescribing is controlled nationally (Ritchie and Lewis, 2003). The four Heads of Medicines Management from these selected PCTs agreed to participate in the semi-structured interviews and will be referred to as the 'interviewees' from this point on. The research settings were allocated for the convenience of the four heads of Medicines Management, thus ensuring their participations in the semi-structured interviews.

5.6.4 Digital recording

Digital recordings were used to encapsulate the depth and tone of the interviewee's own language in order to add another dimension to the analysis of interviewee responses.

5.6.5 Transcribing

The interviewer transcribed verbatim each interview as Word documents on the same day that they were conducted (see Appendix 5).

5.6.6 Thematic analysis

The process of transcription aided familiarisation with the information provided by interviewees. An index was generated using the transcribed data with information tagged into the relevant sub-topics to identify connections between them.

5.7 Key features of the combined approach

The combined approach provided an opportunity to seek plausible accounts of how antibiotic prescribing was controlled by focusing on the use of language and descriptive understanding to capture and interpret common sense, substantive meaning in the data and to identify all key themes, concepts and categories. The key features of the combined approach are explained below.

5.7.1 The setting for the combined approach

The West Midlands SHA region was used as the setting for the combined approach and contained a total of seventeen PCTs. In order to maximise the quality of the data obtained a decision was made to conduct the combined approach within one PCT rather than all PCTs within West Midlands region. The combined approach was used to obtain naturally occurring data from Sandwell PCT with 37.5 hours a week, between December 2008 and October 2009 dedicated to the collection of data.

Sandwell PCT was the ideal choice of PCT within the West Midlands SHA region owing to the demographics and location of departments within the PCT. The key demographic factors that were considered within the present research were a low level of white ethnicity and a high level of deprivation within a given region. In doing so, issues and impact of residents who are culturally diverse and living a lower quality of life were accounted for in the present research. Within the West Midlands, Sandwell was the second most deprived region (The English Indices of deprivation, 2008) and contained the second lowest percentage (79.7%) of people of white ethnicity (Sandwell Trends, 2008). Heart of Birmingham PCT contained the most deprived population and lowest percentage (30%) of people of white ethnicity (Heart of Birmingham, 2008) within the West Midlands. However Sandwell PCT was chosen as the source of naturally occurring data as the Public Health and Medicines Management departments were located within the same building and thus excluded environmental factors as sources of differences between how the two departments are able to improve antibiotic prescribing.

5.7.2 The primary focus of the combined approach

There were two main approaches to analysis, analytical and substantive meanings (Ritchie and Lewis, 2003). In the present research a decision was made to capture and interpret common sense, substantive meanings in the data. This was achieved with all the naturally occurring data techniques incorporated within the combined research.

5.7.2.1 Data storage

The combined research could potentially yield a high volume of data, especially as the data was scheduled to be collected over a ten month period. Therefore attempts had to be made to store the data appropriately in order to allow effective analysis. Consequently, data reduction was a necessity and was achieved in the following research by using thematic summaries (descriptive accounts) and graphic displays of synthesised data. Data was produced within Microsoft Office and stored on a computer to allow ease of storage.

5.7.2.2 Concepts generation

When analysing qualitative studies, a decision was made not to apply any initial labels on the data and instead allow participants to provide their own terminology. These findings could then be developed into more definitive concepts at a later stage.

5.7.2.3 Applying concepts to the data

There were two methods that could have be used to organise and analyse labels and categories, cross sectional 'code and retrieve' and non-cross sectional analysis (Mason, 2002). Cross sectional coding involves the application of categories to the whole data set and therefore allows the retrieval of data. Non cross-sectional data organisation requires the separate analysis of all parts of the data and thus requires an alternative conceptualisation of categories. A decision was made to use cross-sectional coding within the present research as it offered a systematic overview of the data. Therefore all data was separated into folders, depending on the labels and categories placed on them.

5.7.2.4 Analytical tools

In order to undertake robust analysis, it was important to refine and interpret the data collected. As mentioned earlier, all the data was stored on a computer, with data placed in separate folders, depending on the category or categories they encompass. An advantage of using this storage system was the ease within which new categories could be developed with emergent ideas or concepts and the ease with which the naturally occurring data could be re-analysed if required.

As the data was manipulated and stored within different folders it was important to ensure that copies of the naturally occurring data were kept in the original format. Therefore an "original" folder was used to store all primary data.

5.7.2.5 Identifying themes and concepts

The first stage of concept generation was familiarisation with the data, which was further enhanced by personally conducting all qualitative research (including the semi-structured interviews). Following on from this, the second stage involved identifying recurring themes with the data. The combination of these first two steps produces the initial conceptual framework.

Once produced, the conceptual framework was applied to the data obtained and was thus called 'indexing' (Richards and Richards, 1994). Indexing was applied manually and involved reading each graph, phrase, sentence and paragraph and determining which part of the index it applied to. The index was then stored on a computer and was used to electronically move data into the required categories. In some instances, the same data would be placed into more than one category, depending on the content.

The final stage of concept generation involved summarising the data. In order to ensure that the essence of the data was maintained, it was important to follow three key steps. Key terms and phrases were retained as much as possible, interpretation was kept to a minimum and material was not dismissed as irrelevant if their inclusion was not immediately clear.

5.7.2.6 Generalisation of data

Hammersley (1992) discussed generalisation as either empirical or theoretical, both of which could be applied to populations or settings other than the study sample. Empirical generalisation was defined as the application of qualitative research findings and theoretical generalisation was defined as the generation of theoretical concepts. As it was very difficult to distinguish between both empirical and theoretical generalisation, generalisation could be clarified as having three linked but separate concepts. These three concepts were defined as, representational, inferential and theoretical generalisation (Ritchie and Lewis, 2003).

Representational generalisation was the question of whether the results of the research sample could be generalised to the parent population from which the sample was drawn. Inferential generalisation took this concept further to determine whether the results could be generalised to other settings beyond the sampled one. Finally theoretical generalisation drew principles or statements that could be applied generally.

All these concepts were used in order to maximise the results obtained throughout the qualitative research process, which are shown below.

5.8 Results

The results section will be divided into the semi-structured interviews and combined approach. The discussion will then compare the results of both methods in order to determine the impact of methods used to improve antibiotic prescribing by current National Health System managers.

5.8.1 Semi-structured interview results

A key area of analysis during the semi-structured interviews was the intervention methods used by interviewees to improve antibiotic prescribing. Figure 18 summarises the interventions mentioned by interviewees.

Figure 18: A chart showing the intervention methods mentioned by interviewees during their semi-structured interviews

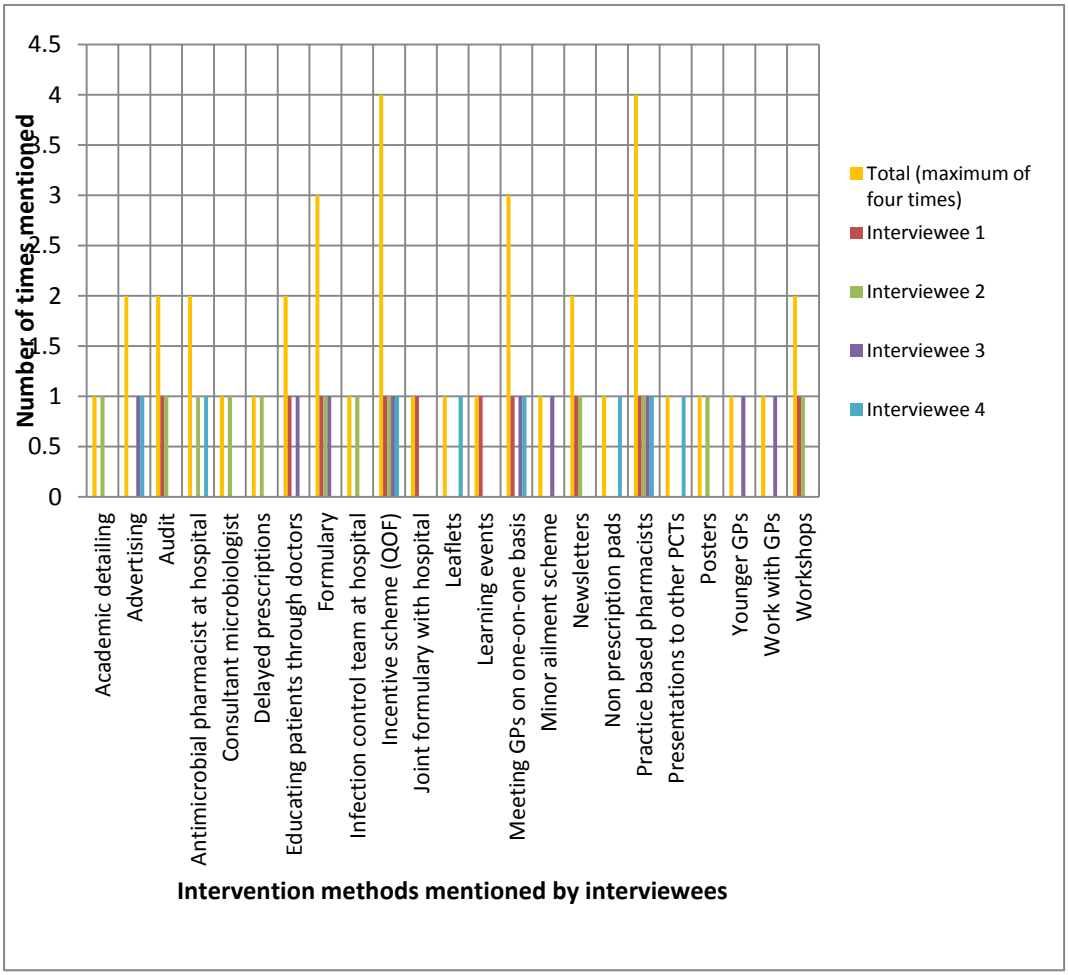


Figure 18 shows that there were twenty-three different intervention methods mentioned, all of which had been used in the review studies (Chapter 4).

Intervention methods mentioned by all interviewees were INCENTIVE SCHEMES and PRACTICE BASED PHARMACISTS. Three interviewees mentioned FORMULARIES and MEETING GPs on a one-to-one basis. There was no one intervention mentioned by all interviewees that were classed as effective, or ineffective in controlling antibiotic prescribing.

Interviewees 1, 2 and 4 thought PRACTICE BASED PHARMACISTS were influential in improving antibiotic prescribing. Interviewee 1 quoted "The biggest success is having a pharmacist in the practice so they can nag the GPs really." This view was supported by interviewee 4 who quoted that "Practice pharmacists are very much clinical and so they can look at an individual practice basis and they can go to a practice meeting and say look

antibiotic prescribing is rubbish, what are we going to do to improve it." Interviewee 2 also stated that PRACTICE BASED PHARMACISTS were a "standard technique used in changing behaviour". Interviewee 3 also considered PRACTICE BASED PHARMACISTS to be a good idea, however felt that "As soon as you take pharmacists out of that practice the GPs will just carry on with their same behaviour." Therefore Interviewee 3 has focused on interventions that "change patient and GPs' behaviour towards antibiotics".

The use of INCENTIVE SCHEMES was another intervention discussed by interviewees. Interviewee 4 did not directly express whether it was effective, or ineffective in improving antibiotic prescribing by quoting "We have got prescribing incentive scheme this year, which has got in it a little about cephalosporin and ciprofloxacin. Basically if the practice has got a greater than average antibiotic use, they must agree to reduce the use of those antibiotics as part of their QOF target. If they don't, they will have their reward reduced by 50%. So it is fairly tough. If they are below average then they won't have to address it because they are not too bad. It is just the top few practices that tend to use them". Interviewees 1, 2 and 3 all were quoted as saying that the incentive scheme was effective in improving antibiotic prescribing. Interviewee 2 quoted "We have used that as a measure in many incentive schemes and so that brings volume down a bit because people take notice of it." Interviewee 3 also was quoted as saying "We also have a prescribing incentive scheme, which has been knocked around in the last couple of years. But if you get it right it is probably the best way to get changes in prescribing."

Interviewee 1 also agreed but raised the issue of how financially costly it could be by quoting the following "Incentives always help but you have to get the funding for it." Funding was also a factor raised by Interviewee 3 who was quoted as saying "We are fairly lucky because we are a fairly cash rich PCT, and because of the work my team has done, if I wanted another post to do something specific, I can always get funding for that from this PCT."

Interviewees also provided their opinions on the success of other interventions used to improve antibiotic prescribing. Interviewee 2 discussed ACADEMIC DETAILING, NEWSLETTERS and ADVERTISING and said "Academic detailing, the newsletter type thing that doesn't work." Interviewee 2 also believed ADVERTISING could not successfully control antibiotic prescribing and quoted "So the government can do their campaign, it will raise public awareness, fine. But that won't affect the volume of antibiotics prescribed."

Interviewee 3 provided an opinion on the effectiveness of FORMULARIES by quoting "You shouldn't have a formulary for antibiotics because GPs are very simple creatures. If you say to them use amoxicillin for simple chest infections, they will hear it is okay to use amoxicillin." This view wasn't expressed by Interviewees 1 and 4 who used formularies to influence their prescribing and believe that GPs actually need a formulary, with Interviewee 4 quoting "Many of ours need a formulary frankly." Interviewee 1 was quoted as saying "Antibiotic formulary that is agreed and updated every year with the local microbiologists and clinicians obviously, and that goes out and is available on our website on our intranet and that supports GPs and their prescribing and it is a guideline and formulary, you know, this is first line, this is second line, and why, so I am fairly confident we do prescribe pretty much to formulary." Interviewee 2 didn't provide an opinion on the use of FORMULARIES but did state that "We don't have a formulary. That was flagged up by the Healthcare Commission, we are actually developing that at the moment."

Of the present policies mentioned, three of the four interviewees considered PRACTICE BASED PHARMACISTS to be a successful method of controlling antibiotic use, with the only exception being interviewee 3 (as discussed earlier). The use of FORMULARIES was also mentioned as a current intervention used, or about to be used, by all interviewees except interviewee 3. The systematic review completed (Chapter 4) also supported the interviewees views, with two possible successful interventions being the use of PHARMACISTS and the implementation of GUIDELINES.

5.8.1.1 Time frame

Figure 18 shows that there are a number of possible interventions available to aid NHS managers improve antibiotic prescribing. A key area of discussion within the semi-structured interviews was the time frame used for their chosen intervention. There was a general consensus from interviewees that priorities were set each year and then reassessed for the forthcoming year, with only interviewee 3 adopting a "two-year plan" for set priorities. Interviewee 1's response summarises how long Interviewees 2 and 4 also set their interventions for with the quote "We do them in yearly blocks, so if you have an initiative going, we've got priorities this year and antibiotics is up there we will continue to monitor and feeding stuff throughout the year and we will monitor prescribing feedback from our team."

5.8.1.2 Antimicrobial specialist/role of Primary Care Trust

All interviewees mentioned the presence of antimicrobial specialist(s) at hospitals within their region. Interviewee 4 stated that they were also appointing an antibiotic pharmacist within their department "who can look at the use in primary care, nursing homes" in order to 'Close the loop". Interviewee 1 only mentioned the presence of an antibiotic pharmacist at their local hospital "who we can call upon". Interviewee's 2 and 3 however provided more detail of their direct relationship with the antibiotic pharmacists used to produce a "joint formulary".

5.8.1.3 Antibiotic data and outcome measures

The semi-structured interviews confirmed that all Primary Care Trusts used outcome measures for antibiotic prescribing. However there seemed to be no universal outcome measure used to present antibiotic data at Primary Care level, which could lead to inconsistency in the analysis of antibiotic prescribing between PCTs. Interviewee 1 stated that "Items of antibiotics prescribed don't give you the full picture" whilst Interviewee 3 was quoted as saying "You have to remember changing antibiotics isn't about cost, but because we have done it we've probably saved around 250000 pounds a year on reduced prescribing within this PCT, so you can justify doing it anyway." Interviewee 4 mentioned that antibiotic prescribing data was provided by "ePACT" who provide a "quarterly toolkit", however did not provide knowledge of exact outcome measures used. In comparison, Interviewee 2 provided details of outcome measures used and was quoted as saying "Previously for antibiotics we have used items per STAR-PU and the number of scripts per patient."

5.8.1.4 Government involvement

All interviewees provided a wide range of views on how the government helps/influences antibiotic prescribing and how information on improving antibiotic prescribing was disseminated to Primary Care Trust level. Interviewee 4 stated "I don't understand why when the government are looking at MRSA and C Diff in hospitals so bad that and that there is a link to antibiotic use, why they don't they get the message out to the public and the GP's. I know there is a perception that the public are requesting it, but in some of our areas it actually

is." Interviewee 1 also quoted that "There is government funding coming down for infection prevention control but not for antibiotics, nothing related to prescribing."

All interviewees discussed the role of the Strategic Health Authority (SHA) and provided differing views of their impact on antibiotic prescribing. Interviewees 2 and 3 both stated that the role of the SHA "has never been well established" and thus they "don't know" exactly what their role is. Contrarily, Interviewee 4 quoted that "They liaise between the Department of Health and PCT level, so it's that kind of cascade of information." Interviewee 1 also stated that representatives from the SHA "did presentations around the other PCTs".

The level of communication between the Heads of Medicines Management of Primary Care Trusts also seemed to be an issue as all four interviewees met regularly, although it was ambiguous whether these were successful for exchanging ideas. Interviewee 4 was quoted as saying "we do work a lot together", whilst Interviewee 2 quoted that "there is certainly shared practice", Interviewee 3 only mentioned that the Heads of Medicines Management "meet as a group" and did not provide any more information.

5.8.2 Results of the combined approach conducted at Sandwell PCT

The combined approach was conducted at Sandwell PCT in order to analyse exactly how a Medicines Management department within PCTs attempt to improve antibiotic prescribing. The results will detail all the interventions used within the Medicines Management team to control antibiotic prescribing in terms of; who was responsible for the implementation and progress of intervention, what the intervention entails and when the intervention was implemented.

5.8.2.1 Audits

Audits have been used for many years to evaluate the quality of prescribing, with antibiotics audited to determine the indication for use, dosing and length of treatment.

5.8.2.1.1 How were audits completed?

The Medicines Management team had always completed audits on a range of drugs on behalf of surgeries within the Sandwell PCT. However the detail of the completed audit depended largely on the ability of the Medicine Management team to balance the number of audits requested against the time available within surgeries to complete the required audits.

For example if a surgery required an antibiotic audit to be completed, a member of the Medicines Management team would arrange a series of dates with the surgery to complete the audit. The detail in which audits were completed depended on the number of patients prescribed antibiotics in a given period of time balanced against the amount of time available to the Medicines Management team member to complete the audit. If the designated member of the team did not have enough time available in their schedule to complete the antibiotics audit in detail, time would be saved by reducing the number of criteria required to complete the audit, such as the indication for use and the patient date of birth.

Antibiotics were mainly audited at those surgeries participating in the antibiotics incentive scheme (explained further in section 5.8.2.1.8) or where the number of antibiotics prescribed exceeded the average antibiotic prescribing within Sandwell PCT.

5.8.2.1.2 Pharmacist and technician involvement

The structure of the Medicines Management team had resulted in an inconsistent spread of pharmacists and technicians working at surgeries within Sandwell PCT, meaning that any pharmacist and/or technician could be required to complete an audit. The differing levels of expertise, qualifications and experience may have therefore had an impact on the results and detail present within audits.

5.8.2.1.3 Audit template

All audits conducted by the Medicines Management team have required the completion of an audit template on a Microsoft Excel spread sheet. The audit templates were individualised to the drug(s) being audited, with antibiotics audit templates including information such as age of patients, drug name and indication for use.

The responsibility for the template content was delegated to the pharmacist present within the surgery. However, if no pharmacist was present within a surgery then a technician was delegated the task of completing the audit template produced with the help of a pharmacist from the Medicines Management team. Pharmacists had autonomy in the design of audit templates produced and thus there were no single standardised templates used, which resulted in inconsistent results.

5.8.2.1.4 Prescribing software

The lack of control demonstrated by Sandwell PCT over the choice of a single prescribing software choice for surgeries resulted in the use of five different prescribing softwares within surgeries in Sandwell PCT. These were Synergy, EMIS, SystmOne, Torex and Vision, all of which contained unique programs to produce audits and thus influenced the inconsistent retrieval of results. For example Vision did not allow patient numbers or indication for antibiotic use to be searched like all other software, instead patient records had to be analysed manually to retrieve the required data.

5.8.2.1.5 Length of audit period

The chosen length of audit period was ultimately decided at the discretion of the pharmacist or technician completing the audits, thus leading to inconsistent lengths of audit periods. Their judgement was dependant on the amount of time they had to complete the audits, the number of patient records they would have to search through to complete an audit template, their ability to maximise the computer software and the quality of records kept by prescribers. There was no direction from the Head of Medicines Management on how many patient records were required to validate the audit, or deadlines for the audits.

5.8.2.1.6 Antibiotics audited

Antibiotics prescribed in Primary Care included; cephalosporins, quinolones, macrolides, penicillins and tetracyclines with the choice of antibiotics chosen for audit depending on their association to cases of resistance (and the consequences of resistance). Therefore audits in Sandwell PCT focused on cephalosporin and quinolone prescribing within surgeries. A drawback of focusing on specific antibiotic groups was the lack of knowledge the reduction of one antibiotic class had on the use of others. For example focusing on reducing cephalosporins may have increased the use of co-amoxiclav.

5.8.2.1.7 Actions set and follow up

The results of completed audits were reported back to prescribers, from which actions were set with prescribers to improve prescribing. However once actions were set there was no consistency in the follow up audits to ensure actions were completed successfully. This negated the importance of the audit as the follow up on improvements were not consistently assessed.

5.8.2.1.8 Prescriber incentives

There were two incentive schemes provided to surgeries by the Medicines Management team called the Prescribing Incentive Scheme (PrIS) and mm6. The aims of these prescribing incentives were to motivate prescribers to improve prescribing by providing financial rewards based on the results of audits completed at the start and end of the financial year.

The PrIS was developed by the Medicines Management team in 2006 with financial rewards provided for improvements within surgeries. A selection of audit targets were provided each year to all surgeries, with the final choice of targets being decided in a meeting between prescribers representing a surgery and a pharmacist representing the Medicines Management team.

In June 2003 the government modernised general practice by producing an NHS contract between PCTs and surgeries (not individual prescribers) called the GMS contract. Under the Medicines Management section of the GMS contract surgeries were provided points for achieving targets (called mm6). The financial rewards were calculated using a formula based

on the number of points achieved and the surgery population profile, such as list turnover for each surgery and the cost of living for staff.

5.8.2.1.9 Quality of record keeping

The success of any audit was dependent on the quality of record keeping by prescribers, therefore it was essential for all prescribers to record all patient consultations appropriately on their prescribing software. The quality of record keeping may have been affected by many factors, two of which include IT literacy and prescriber motives.

The lack of IT literacy demonstrated by a prescriber affected the quality of patient records kept on the computer software with the prescriber writing very minimal notes on the prescribing software or relying on paper notes, thus reducing the amount of information retrieved on audits.

The motives of prescribers also affected results of audits as information may have been purposely omitted in the hope that the Medicines Management could not retrieve the required data to complete audits. In doing so it was impossible for actions to be set, as the results were considered invalid.

5.8.2.2 Newsletters

There were two newsletters produced by the Medicines Management team every financial quarter that targeted pharmacists and prescribers. The contents of the newsletters were based on current topics of interest or issues pharmacists within the Medicines Management wanted to feedback to either GP's or pharmacists, meaning that the issue of antibiotics and resistance would only be mentioned in newsletters on an *adhoc* basis when there were growing concerns over antibiotic prescribing.

A pharmacist within the Medicines Management team was responsible for the continuing production of the Newsletters and decided on the content after discussion with all members of the Medicines Management team.

5.8.2.3 Policies and formulary

The Sandwell PCT Formulary was revised by the Head of Medicines Management every two years and contained an antibiotics section focusing on treatments for general conditions seen within Primary Care. There was no consultation with the infection team present at the Acute Trust on the choice of antibiotics in order to factor in local sensitivity and resistance data. The impact of the formulary had never been analysed as data retrieval failed to assess compliance to formulary guidance.

5.8.2.4 Prescriber meetings

Prescriber meetings were the most popular strategy used by the Medicines Management team to inform prescribers, ranging from one-to-one meetings to practice meetings. The meetings were facilitated by all members of the Medicines Management team and involved discussion of any issues that needed flagging with prescribers. The prescriber meetings were either arranged on a regular basis or on an *ad hoc* basis.

5.8.2.5 Prescribing alerts

Alerts were an option used on some prescribing software and involved linking the choice of a drug with a pop up message appearing on the computer screen. Once installed, the prescribing alerts could only be stopped if uninstalled by the Medicines Management team. In the case of antibiotics, alerts were used to link the use of cephalosporins and quinolones to the rise of *Clostridium difficile*. Alerts had been implemented to some surgeries by different members of Medicines Management, thus leading to inconsistency in the content and appearance of the prescribing alerts.

5.8.2.6 Prescribing events

The Medicines Management team have conducted prescribing events for target audiences in an *ad hoc* manner because of requests to do so or events organised by the Medicines Management team. Antibiotic events have not been conducted regularly with only one large

event held in the past 3 years to address the issues of antibiotics and resistance to prescribers, with the presence of an influential guest speaker.

There was one event held every quarter called the Protected Learning Time (PLT) event available for prescribers who were incentivised to attend by providing a prescriber (free of charge) to cover their absence from their surgery. The contents of each PLT event was organised by the Medical Director who occasionally provided the opportunity to the Medicines Management team to influence a large audience of prescribers with presentations.

5.8.2.7 Surveillance

Antibiotic prescribing was analysed by a member of the Medicine Management team on a monthly basis using ePACT with all surgeries graphically placed in ranking order, from the highest prescribers of any given antibiotic at the top and the lowest at the bottom. Antibiotics associated to cases of resistance (and the consequences of resistance), which have been analysed in this manner include cephalosporins and quinolones. Analyses of the impact of individual interventions were never attempted with prescribing analysis, instead the focus was placed on how the PCT compared to the national average for total antibiotics, cephalosporin and quinolone prescribing.

5.8.2.8 Interaction with other Primary Care Trusts

There was very little communication between Sandwell PCT and neighbouring PCTs regarding antibiotics and infection control. Sandwell PCT shared the same Acute Trust as Heart of Birmingham PCT, however tackled issues of antibiotic control very differently.

Heart of Birmingham PCT did not have a Specialist Antibiotic Pharmacist and thus measured success in terms of prescription numbers with the objective being to reduce the number of total antibiotics prescribed. Alternatively, Sandwell PCT measured prescribing in terms of compliance with the objective of improving prescriber adherence to the formulary.

5.9 Discussion

Qualitative research was conducted in order to explore the impact of methods used to improve antibiotic prescribing by current National Health System managers within selected Primary Care Trusts. Two types of qualitative research were conducted, semi-structured interviews and the combined approach. The use of a combination of generated and naturally occurring data provided varying insights in order to achieve the aim set in section 5.2. The achieved results stimulated discussion of three areas which affect antibiotic prescribing; interventions, outcome measures used to analyse prescribing and government involvement to improve antibiotic prescribing.

5.9.1 Interventions

The qualitative research process highlighted a number of interventions that have been, and are currently used to improve antibiotic prescribing. However a key finding from the semi-structured interviews was the lack of agreement on which interventions successfully control antibiotic prescribing. The combined approach highlighted why this was the case, as the impact of interventions was never analysed. Instead the interviewees provided their opinions on which interventions they felt have worked within the multifaceted approach present within their PCT. Interviewees may have reached an agreement on the impact of interventions if focus groups were used and thus the use of semi-structured interviews may have been a limitation in this respect.

The most commonly mentioned interventions within the semi-structured interviews were incentive schemes, practice based pharmacists (pharmacy intervention), formularies or guidelines and meeting GPs on a one-to-one basis. The use of pharmacy intervention was highlighted as a key intervention used to improve antibiotic prescribing by Pastel (1992), Dranitsaris (2001) and Seager (2006) within the systematic review completed in Chapter 4. However, they also stated that caution was needed when generalising these findings to other settings as studies provided insufficient detail and comparisons in how pharmacy intervention was best achieved.

The use of guidelines was also seen as a key intervention used to improve prescribing within the systematic review completed in Chapter 4. This was supported by the systematic review

completed by Thomas *et al* (1999), who also concluded that caution was needed when generalising these findings to other settings as studies provided insufficient detail. Therefore more research was required in the application of both pharmacy intervention and guidelines to improve antibiotic prescribing within Primary Care, this was achieved through the combined approach used.

The combined approach also highlighted the importance placed on the use of incentive schemes to improve antibiotic prescribing within Primary Care. However, research conducted by Doran *et al.* (2011) and Campbell *et al.* (2009) on the impact of financial incentive schemes within Primary Care in England produced two key conclusions. Firstly, improvements in prescribing were associated with the use of incentive schemes, sometimes at the expense of quality of care with non-incentivised indications. Secondly, continuity of care was reduced after the introduction of the incentive scheme. Therefore the use of financial incentive schemes to improve antibiotic prescribing within Primary Care may be successful, however has to be balanced against the possibility of reduced quality of care in other areas of practice and also the need to for continuing incentives to ensure improvements in antibiotic prescribing were met.

The combined approach also highlighted the lack of importance placed on the use of audits to improve antibiotic prescribing, with their effectiveness in improving prescribing being supported by three systematic reviews conducted Ostini, *et al* (2009), Grindrod, *et al* (2008) and Arnold and Straus (2007). The combined approach identified that audits required the involvement of practice based pharmacists to provide analysis of prescribing at surgeries (especially those participating in the incentive scheme) by using the formulary to justify appropriate antibiotic prescribing. The results of the audits were then presented back to prescribers through practice meetings or one-to-one meetings.

Overall, the qualitative research has highlighted the scope of interventions available to improve antibiotic prescribing within Primary Care, however more research has to be undertaken to determine their impact on antibiotic prescribing. Therefore the outcome measures used analyse antibiotic prescribing is an important issue and will be discussed further below.

5.9.2 Outcome measures used to analyse antibiotic prescribing

The interviewees mentioned several outcome measures that had been used to analyse antibiotic prescribing, with only interviewee 4 indicating where this prescribing data was obtained from. Therefore there was no clarity on how these outcome measures were decided upon, or where this data was obtained or calculated. These questions were answered with the use of the combined approach as the source of data was found to be ePACT, which also contained agreed national outcome measures for antibiotic prescribing. These outcome measures were number of prescriptions and items per STAR-PU and were available to PCTs. The outcome measures were decided after consultation and agreement with all NHS bodies and were an example of assistance provided by the government to improve analysis of prescribing.

5.9.3 Government involvement in improving antibiotic prescribing

All interviewees demonstrated a lack of knowledge on how information was disseminated from the government to the Primary Care Trust level. This could firstly be the result of too many publications and policies produced by the Department of Health to guide control of antibiotic use, which made it difficult to track policies produced for antibiotics. Secondly there could be a lack of communication between the Department of Health, the Strategic Health Authorities and Primary Care Trusts in implementing the policies produced.

The level of communication between the Heads of Medicines Management of Primary Care Trusts also seemed to be an issue as all four interviewees met regularly, although it was ambiguous whether these were successful for exchanging ideas.

With regard to the direct implementation of interventions by the government, the interviewees expressed a need for national promotion of the implications of antibiotic use to the public. The interviewees felt that national awareness campaigns would help ease the pressures placed on prescribers and thus reduce overall antibiotic prescribing. Questions regarding the

influence of the SHA on antibiotic prescribing also provided mixed opinions with the majority of interviewees stating that they provided little assistance to improve prescribing.

Analysis of these issues through the combined approach seemed to provide agreement with the majority of views expressed by interviewees. The SHA provided little or no assistance to PCTs to improve antibiotic prescribing and the government never prioritised improvements in antibiotic prescribing as a national promotional campaign. The Department of Health website did contain antibiotic leaflets and posters which could be downloaded or ordered and used within healthcare practices. However no incentives were placed to use these documents, nor were they promoted to all health care bodies.

5.9.4 Limitations of the qualitative research used

The semi-structured interviews and combined research approaches used within the present research achieved the aim and objective set. However there were limitations in the research conducted which will be discussed further below.

5.9.4.1 'Theoretical saturation'

Ritchie and Lewis (2003) stated that "The key criteria for selection in theoretical sampling are theoretical purpose and theoretical relevance. Sampling continues until 'theoretical saturation' is reached and no new analytical insights are forthcoming. In so doing, the researcher does not look just for confirmatory evidence but also searches for 'negative cases."

The results of the semi-structured interviews highlighted that 'theoretical saturation' was not reached on many issues discussed as there were no firm conclusions on many issues covered. Therefore it can be assumed that more than four interviewees should have been selected to conduct the semi-structured interviews. The combined approach provided many answers to the issues concerned within the semi-structured interviews, however it could be argued that a limitation of the approach was that the research was only conducted in one SHA and PCT region. This limitation also applies to the selected interviews as they were all located within one SHA, therefore the results were maybe not representative of the situation in the rest of the United Kingdom. In hindsight, the purposive sample should have included more than four interviews and offered all Heads of Medicines Management within England the opportunity

to participate in the semi-structured interviews. More attention should have also been paid to the role of prescribers to improve antibiotic prescribing and they should have also been invited to participate in the semi-structured interviews as their insight may have provided more avenues to improve antibiotic prescribing and provide further insight into how effective the current government structure is in improving antibiotic prescribing.

5.9.4.2 Bias

Bias is a limitation that has already been touched upon within the discussion of 'theoretical saturation' as the qualitative research was only conducted within one SHA region. However bias may also have been present within interviewee responses and the behaviour of staff when conducting the combined approach. A key disadvantage of the semi-structured interviews was the balance between answers provided by interviewees against their openness in answering questions, although it was likely that a number of factors affected the answers obtained. These include, the location for the conduct of interviews, the time available to complete interviews, the interviewee interest in antibiotics resistance and the experience of the interviewees in their current roles. All attempts were made to keep the qualitative research as consistent as possible, however the nature of semi-structured interviews and combined approach means any bias present may have affected the approach adopted by interviewees and PCT staff.

5.9.4.3 Reliability

Semi-structured interviews are difficult, if not impossible to repeat exactly since many of the questions are not pre-determined and the interviewees are encouraged to talk freely and in-depth about many issues. Reliability was also an issue within the combined approach as it is very difficult to replicate the methods within other PCTs as the structure and availability of staff could vary greatly. Therefore reliability may have been a limitation within the present research.

5.9.4.4 The rigour of qualitative research conducted

A limitation of the present research was the use of a single pilot semi-structured interview in order to analyse the quality of responses achieved from the questions posed. Ideally, two interviews would have been used to pilot the interview schedule and the lack of pilot research and quality assurance approaches ultimately led to an oversight in how the interviews were approached and conducted. An example of this was the great variability in the information, as interviews were conducted at convenient locations for the interviewees and thus conducted within an open or private office. Conducting interviewees in open-plan offices may have led to interviewees not providing honest responses because of the presence of other colleagues within the office. In hindsight the qualitative research conducted was not as rigorous as it could have been and can be considered as a major limitation.

5.10.5 Further work

The qualitative research raised a number of areas within Primary Care where improvements can be made to improve antibiotic prescribing, focusing on increased communication, improved prescribing analysis and employment of antibiotic pharmacists.

5.10.5.1 Employment of Antibiotic Pharmacists

The semi-structured interviews have identified the presence of antimicrobial specialist staff either employed within PCTs, or employed at the local Acute Trust. However, the lack of knowledge between interviewees of which interventions successfully controls antibiotic use suggest that either there is poor communication between the antimicrobial specialist (working within Acute Trust and/or PCT) and heads of Medicines Management. To overcome this lack of information a Specialist Antibiotic Pharmacist should be employed at SHA level to evaluate the strategies implemented at PCT level, improve collaborative work between all PCTs in the region and to produce a detailed prescribing feedback tool.

5.10.5.2 Prescribing analysis

The qualitative research has identified the inconsistent analysis of antibiotic prescribing being undertaken at PCT level where different antibiotics were analysed and different outcome measures used to analyse their prescribing. Therefore a prescribing feedback tool should be produced which allows analysis of all antibiotics prescribed in Primary Care. The production of the feedback tool should be undertaken at SHA level to ensure there is consistency in the outcome measure used and antibiotics analysed. The data should be specific to surgery level and be disseminated to PCTs who can then analyse and disseminate results to their respective surgeries. The prescribing feedback tool can also be used to analyse the impact of any intervention used and thus determine whether interventions are worth continuing.

5.10.5.3 Communication

There needs to be more effective communications within Primary Care to improve antibiotic prescribing. Therefore there needs to be more focused meetings on how to control antibiotic prescribing, which can be facilitated by an Antibiotic Pharmacist present at SHA level. It is also important for more collaborative work to be conducted between PCTs and their nearest Acute Trust in order to identify areas where improvements in antibiotic prescribing can be made, for example with the production of a collaborative formulary or joint presentations to prescribers.

5.11 Conclusions

Overall the qualitative research provided comprehensive analysis of the issues faced, and attempts made to improve antibiotic prescribing within Primary Care. The semi-structured interviews facilitated discussion of very complex issues regarding the control of antibiotic prescribing and the combined approach allowed analysis of how improvements in antibiotic prescribing were attempted.

The qualitative research used in the present research achieved the set aim and objective, however there were many limitations in the choice of qualitative research methods chosen and how it was implemented. These limitations however must be juxtaposed with the potential significance of the results achieved.

The first key conclusion from the qualitative research was the lack of intervention analysis conducted within Primary Care. Therefore interviewees were unable to provide evidence for the success of particular interventions implemented and thus focused on the impact of a multifaceted approach. Even the impact of their multifaceted approaches were only analysed in comparison to other PCTs and SHAs rather than against their own long term prescribing.

The second key conclusion was the lack of importance placed by interviewees on the use of audits to improve prescribing. Many interventions were mentioned by interviewees throughout the semi-structured interviews, however it was only the conduct of the combined approach that highlighted the importance of audits within Primary Care. Many of the interventions deemed as important by interviewees in improving antibiotic prescribing were actually used as a component of the audit process. It may be that the uses of audits were so embedded within Primary Care that interviewees failed to acknowledge it as a noteworthy intervention.

Outcome measures used to analyse antibiotic prescribing was a key area of analysis within the qualitative research. The semi-structured interviews failed to obtain much information from interviewees on how they analyse antibiotic prescribing. However the combined approach provided a very detailed insight into not only what outcome measures were used, but also how and when this information was obtained. This area of analysis alone highlights how the variations in the qualitative research facilitated the retrieval of accurate and detailed information by using a combination of qualitative research. The key outcome measures used

within Primary Care were number of prescriptions and items per STAR-PU. This data could be regularly obtained through ePACT.

The final key conclusion focuses on the lack of communication between the Government, Department of Health, Strategic Health Authorities and PCTs. Overall there is agreement that antibiotic prescribing is a national concern, however there seems to be no cohesive approach between all Healthcare bodies to improve antibiotic prescribing. Instead there seems to be reluctance by all Healthcare bodies to take responsibility for the improvements in antibiotic prescribing and thus place more importance on other bodies to find solutions to improve prescribing.

Overall the qualitative research has highlighted a number of issues that need to be addressed in order to improve antibiotic prescribing. These include, improving prescribing analysis (and thus determine the impact of any given intervention), employing specialist Antibiotic Pharmacists within Primary Care and improving communication between all Healthcare bodies.

6. Development and implementation of the prescribing analysis tool

The qualitative research conducted in Chapter 5 highlighted the potential importance of improved communication, improved prescribing analysis and employment of antibiotic pharmacists on improving antibiotic prescribing within Primary Care. A qualified pharmacist who specialises in antibiotics (HD, who will be subsequently referred to as the referred to as the "Specialist Antibiotic Pharmacist") personally produced and implemented the aims and objectives (as shown below) in order to improve antibiotic prescribing through improved antibiotic prescribing analysis and communication within a selected Primary Care Trust.

6.1 Aim

- To devise and implement an antimicrobial prescribing analysis tool within a Primary Care Trust.

6.2 Objectives

1. To produce and implement the prescribing analysis tool within Sandwell Primary Care Trust to analyse prescribing:
    a) By Sandwell Primary Care Trust.
    b) By all General Practitioners within Sandwell PCT.
    c) Every financial quarter.
    d) In terms of their chemical substance (for example ciprofloxacin being the chemical substance instead of Ciproxin tablets).
    e) To practice level.
    f) By using two outcome measures for analysis of prescribing called:
        - Number of prescriptions for antibacterial drugs (5.1) per Star-PU.
        - Number of prescription items for cephalosporins and quinolones as a percentage of the total number of prescription items for selected antibacterial drugs (BNF 5.1).

2. To produce the prescribing analysis tool on Microsoft Excel because:

    g) All members of the Medicines Management team were familiar with Microsoft Excel.
    h) It enables analysis of trends in prescribing using drop down menus.
    i) It uses a number of visual electronic outputs with different visual displays.

3. To use the prescribing analysis tool as an intervention to achieve reductions in overall antibiotic, cephalosporin and quinolone prescribing within Sandwell Primary Care Trust, in comparison to:
    j) The previous financial year.
    k) The West Midlands Strategic Health Authority average prescribing rate.
    l) The national average prescribing rate.

4. To use log odds ratios (using 95% confidence intervals) to analyse the significance of the prescribing analysis tool on reducing overall antibiotic, cephalosporin and quinolone prescribing within Sandwell Primary Care Trust, in comparison to:
    m) The West Midlands Strategic Health Authority average prescribing rate.
    n) The national average prescribing rate.

5. To evaluate the significance of the prescribing analysis tool on reducing overall antibiotic, cephalosporin and quinolone prescribing within Sandwell Primary Care Trust, in comparison to:
    a) The West Midlands Strategic Health Authority average prescribing rate.
    b) The national average prescribing rate.

6.3 Source of data for the prescribing analysis tool

The qualitative research conducted in Chapter 5 identified two key sources of data that could achieve the objectives set in section 6.2 (ePACT and the completion of audits). Therefore both options were further evaluated in order to determine which would be used as the source of data within the prescribing analysis tool, as shown in Table 13 below.

Table 13: Evaluation of ePACT and audits as a source of data for the prescribing analysis tool

ePACT	Audits
Data can be extracted from all surgeries by one person	Data extraction from all surgeries requires involvement of more than one person
Consistency in data extraction can be achieved	Data extraction can be inconsistent
Training on one database is required to retrieve data	Training on five different prescribing software required to retrieve data
Prescriptions that are not entered within GP prescribing systems can be accounted for	Does not include antibiotics not entered on the GP prescribing system
All required data can be downloaded in minutes	Data extraction can last hours
Outcome measures are already applied to prescribing data	Outcome measures have to be manually applied to prescribing data
Provides an opportunity to produce an efficient national prescribing feedback system	Producing a national surveillance system is possible
Access to ePACT requires use of password	Access to GP prescribing systems requires use of a password
ePACT can be accessed from any location within the PCT	GP prescribing data can only be accessed from the respective surgeries
Reasons for why antibiotics were prescribed is not retrievable	Provides opportunity to read patient notes and obtain details of why antibiotic was prescribed

ePACT was chosen to provide data for the prescribing analysis tool owing to the key advantages (in comparison to audits) highlighted green in Table 13. Therefore a key disadvantage of using ePACT instead of audits was the inability to determine indications for antibiotic prescribing. Appendix 6 details how ePACT was used to retrieve the required data and produce the prescribing analysis tool.

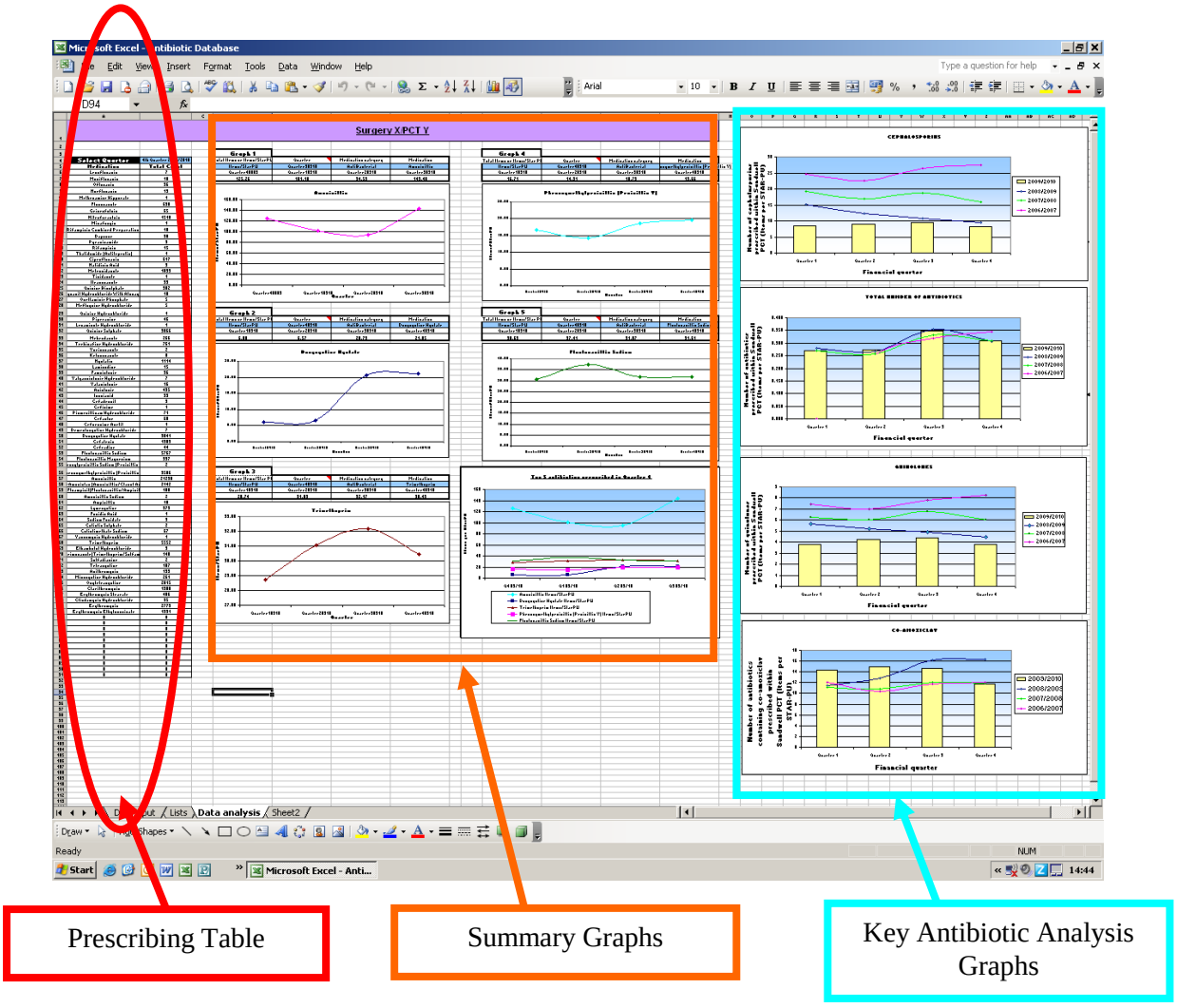
6.4 The completed design of the Database

The final version of the prescribing analysis tool was produced using Microsoft Excel and contained data on 117 drugs present in Chapter 5 of the British National Formulary (BNF), from Q2 04/05 to the present, thus making it a unique form of feedback within Primary Care.

The Antibiotic Database currently contained data for antibacterial, antifungal, antiviral, antiprotozoal and anthelmintic drug categories which could be selected between by using the Medication category column (as shown in Figure 27). However, the Specialist Antibiotic Pharmacist named the database the "Antibiotic Database" as it was only used to analyse antibacterial prescribing.

The layout of the Antibiotic Database was divided into three distinct areas of surveillance, (1) Prescribing Table, (2) Summary Graphs and (3) Key Antibiotic Analysis Graphs as shown in Figure 19 below.

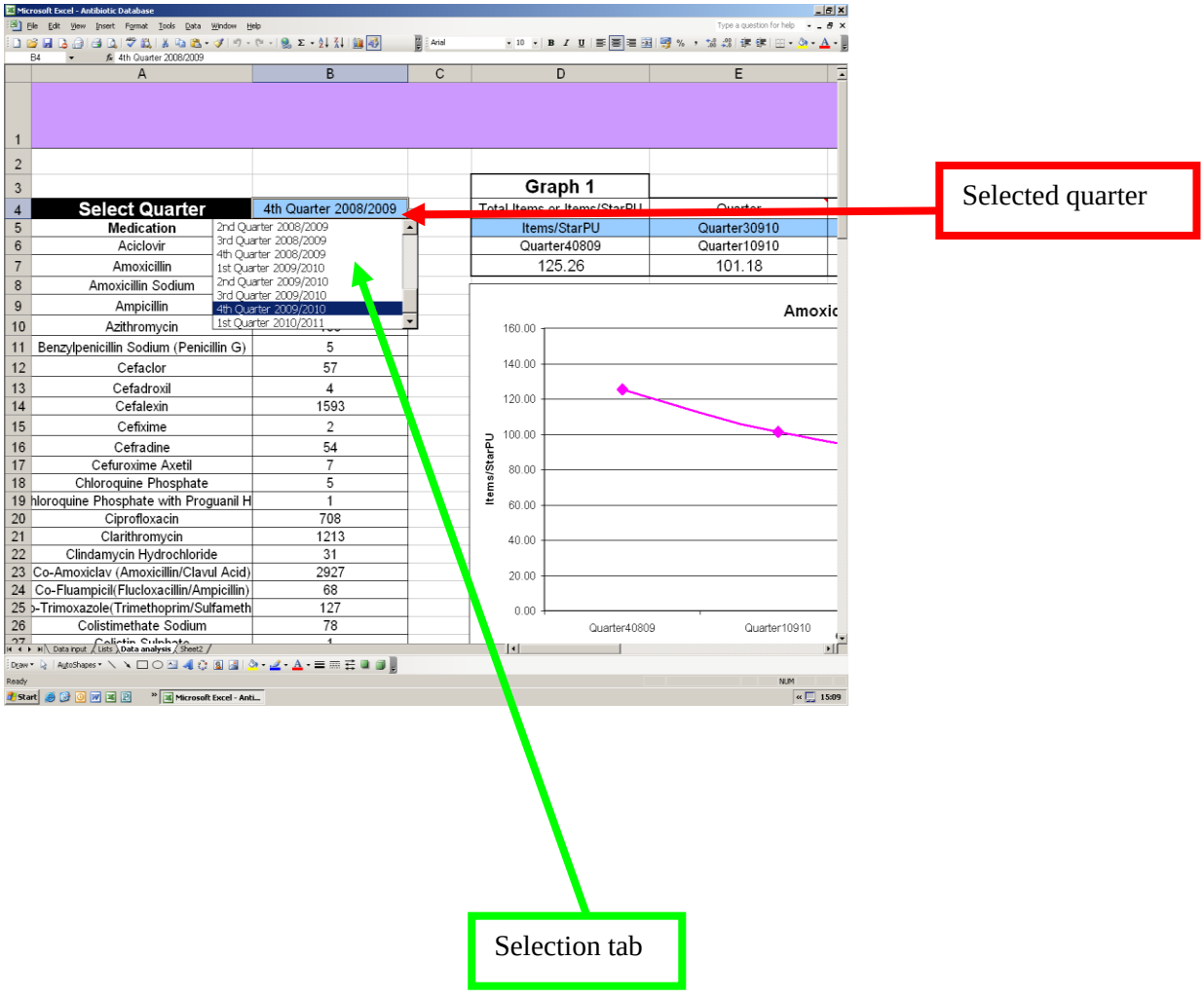
Figure 19: Screen capture of the Antibiotic Database



6.4.1 The Prescribing Table

The Prescribing Table contained details of all the drugs (from Chapter 5 of the BNF) prescribed by a practice or PCT within a selected period of time. Figure 20 shows the prescribing table in more detail.

Figure 20: Screen capture of the Prescribing Table

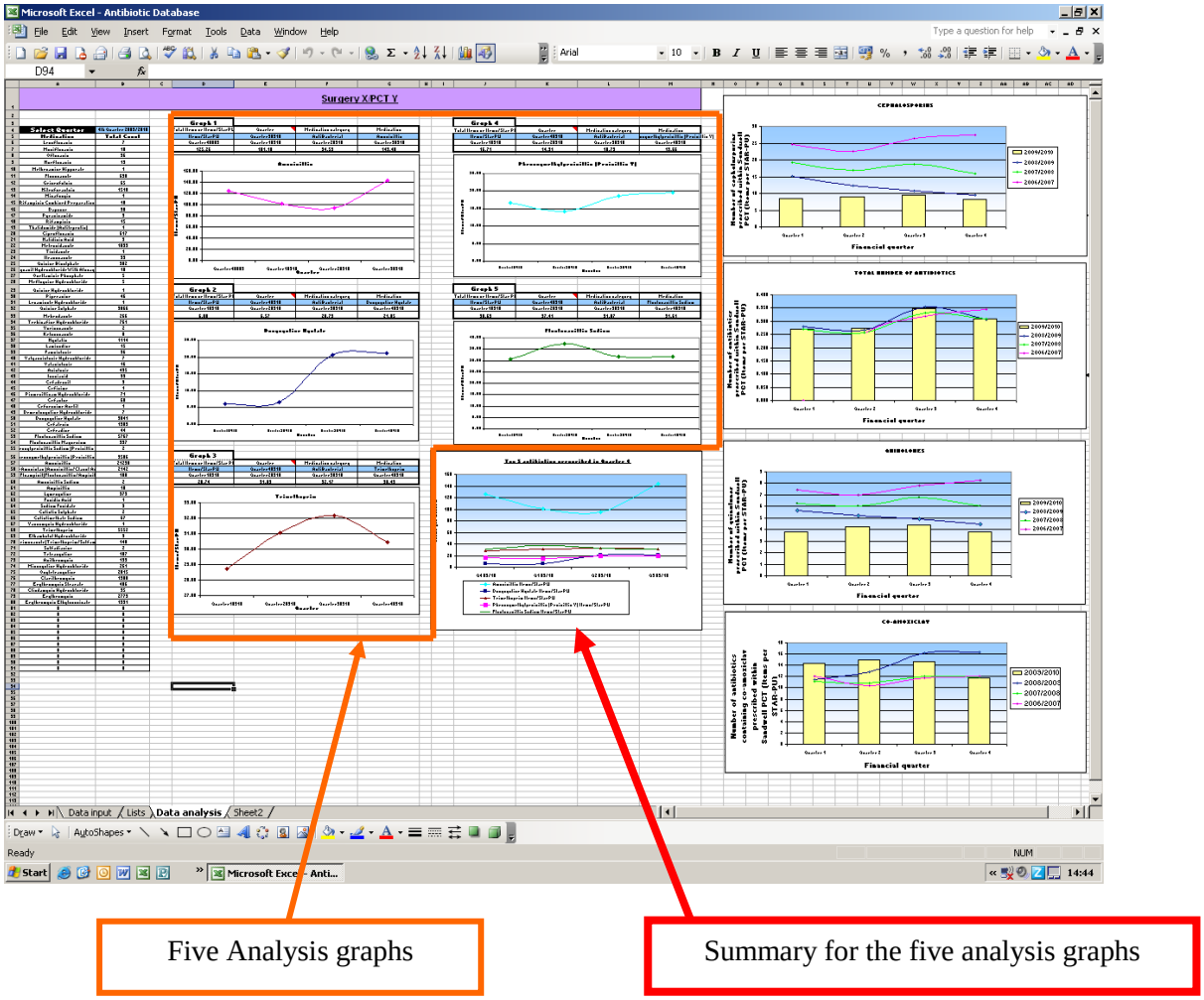


The Prescribing Table contained two columns, the first contained the names of drugs prescribed and the second column contained the number of times they were prescribed. If a chemical substance from Chapter 5 of the BNF was not prescribed within a given quarter then the drug name did not appear in the Prescribing Table. The user could select the data for any quarter since (and including) Q2 04/05 by using the selection tab. When a new quarter was selected the data within the prescribing table automatically updated to present the prescribing data from the selected quarter.

6.4.2 Analysis of antibiotics prescribed

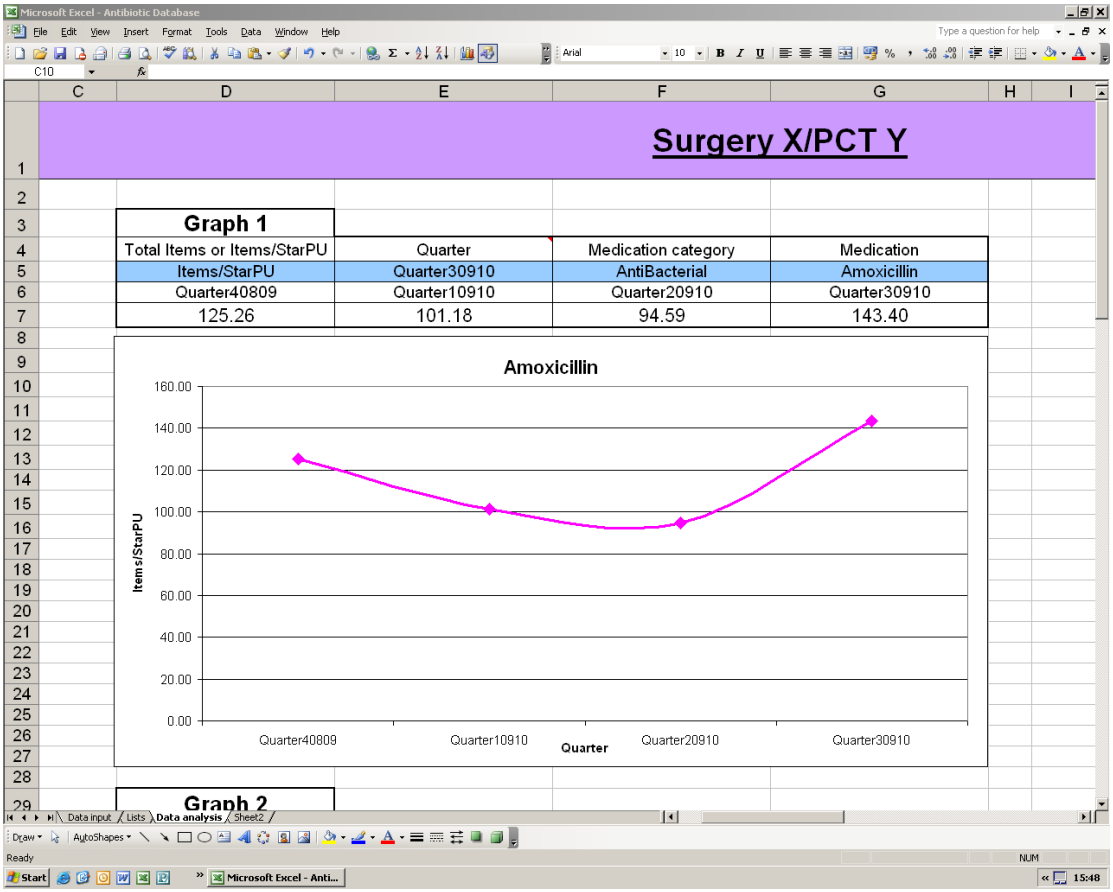
Figure 21 below shows that the analysis of antibiotics was achieved using the six summary graphs. Five of these graphs allowed analysis of any given chemical substance from Chapter 5 of the BNF, and the sixth graph was used to present the summary results of the five analysis graphs.

Figure 21: Screen capture of visual electronic outputs used to analyse antibiotics prescribed by a practice, PCT, SHA or nationally



The Summary Graphs allowed the user to view prescribing in a variety of ways as shown within Figures 22 to 30.

Figure 22: An example of Analysis Graphs



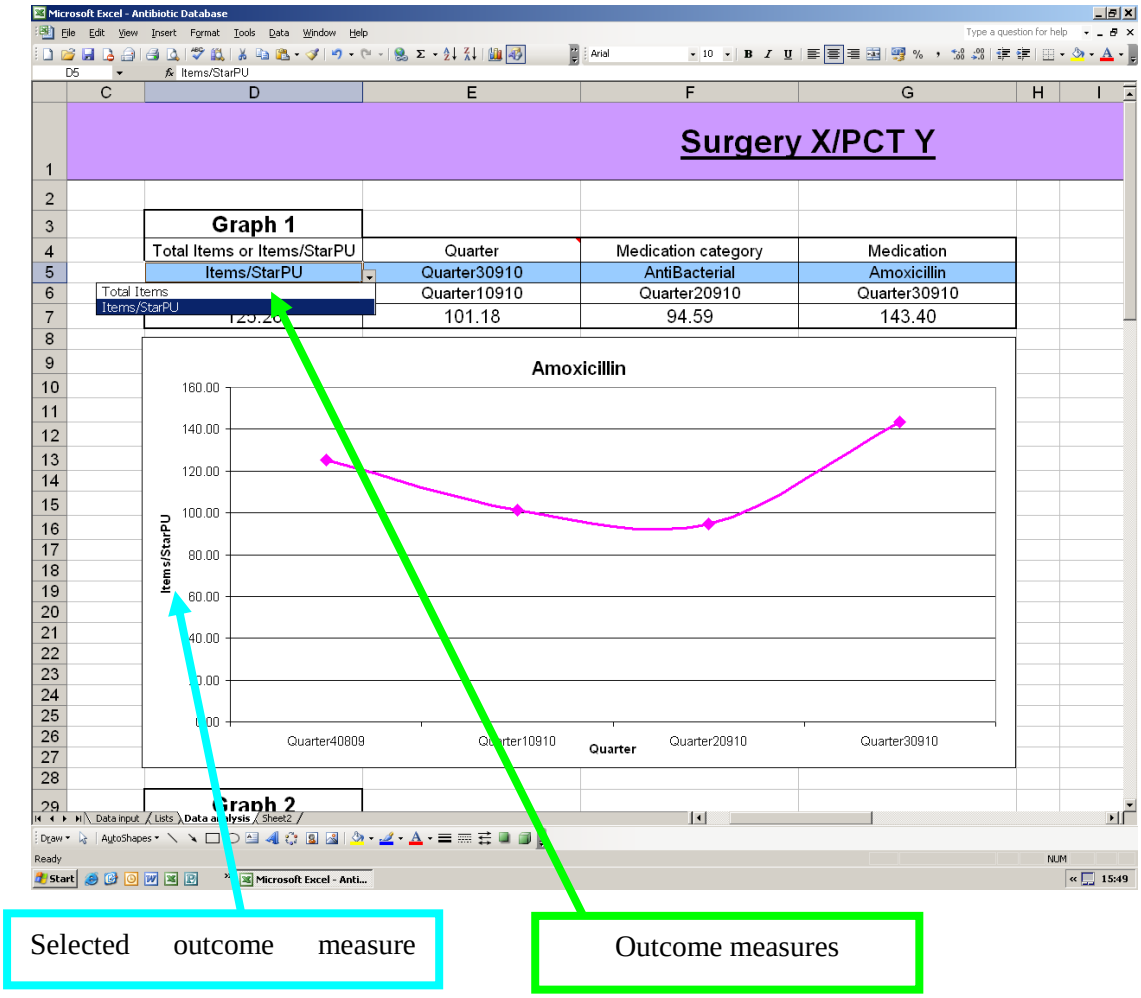
The Analysis Graphs could be automatically updated using data within the table above the graph. The table contained four criteria, (1) Total items or Items per STAR-PU (explained further in section 6.4.3), (2) Quarter (explained further in section 6.4.4), (3) Medication category (explained further in section 6.4.5) and (4) Medication (explained further in section 6.4.6).

6.4.3 Outcome measure selected within Analysis Graphs

Total items or Items per STAR-PU were abbreviations for the outcome measures contained within the Antibiotic Database. "Items" refers to the outcome measure "prescription numbers" and Items/STAR-PU was an abbreviation for measuring antibiotic use in terms of

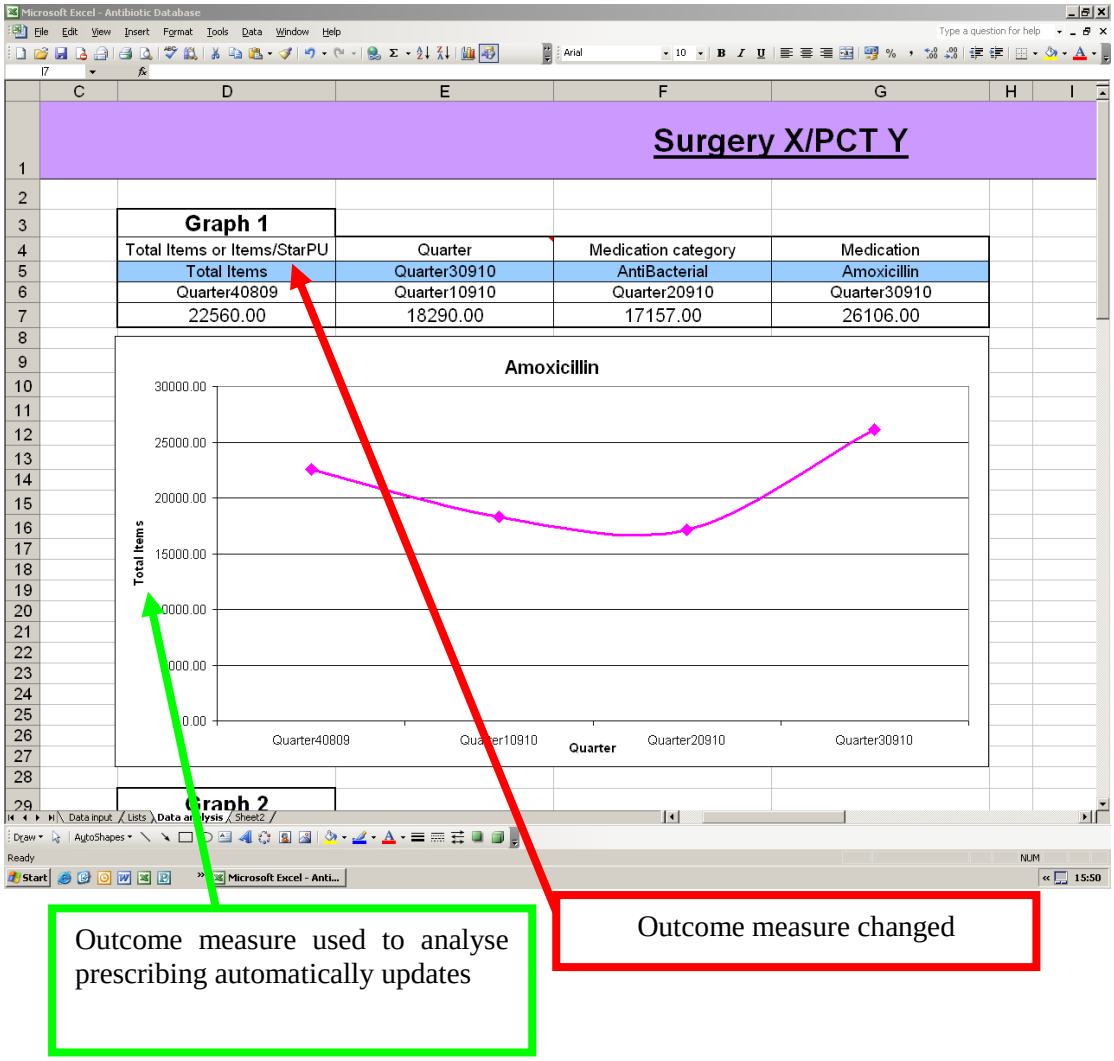
"Items per STAR-PU". The user can select between the two outcome measures as shown in Figure 23.

Figure 23: Selection between outcome measures used within the Analysis Graphs



The drop down options (shown by the green arrow in Figure 23) can be used to select between the two outcome measures. The chosen outcome measure was then displayed within the Analysis Graph, as shown by the two arrows in Figure 23. Figure 24 shows how the data and appearance of the graph changed automatically when a different outcome measure was chosen.

Figure 24: An example of the Analysis Graph when the outcome measure was changed



6.4.4 Time period for analysis selected within Analysis Graphs

The column called "Quarter" allowed the user to select a time period for analysis. The time period was abbreviated to contain the financial quarter in question, for example Figure 25 shows that the chosen quarter was 30910, which indicates that the third quarter for financial year of 2009 to 2010 was selected. Figure 25 shows how the time period for analysis can be changed.

Figure 25: The time period chosen for analysis

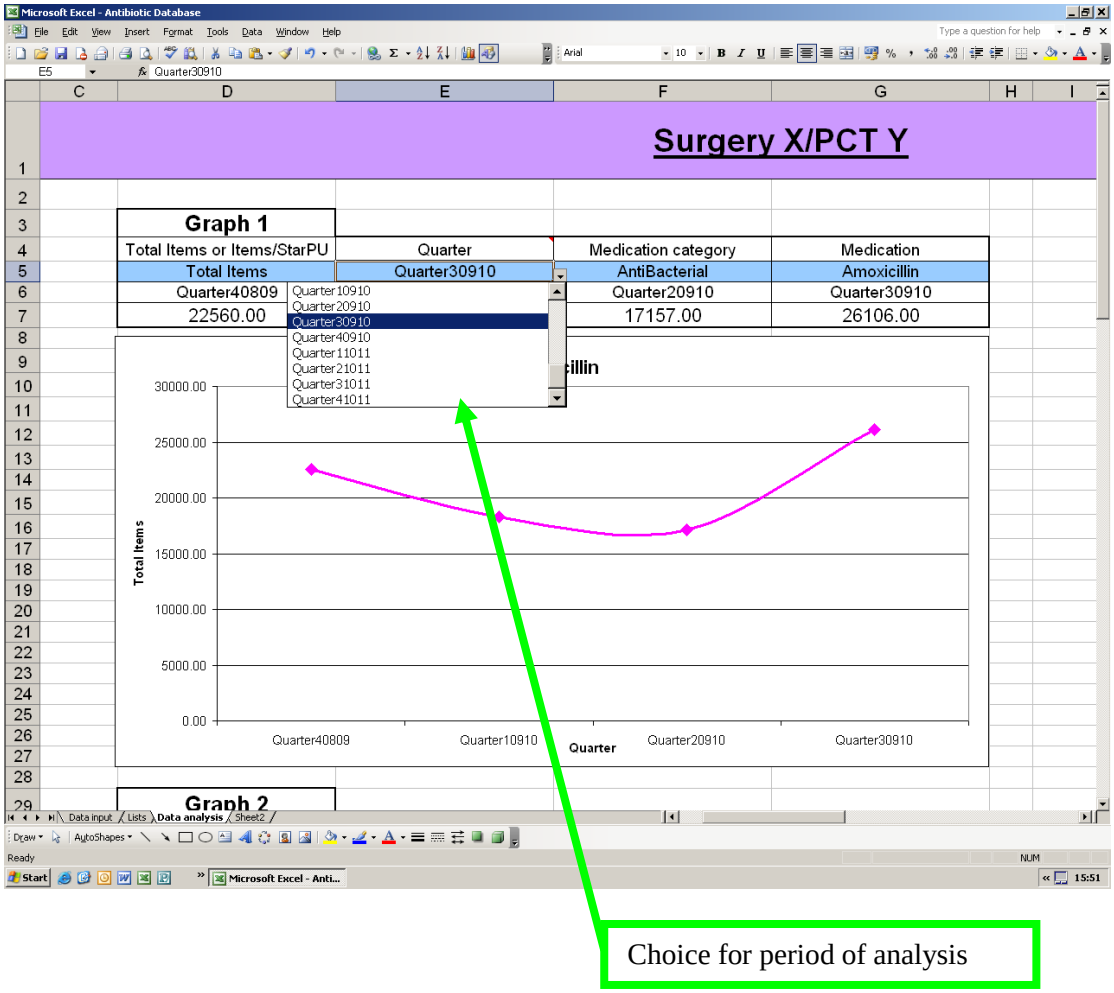
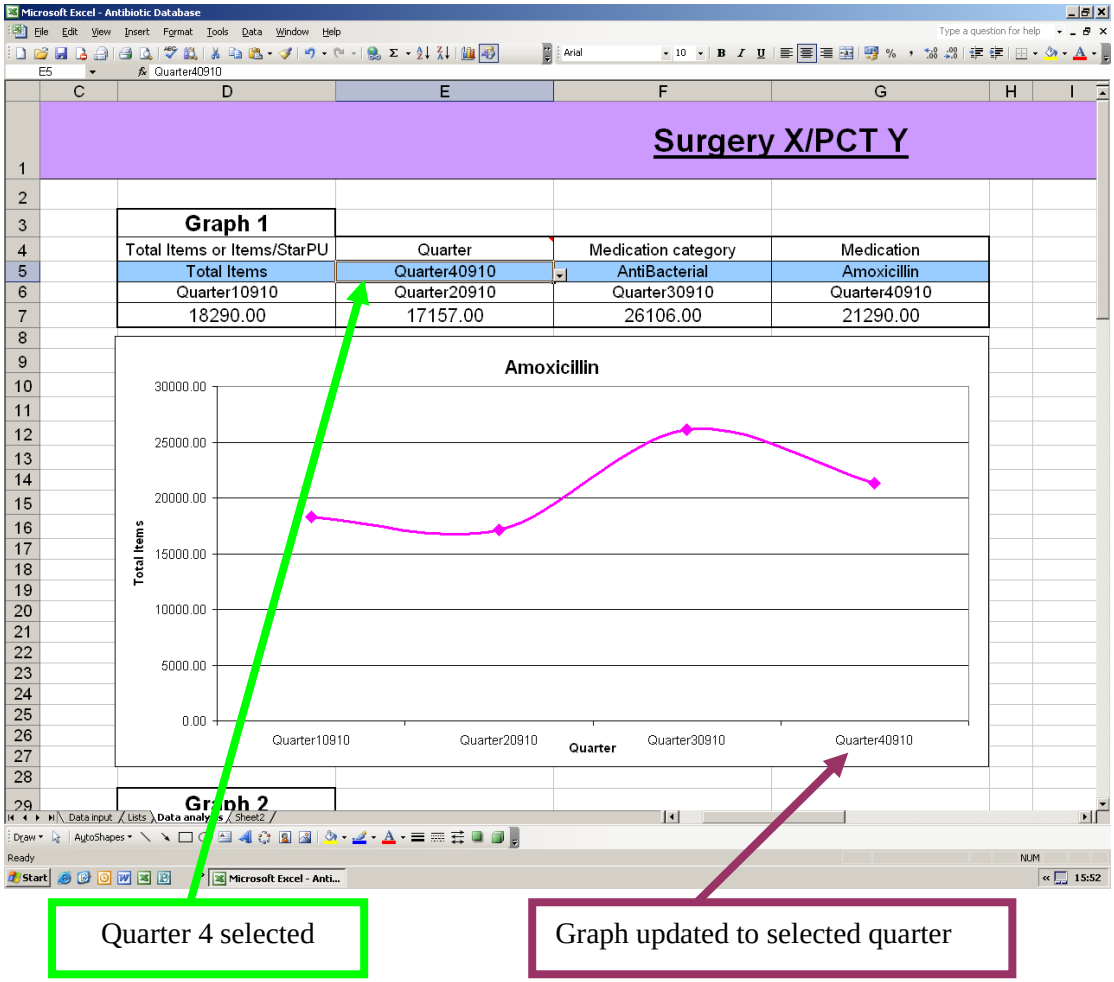


Figure 25 shows how the user can change the time period analysed with use of the drop down menu (as shown by the green arrow). Figure 26 shows how the graph changes when a new time period was chosen.

Figure 26: An example of the Analysis Graph when the time period was changed



When a new financial quarter was chosen the analysis graph automatically updated to present the selected data. The purple arrow shows the location of the selected quarter data and the three preceding financial quarters. The green arrows shows the new time period selected.

6.4.5 Medication category selected for analysis within Analysis Graphs

As mentioned earlier in section 6.4, the Antibiotic Database contained all drugs present within Chapter 5 of the BNF. As the data required for the Antibiotic Database was taken from ePACT, any changes to the drug list present within Chapter 5 were automatically updated within the Antibiotic Database.

Figure 27: Screen capture of the Medication Category chosen for analysis

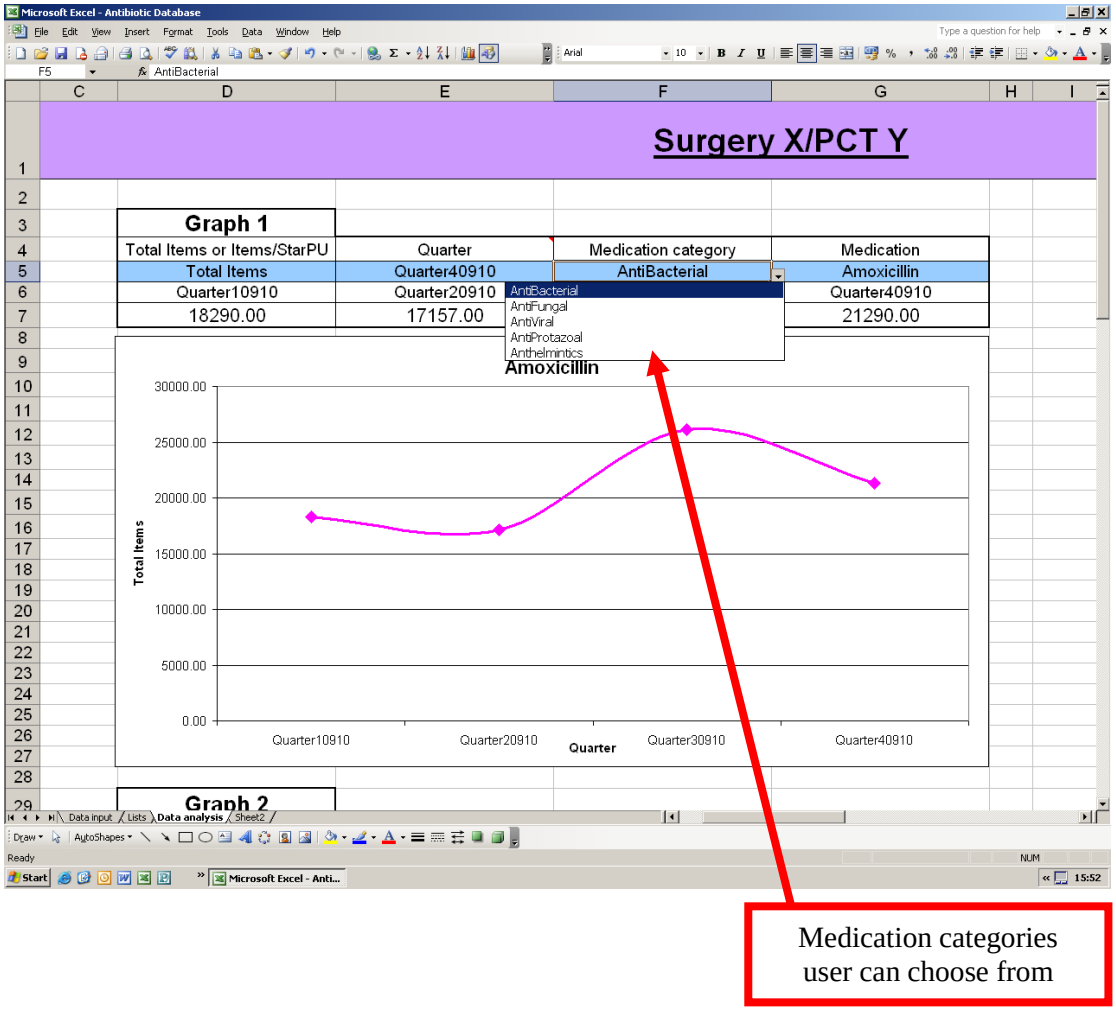
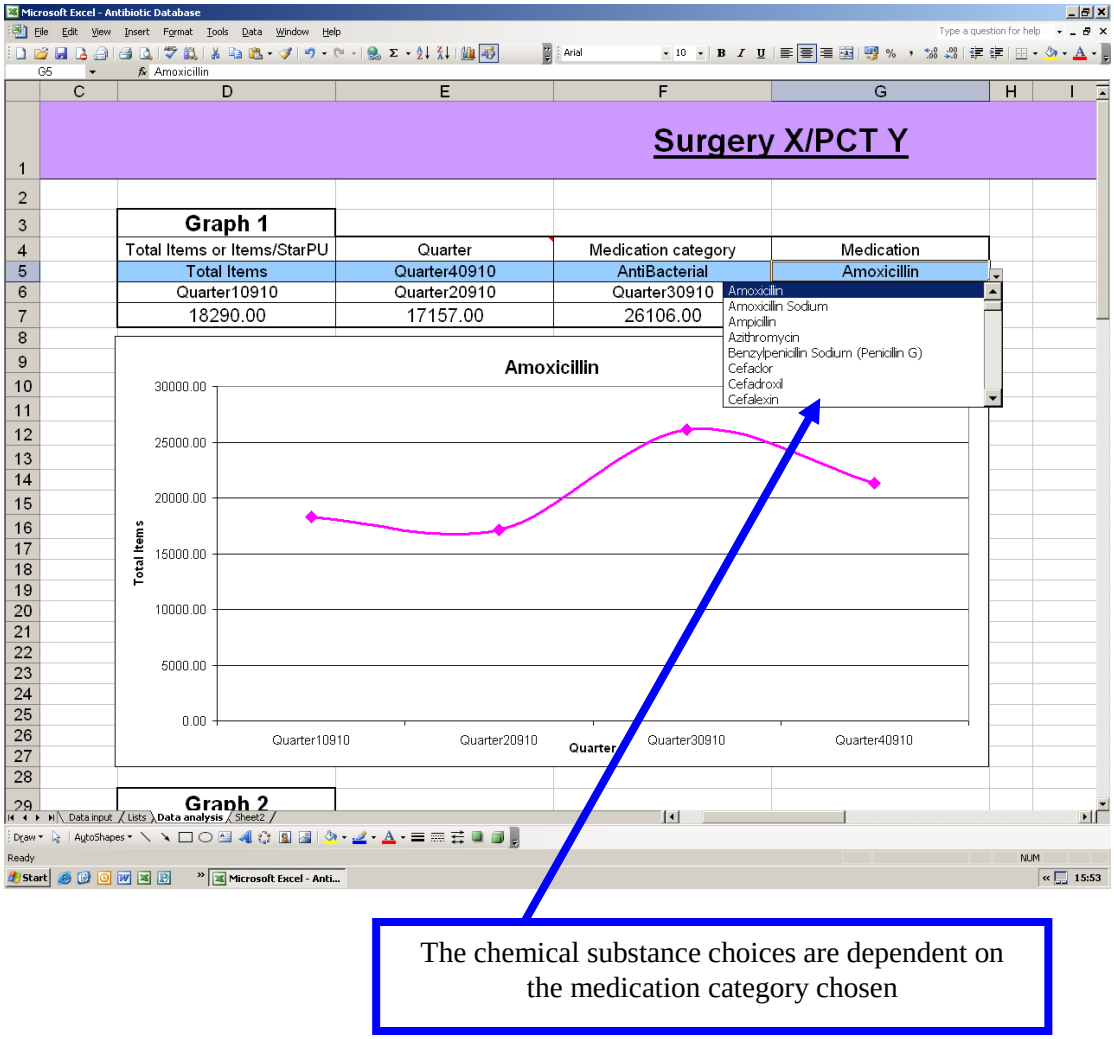


Figure 27 shows the five medication categories included within the Antibiotic Database which the user could choose between. The selected category then automatically updated the medication column of the analysis graph, as shown in Figure 28.

Figure 28: Screen capture of the medication chosen for analysis



6.4.6 The chemical substance selected for analysis with Analysis Graphs

The Medication column of the analysis graph was used to present the chemical substances available within each Medication category. Therefore, if the Medication category Antibacterial was chosen then the Medication column would allow the user to select between all chemical substances used as an Antibacterial, as shown in Figure 28.

Figure 29 shows the drop down menu for the Medication column changed when a new Medication category was chosen.

Figure 29: An example of the Analysis Graph when the Medication category was changed

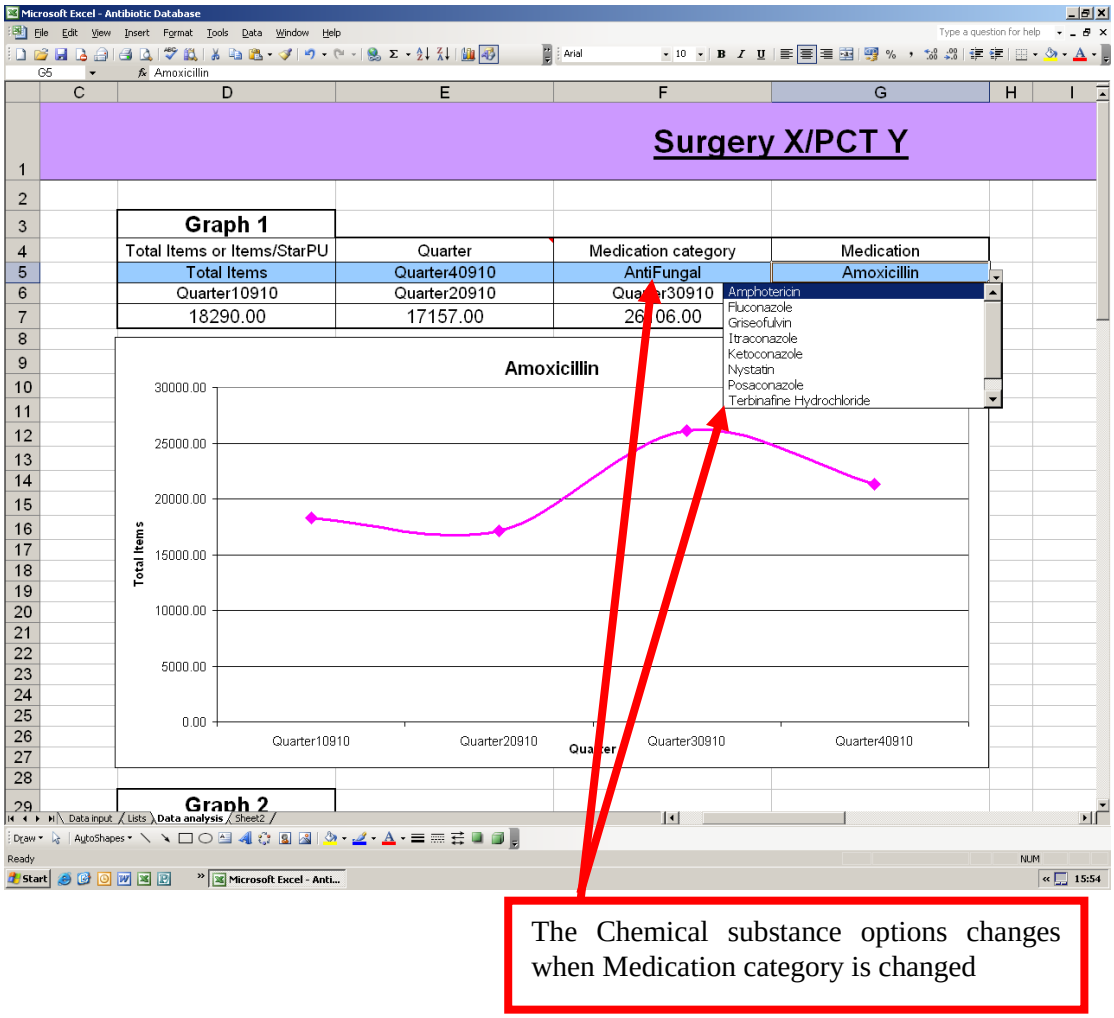
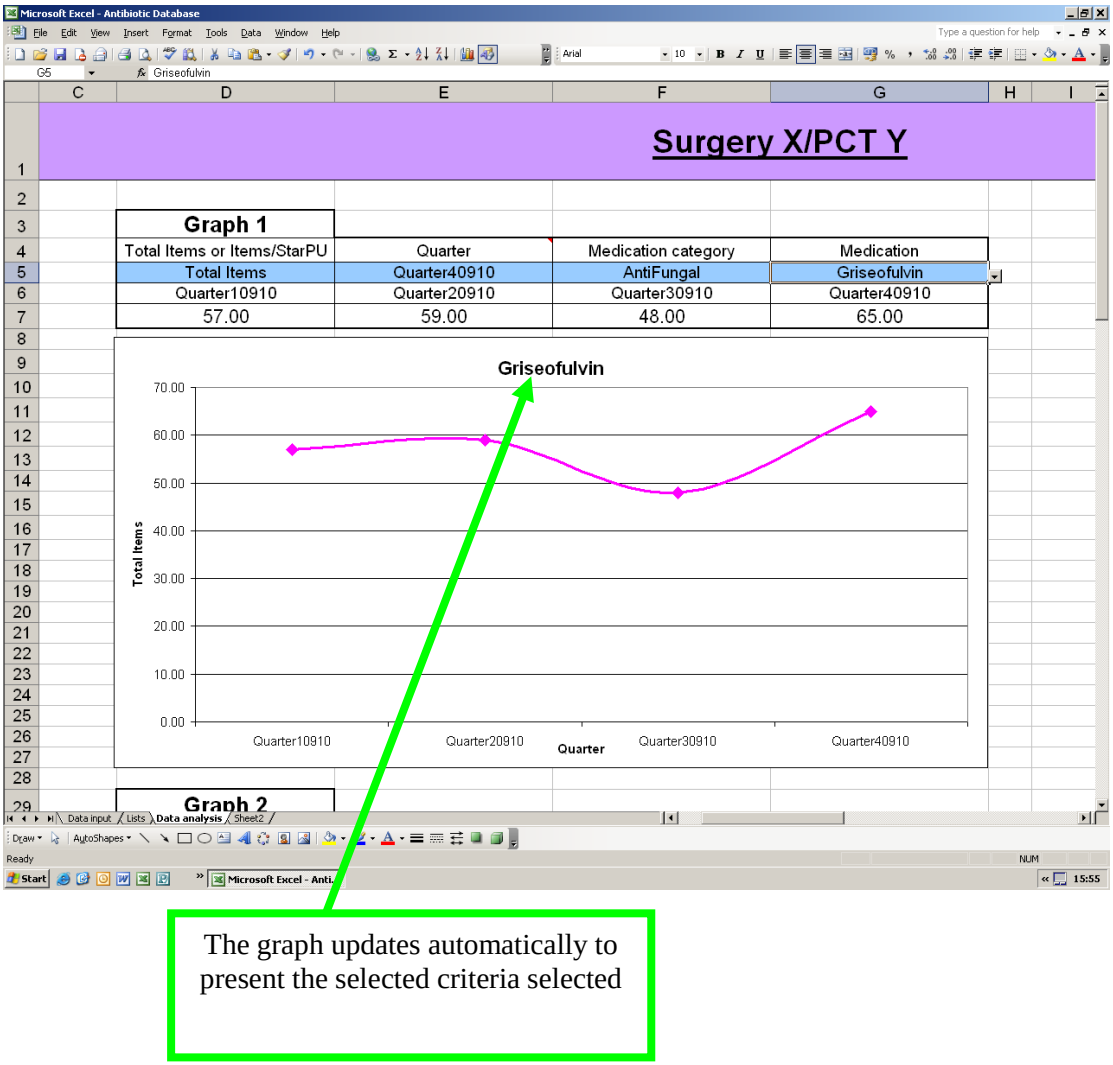


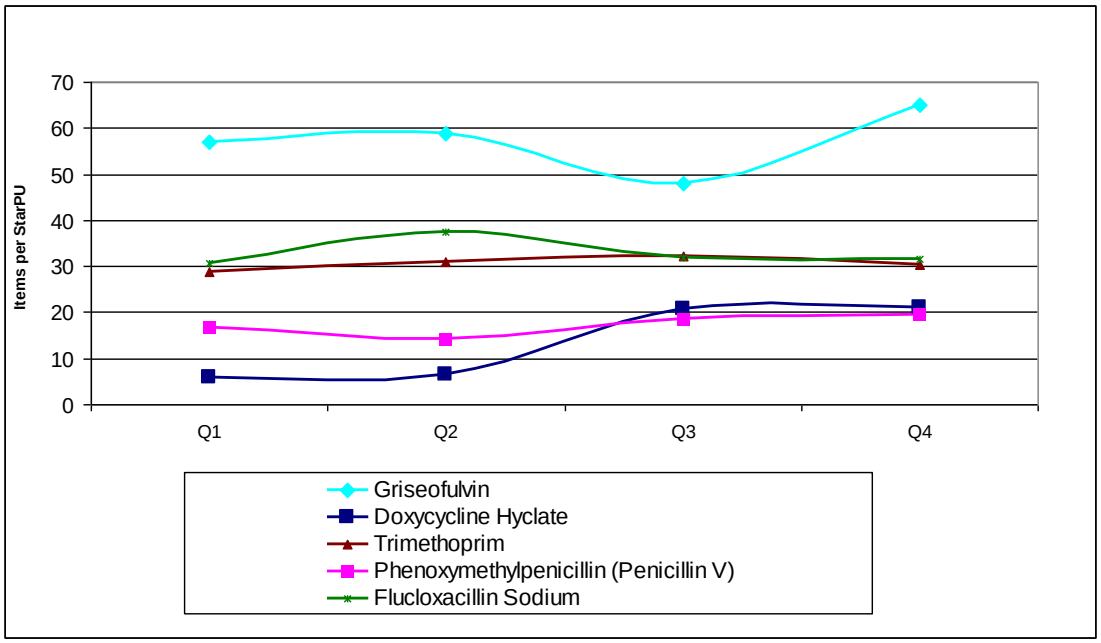
Figure 30 shows how the display of the graph changed when a new chemical substance was chosen.

Figure 30: An example of the Analysis Graph when the medication was changed



The data selected in the Analysis Graphs were updated automatically onto the graph used to summarise the five Analysis Graphs, as shown in Figure 31.

Figure 31: An example of the Summary Graph produced using the five Analysis Graphs present within the Antibiotic Database



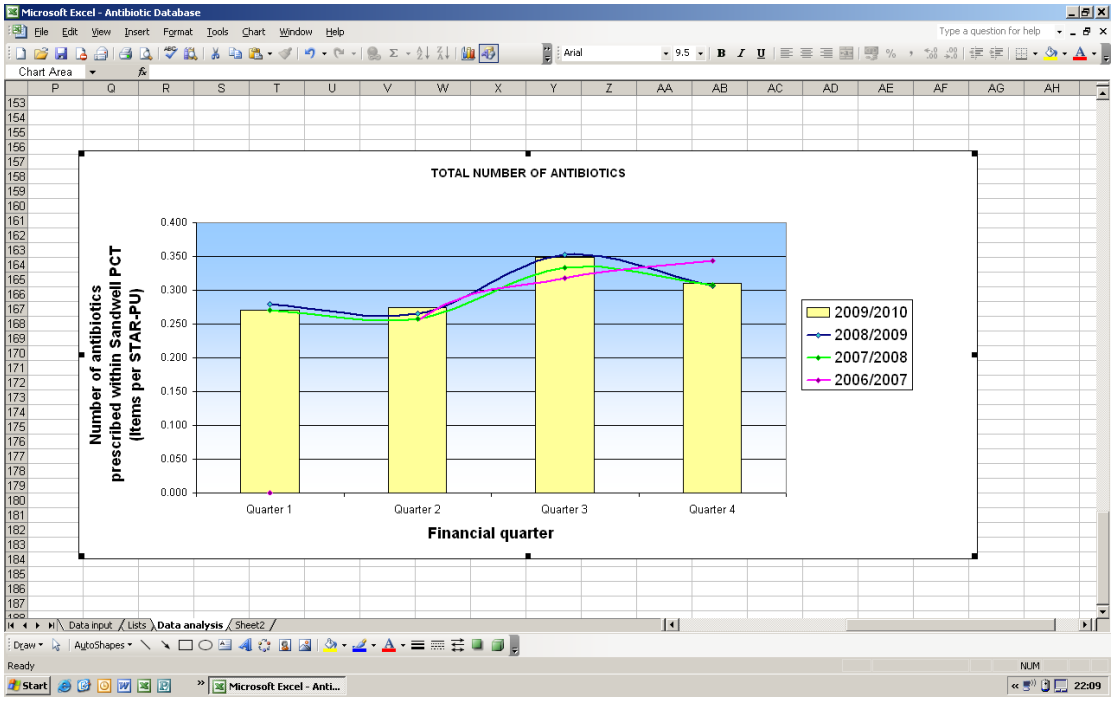
The summary for the five Analysis Graphs allowed the user to visualise a snapshot of any number of specific criteria and summarise the results in one graph.

6.4.7 Key Antibiotics Analysis Graphs

The Key Antibiotics Analysis Graphs differ from the Summary Graphs as only selected antibiotic(s), outcome measures and time periods could be analysed. The advantage of the Key Antibiotic Graphs was that the prescribing of the chosen antibiotic(s) could be analysed over the last four years and thus provide more detailed analysis. An example is shown below in Figure 32.

Cephalosporins and quinolones were included within the key antibiotic analysis graphs because the HPA (2008) stated that use of cephalosporins quinolones should be minimised owing to their association with the increase in *clostridium difficile* cases reported. Therefore, appropriate prescribing of cephalosporins and quinolones have been included as QoF targets in order to limit their use.

Figure 32: An example of a Key Antibiotic Analysis Graph



6.5 Implementation of Antibiotic Database as an intervention within Sandwell PCT – intervention period

The Antibiotic Database was implemented as an intervention within Sandwell PCT in quarter 3 (autumn/winter) of financial year 2009/2010 by the Specialist Antibiotic Pharmacist. The intervention process can be divided into three distinct stages; the launch of the Antibiotic Database, the introduction of Antibiotic Database to Sandwell PCT prescribers and the presentation of personalised data to all surgeries.

6.5.1 Launch of the Antibiotic Database

The first stage of the implementation of the Antibiotic Database as an intervention within Sandwell PCT was gaining the approval of the Sandwell PCT board for its use. The information contained in sections 6.1 to 6.4 of the present thesis were presented to the board

in order to explain how the Antibiotic Database worked and how it could be used within Sandwell PCT. The Antibiotic Database was then used to demonstrate the latest Sandwell PCT antibiotic prescribing data, including an insight into how antibiotic prescribing (especially cephalosporins and quinolones) had fluctuated over the past three years. The board unanimously approved the use of the Antibiotic Database within Sandwell PCT to improve prescribing and provided the Specialist Antibiotic Pharmacist with a requested fifteen minute allocation to present antibiotic prescribing data at the next PLT event held at the start of Quarter 3 (2009).

6.5.2 Introduction of Antibiotic Database to Sandwell PCT prescribers

The Specialist Antibiotic Pharmacist used the fifteen minute allocation at the PLT event to present the latest antibiotic prescribing trend analysis graphs produced from the Antibiotic Database (see Appendix 7). The aim of this presentation was to promote the need for improvements in prescribing of all antibiotics, especially quinolones and cephalosporins. In total there were around 200 prescribers present at the event, with representation from every practice within Sandwell. All attendees were made aware that the Specialist Antibiotic Pharmacist would be organising meetings at all surgeries between October and December 2009 (quarter 3 of financial year 2009/2010) to present surgery specific antibiotic prescribing data produced using the Antibiotic Database.

6.5.3 Presentation of personalised data to all surgeries

In total there were sixty-three surgeries within Sandwell PCT who were contacted via telephone by the Specialist Antibiotic Pharmacist and agreed to the presentation of their personalised antibiotic prescribing data using the Antibiotic Database. The presentation focused on the importance of prudent antibiotic prescribing, analysis of their overall and key antibiotic prescribing and ended with actions that can be implemented to improve their antibiotic prescribing (see Appendix 8 for a template of these presentations). It was

anticipated that these presentations would take fifteen minutes with time allocated at the end for questions and the agreement of actions to improve antibiotic prescribing by all attendees. All prescribers and the manager within each surgery were requested to attend the organised meetings, with the Specialist Antibiotic Pharmacist arranging one-to-one meetings to discuss surgery presentations and agreed actions with any individuals who failed to attend requested surgery meetings.

6.6 Results

The Antibiotic Database itself was used to analyse the short and long term impact of its use at all surgeries during October to December 2009 (quarter 3 of financial year 2009/2010). Short term impact will be classed as prescribing during quarter 3 of financial year 2009/2010 and long term impact will be classed as prescribing up to, and including quarter 3 2010/2011. Quarterly prescribing data will be analysed in preference to annual data in order to allow direct comparison of prescribing in quarter 3 of the pre-intervention (quarter 3 2008/2009), intervention and post-intervention period. Annual Sandwell antibiotic prescribing data will also be compared to the annual average SHA and national prescribing data for overall antibiotics, cephalosporin and quinolones. The significance of changes to antibiotic prescribing will be determined through log odds ratio (95% CI) calculations using StatsDirect (2007).

6.6.1 The total number of antibiotics prescribed within Sandwell PCT

Figure 33 shows the total number of antibiotics prescribed within Sandwell PCT since March 2007.

Figure 33: The total number of antibiotics prescribed annually within Sandwell PCT since the financial year 2006/2007

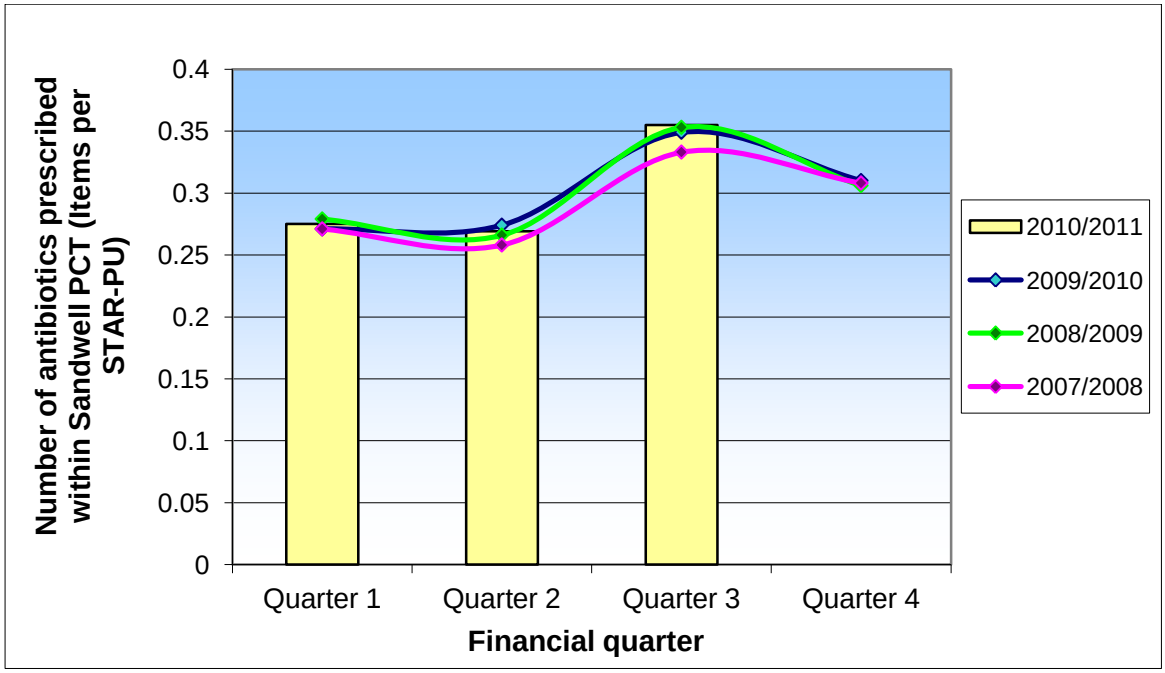


Figure 33 shows that antibiotic prescribing has seasonally fluctuated since March 2007 to March 2010, with the highest rates of prescribing occurring in quarter 3 (autumn/winter) of the financial year. The intervention period coincided with a slight reduction in antibiotic prescribing in comparison to the same quarter in 2008/2009 although prescribing was still higher in comparison to quarter 3 in 2007/2008. Post-intervention analysis of quarter 1 and 2 data showed that antibiotic prescribing remained slightly lower than in the corresponding period in 2008/2009, but still higher than the corresponding periods in 2007/2008. Quarter 3 of the post-intervention period coincided with an increase in antibiotic prescribing in comparison to previous years.

6.6.2 Comparison of Sandwell PCT's to SHA and National antibiotic prescribing data

Figure 34 shows the comparison of overall antibiotics prescribed at Sandwell PCT, the West Midlands SHA and nationally.

Figure 34: Overall antibiotics prescribed by Sandwell in comparison to their SHA and national antibiotic prescribing figures

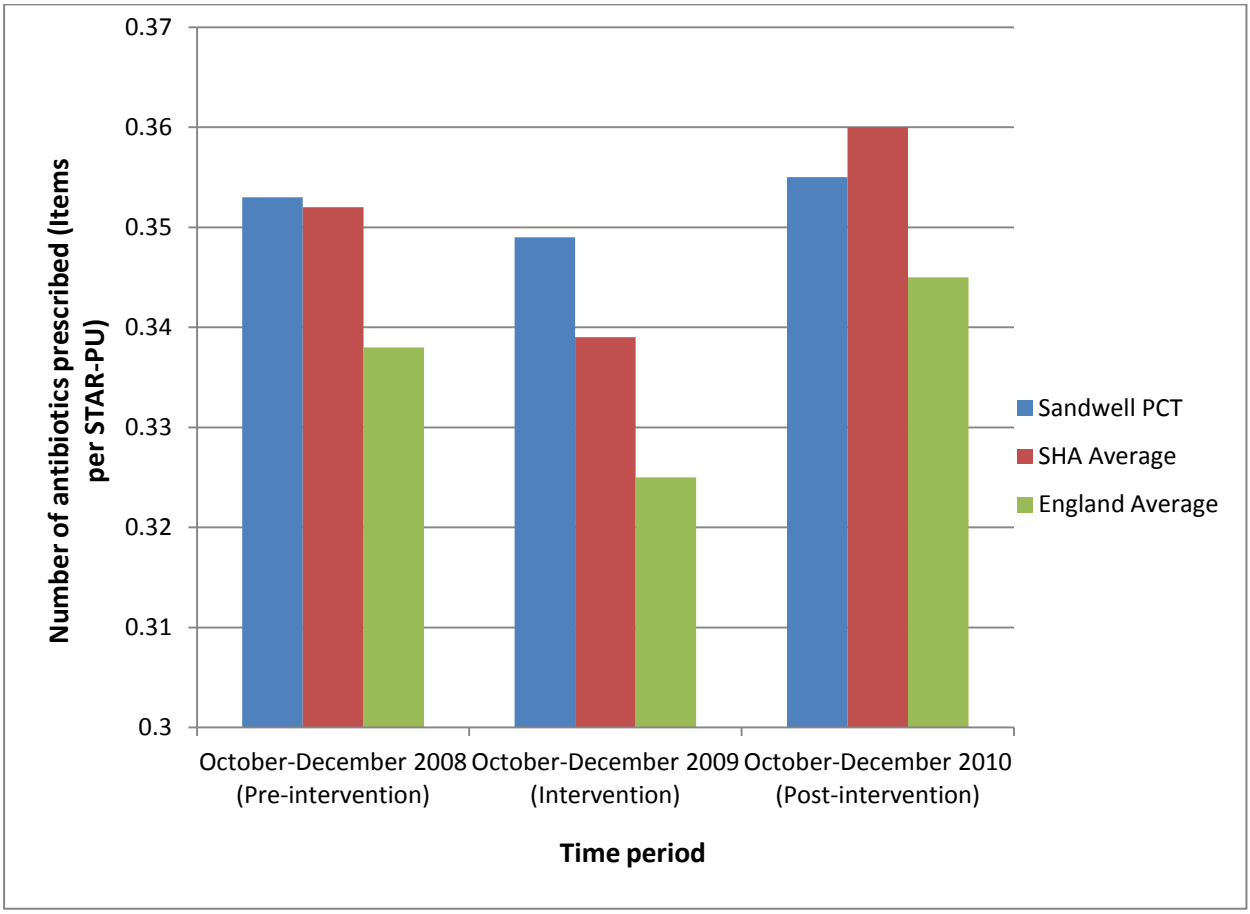


Figure 34 shows that antibiotic prescribing within Sandwell PCT decreased during the intervention period in comparison to the pre-intervention period. However, antibiotic prescribing in the post-intervention period increased to higher levels in comparison to the pre-intervention period. This has followed the same pattern as antibiotic prescribing within the SHA and nationally. Antibiotic prescribing (OR (95% CI) was not significantly reduced in Sandwell PCT 0.98 (0.55-1.76) in comparison to national antibiotic prescribing 0.91 (0.51-1.65) and SHA antibiotic prescribing 0.94 (0.5.3-1.69) during the intervention period.

Figure 34 shows that both Sandwell PCT and the SHA are higher prescribers of antibiotics in comparison to the national average. The SHA were also lower prescribers of antibiotics than Sandwell PCT in both the pre- and intervention period, although the SHA were higher prescribers in comparison to Sandwell PCT in the post-intervention period. Antibiotic prescribing (OR (95% CI) in the post-intervention period did not significantly increase in Sandwell PCT 1.01 (0.57-1.80) in comparison to national antibiotic prescribing 1.03 (0.58-1.85) and SHA antibiotic prescribing 1.04 (0.58-1.85).

6.6.3 The number of cephalosporins prescribed annually within Sandwell PCT

Figure 35 shows the number of cephalosporins prescribed within Sandwell PCT since March 2007.

Figure 35: The total number of cephalosporins prescribed annually within Sandwell PCT since the financial year 2007/2008

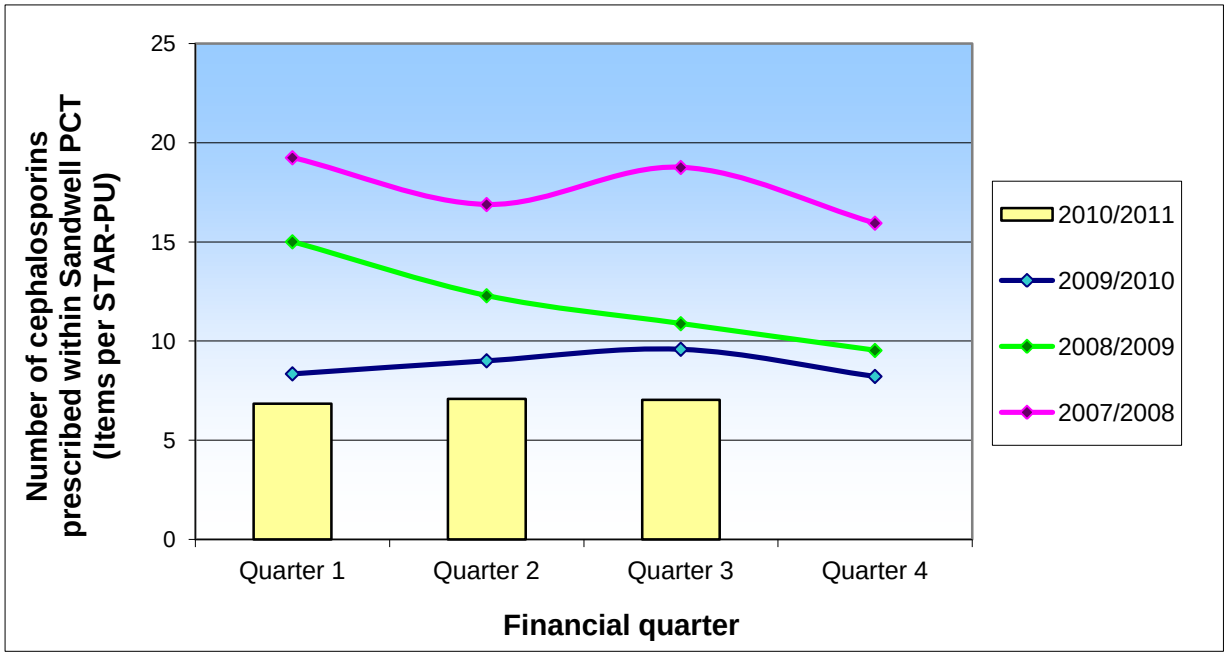


Figure 35 shows that cephalosporin prescribing has been decreasing every year since 2007 and reached a new low level of prescribing in quarter 1 in year 2010/2011. Analysis of the intervention period showed that cephalosporin prescribing decreased in comparison to previous years and the trend has continued with a further reduction in quarter 3 in financial year 2010/2011.

6.6.4 The number of quinolones prescribed annually within Sandwell PCT

Figure 36 shows the number of quinolones prescribed within Sandwell PCT since March 2007.

Figure 36: The total number of quinolones prescribed annually within Sandwell PCT since the financial year 2007/2008

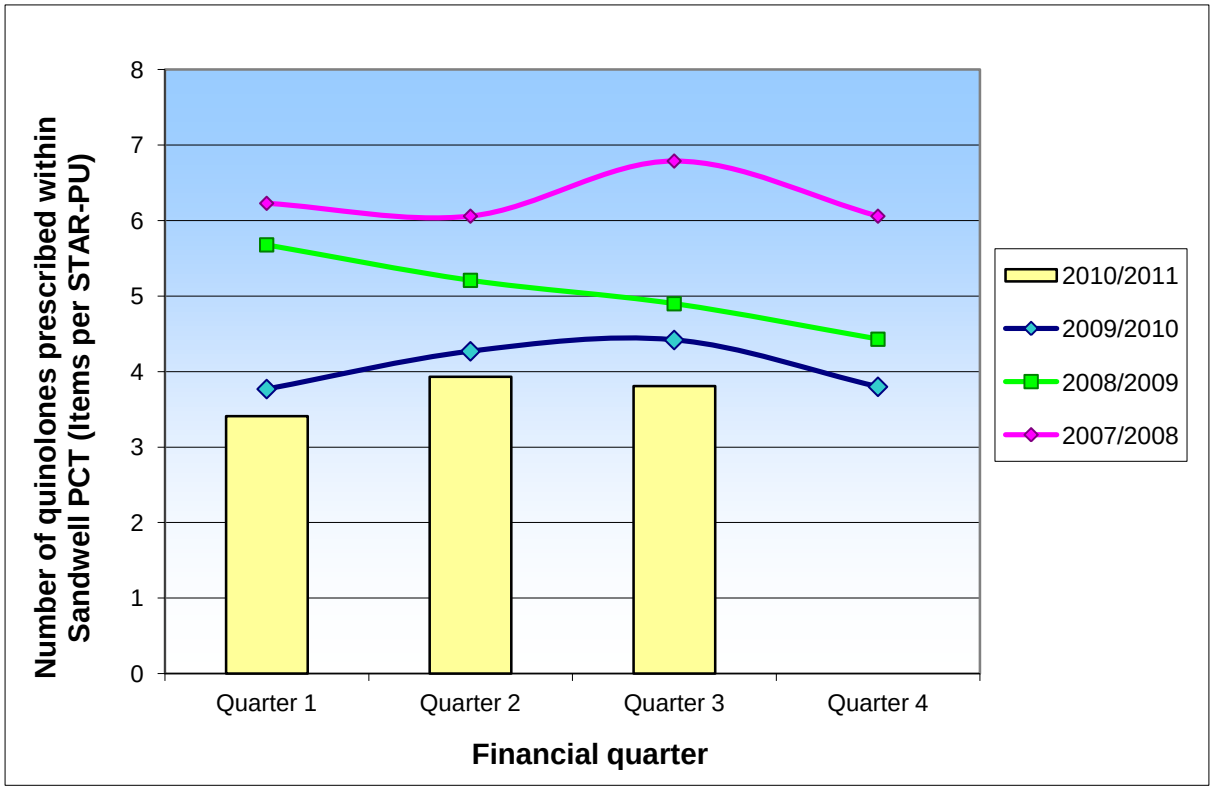


Figure 36 shows that quinolone prescribing has been decreasing every year since 2007 and reached a new low level of prescribing in quarter 1 of year 20010/2011. Analysis of the intervention period showed that quinolone prescribing reduced in comparison to the same quarter in previous years. This has continued into the post-intervention period with quarter 3 in financial year 2010/2011 also showing a further reduction in comparison to previous years.

6.6.5 Comparison of Sandwell PCT's to SHA and National prescribing data for cephalosporins and quionolones

Figure 37 shows cephalosporins and quinolones prescribed by Sandwell in comparison to their SHA and national prescribing figures.

Figure 37: A comparison of the number of cephalosporins and quinolones prescribed within Sandwell PCT, the West Midlands SHA and England

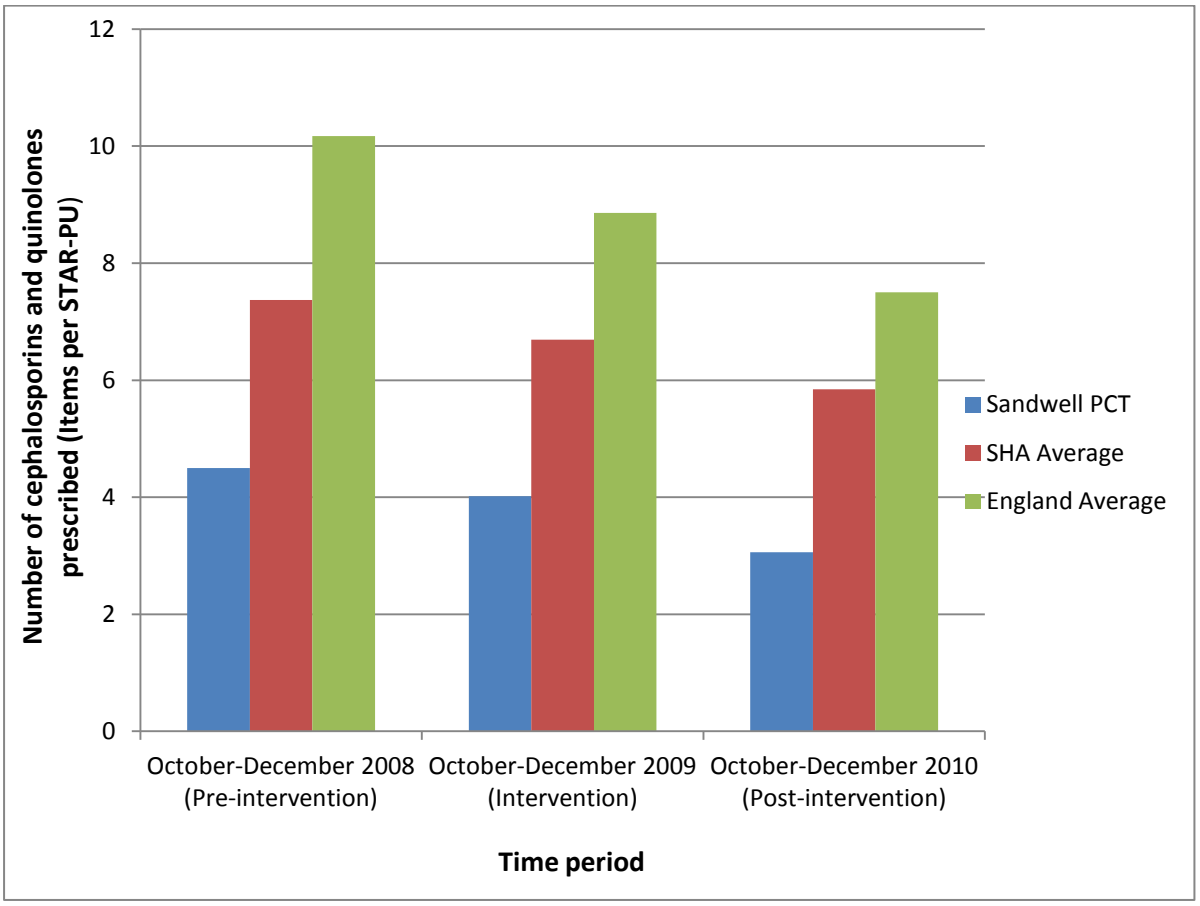


Figure 37 shows that cephalosporin and quinolones prescribing has been reducing in Sandwell PCT from the pre-to-post intervention periods. This same pattern of prescribing has also been present at SHA and national level. Figure 37 also shows that Sandwell PCT has been lower prescribers of cephalosporins and quinolones in comparison to SHA and national prescribing averages with national prescribing being higher than seen in the SHA. However,

cephalosporin and quinolone prescribing (OR (95% CI) did not significantly increase in Sandwell PCT 0.89 (0.22-3.50) in comparison to SHA prescribing 0.90 (0.30-2.67), and significantly reduce in comparison to national prescribing 0.86 (0.33.3-2.21) during the intervention period.

Cephalosporin and quinolone prescribing (OR (95% CI) in the post-intervention period did not significantly increase in Sandwell PCT 0.68 (0.15-2.99) in comparison to national antibiotic prescribing 0.72 (0.27-1.92) and SHA antibiotic prescribing 0.78 (0.25-2.40).

6.7 Discussion

The qualitative research conducted in Chapter 5 raised the issue of how antibiotic prescribing was analysed at PCT level, with the use of ePACT and audits not being utilised to maximise data analysis. Therefore objective 1 was set to produce a prescribing analysis tool to provide detailed analysis of antibiotic prescribing for all surgeries within Sandwell PCT. In doing so the Antibiotic Database was produced and used, not only to analyse prescribing, but also as an intervention to improve antibiotic prescribing.

6.7.1 The Antibiotic Database

The Antibiotic Database was an innovative feedback system produced to analyse antibiotic prescribing. It ensured that antibiotic prescribing was always analysed in a consistent manner which therefore saved time and money spent on producing *ad hoc* visual electronic outputs to analyse antibiotic prescribing using an inaccurate outcome measure or time period for analysis. The advantage of using prescription numbers as the outcome measure for the Prescribing Table was the ease with which the use of particular antibiotics could be analysed.

As the data provided by the National Prescribing Service allowed analysis of prescribing at PCT, SHA and DH level the Antibiotic Database could also be used to analyse antibiotic prescribing within all Primary Care arenas in more detail and thus provide a national feedback system. This is further aided by the compatibility of the Antibiotic Database with all Microsoft applications in order to evaluate any intervention used. Therefore the aim of devising and implementing an antimicrobial prescribing analysis tool within a Primary Care Trust was achieved.

The advantages of the Antibiotic Database include the production of detailed analysis for each practice within Sandwell PCT. The production of the Antibiotic Database initially took 30 minutes, which could then be updated in five minutes when the new data from the National Prescribing Service was retrieved every quarter. The outputs were easy to understand and the database could be easily manipulated with Microsoft Excel.

A key disadvantage of the Antibiotic Database was the requirement of an individual Antibiotic Database to analyse prescribing for any given PCT or practice. This could be overcome by the conversion of the Antibiotic Database from Microsoft Excel to a web based output. In doing so the database would be more robust and allow analysis of any practice or PCT on one database.

A second disadvantage of the Antibiotic Database was the reliance on ePACT to provide the required data. In doing so, the latest data contained within the Antibiotic Database was always three months in arrears.

6.7.2 Impact of the Antibiotic Database as an intervention tool

The Antibiotic Database was used to provide personalised antibiotic prescribing data to all surgeries within Sandwell PCT in the form of PowerPoint presentations at practice meetings between the months of October to December in 2009 (quarter 3 in financial year 2009/2010). The impact of the intervention was analysed on two levels and covering prescribing of overall antibiotics, cephalosporins and quinolones.

The first type of analysis focused on trend analysis of prescribing within Sandwell PCT since the start of the 2007/2008 financial year. Data was divided quarterly in order to compare the prescribing within the intervention period to the same periods in years before and after intervention implementation. This form of analysis was important in order to determine the effectiveness of the intervention by comparing the prescribing data to that seen in the same time period in different years, thus achieving long term intervention analysis. Data was divided into quarterly periods to analyse what impact the intervention has had in the long term within Sandwell and also to highlight the seasonal variations present in antibiotic prescribing. Figure 33 highlights the seasonal variation in antibiotic prescribing and thus provides support to the comparison of antibiotic prescribing to the same quarterly periods (financial).

The second form of analysis involved the comparison of total antibiotics, cephalosporins and quinolones within Sandwell PCT to those seen within the West Midlands SHA and the national averages. The data was presented for the pre-intervention period (October-December 2008), the intervention period (October-December 2009) and the post-intervention period

(October-December 2010). This type of analysis helped to ensure attempts were made to account for confounding factors. Log odds ratio calculations were used to determine the significance of changes to antibiotic prescribing produced by the intervention in comparison to that achieved at SHA and national level.

6.7.3 Analysis of overall antibiotic prescribing

The results showed that the Antibiotic Database did not provide a significant reduction in antibiotic prescribing in comparison to the same period in the previous year (pre-intervention). Long term (post-intervention) analysis showed that both Sandwell PCT and the SHA were higher prescribers of antibiotics in comparison to the national average. However the increase in antibiotic prescribing was not significant in comparison to antibiotic prescribing at SHA and national level. These results suggest that the Antibiotic Database had no significant short or long term impact on antibiotic prescribing.

6.7.4 Analysis of cephalosporin and quinolone prescribing

The results showed that cephalosporin and quinolone prescribing had consistently reduced since the pre-intervention period. However this reduction was not significant in comparison to SHA and national cephalosporin and quinolone prescribing figures. The reductions in prescribing seen since the pre-intervention period have also been achieved on a SHA and national level. This suggests a factor, other than the Antibiotic Database, produced the reductions achieved at Sandwell PCT, SHA and national levels.

6.7.5 Factors affecting antibiotic prescribing

The Antibiotic Database produced no significant reductions in antibiotic prescribing in comparison to SHA and national level. The key reason for this result was the level of engagement obtained by prescribers to use the Antibiotic Database, or any other intervention to improve their antibiotic prescribing at Sandwell PCT, the SHA or national level. However, it must also be noted that there may have been surgeries, PCTs or regions within England that have produced significant reductions in prescribing. Therefore more research is required to determine whether significant reductions in antibiotic prescribing have been achieved at any surgery, PCT or regional level and if so, how prescribers were engaged to improve their prescribing.

6.7.6 Limitations in the development and implementation of the Antibiotic Database

There were many limitations that may have impacted on the influence of the Antibiotic Database as an intervention, and can be divided into; developmental, implementation and analytical limitations.

6.7.6.1 Developmental limitations

A key decision made at the developmental stage of the Antibiotic Database was to use ePACT as the source of data. In doing so, the objectives 1, 2 and 3 were achieved and data was easily obtained and accurate. However, ePACT data was produced by a third party organisation and thus the production of the Antibiotic Database was reliant on ePACT providing the required data. Changes that could be made without consultation could have included, the outcome measures used to analyse prescribing and access to ePACT itself. Although audits were considered a labour intensive process, total control of the data obtained would have been a key advantage with its use.

A second key limitation of using ePACT was the three month delay in providing new prescribing data. If audits were used as the source of data then real time data was a

possibility, although section 4.5.2.1 describes the difficulties in completing audits, such as access to surgeries to complete audits and time taken to complete audits.

If real time data was used, the Antibiotic Database would have been considered as a surveillance tool rather than a feedback tool. A surveillance tool may have had a further impact on prescribing as prescribers could have been made aware of their current prescribing and thus influenced before further prescriptions were provided. Instead the feedback tool allowed their normal prescribing practices to continue for three months before being reviewed.

6.7.6.2 Implementation limitations

The implementation of Antibiotic Database involved presentations at a PLT event and practice meetings. To ensure consistency in presentation and content were achieved, a standardised presentation was produced for all prescribers. The Antibiotic Database was then used to provide personalised data to all surgeries. Key limitations of the implementation process were the lack of consistency in attendees to both the PLT and surgery meetings and the timing of the presentations at surgery meetings.

The PLT was used as a platform to address the issues around antibiotics and promote the Antibiotic Database and thus can be classed as a stage of the intervention process. If prescribers attended both the PLT and practice meetings then it could be argued that they were exposed to an intervention twice. Inconsistency in the intervention process was therefore present as some prescribers may not have attended either the PLT or practice meeting and thus be exposed to the intervention only once. It could be argued that the more a prescriber is exposed to the intervention, the more they are likely to change their prescribing and thus the results may have been affected.

The timing of practice meeting presentations was also a key factor in determining the impact of the intervention. The intervention period was set between October and December in 2009 and the intervention data analysis was also set within this time period. Therefore a limitation of the present research was the varying times that surgeries were presented with their antibiotic prescribing data. Those surgeries that had their presentations conducted at the start of the intervention period had further time to improve their antibiotic prescribing in comparison to those surgeries having their presentations at the end of the intervention period.

A limitation of the development and implementation of the Antibiotic Database was the lack of integration with standard approaches, such as the MRC Framework for developing complex interventions (2000). However, the present semi-structured interviews highlighted the need for the production of a prescribing feedback tool in order to provide consistency in the analysis of antibiotic prescribing undertaken at PCT level (see section 5.10.5.2). These views should have been balanced with consideration of literature on implementation Science that raises concerns in the use of a prescribing feedback tool.

The present systematic review highlighted the use of guidelines and pharmacists to improve antibiotic prescribing, and these interventions could have been utilised more effectively within the development of the Antibiotic Database. For example, the graphs produced from the Antibiotic Database could have been combined with current guidelines to further inform prescribers of how antibiotic prescribing could be improved during the meetings conducted. In addition, even though the Antibiotic Pharmacist produced the Antibiotic Database and met all prescribers to improve their prescribing, no analysis of the Antibiotic Pharmacist's ability to present, educate and influence prescribers to modify their prescribing was taken into account. The effectiveness of the Antibiotic Pharmacist could have been analysed by qualitative research conducted with prescribers and thus was an oversight in evaluation of the intervention. A more clinical approach to the meetings, based on audits conducted at surgeries and detailed reference to guidelines may have produced a more significant impact than meetings based on trend analysis of antibiotic prescribing.

Finally, randomisation of prescribers within Sandwell PCT was also not considered when implementing the interventions as their effects were considered to be so potentially large that confounding the underlying trends were unlikely to explain differences before and after exposure to the intervention. However, randomisation of prescribers into experimental and control groups should have been considered in order to reduce selection bias and thus can be considered a limitation of the present research.

6.7.6.3 Analytical limitations

The Antibiotic Database was produced to analyse antibiotic prescribing using defined outcome measures and thus the appropriateness of antibiotic prescribing could not be determined. For example, a practice prescribing a high number of antibiotics may have been classed as poor prescribers of antibiotics even though those antibiotics were prescribed appropriately, therefore highlighting a key limitation of the Antibiotic Database. Using audits

as the source of data would have overcome this issue as the reason for prescribing could also have been accounted for.

6.7.7 Future research

The Antibiotic Database has highlighted two key areas for future research. Firstly, analysis of the impact of the Antibiotic Database should be increased to a further year to determine whether the Antibiotic Database reduced overall prescribing further when compared to national prescribing. Secondly, the intervention period set for analysis should be modified to ensure that all practices are presented with the required data before analysis of their prescribing is measured.

The results of this present research has also highlighted that there could be many confounding factors that have impacted on antibiotic prescribing at PCT to national scale. Therefore more research should be conducted to determine what these confounding factors are and how effective they have been to improve prescribing.

The results of this present research have also highlighted that reductions in antibiotic prescribing may not necessarily equate to improved antibiotic prescribing. Therefore data from audits should be incorporated into the Antibiotic Database in order to provide reasons for why antibiotics have been prescribed. In doing so, the quality of prescribing can also be measured.

6.8 Conclusion

In conclusion the Antibiotic Database was developed and implemented as not only a method of monitoring antibiotic prescribing, but also an intervention within Sandwell PCT. In doing so the aim and objectives set at the beginning of this chapter were met.

The Antibiotic Database was developed using Microsoft Excel and allowed users to analyse prescribing of any antibiotic over an extended period of time. The Antibiotic Database was updated quarterly, with data also broken down to quarterly level as antibiotic prescribing fluctuated greatly between quarterly periods. The Antibiotic Database proved that antibiotic prescribing was highest during the months between October and December, and lowest between July and September.

The source of data used to populate the Antibiotic Database was generated from ePACT, using the number of prescriptions and Items per STAR-PU as the outcome measures of choice. Users were able to view antibiotic prescribing using both outcome measures in table form (Prescribing Table), five summary graphs, and four key antibiotic analysis graphs.

The Antibiotic Database was used as an intervention tool between October and December in 2009, with personalised Sandwell PCT data being presented at a local PLT event and personalised surgery level data being presented at all surgery meetings within Sandwell. The success of the intervention was based on a reduction in overall antibiotic, cephalosporin and quinolone prescribing within Sandwell PCT from pre-to-post intervention periods. These results were then compared to prescribing of overall antibiotic, cephalosporins and quinolones at local SHA and national level to account for any confounding factors.

The results showed that there were reductions to overall antibiotic prescribing during the intervention period at Sandwell**.** However, these reductions were not significant in comparison to antibiotic prescribing at SHA and national level. The reduction in post-intervention antibiotic prescribing at Sandwell PCT was also not significant in comparison to post-intervention prescribing at SHA and national level.

Analysis of cephalosporin and quinolone prescribing within Sandwell showed that prescribing reduced during the intervention period and then continued to reduce in the post-intervention period. However these positive results were also matched by the same pattern being present

at SHA and national level, thus providing no significant reductions in cephalosporins and quinolones at Sandwell PCT. Therefore more research is required to determine how prescriber engagement has been achieved at surgeries, PCTs or regions that have produced significant reductions in antibiotic prescribing.

Overall, the Antibiotic Database is a useful tool to analyse antibiotic prescribing and as an intervention to reduce antibiotic prescribing, however more research is required to determine how prescribers can be motivated to improve antibiotic prescribing. Therefore the Antibiotic Database should be used nationally within all healthcare departments, especially within DH, SHAs and PCTs. In doing so antibiotic prescribing can be continually monitored and intervention use can be analysed on a much larger scale.

In order to improve intervention analysis, Medicines Management teams within PCTs, SHAs and the DH have to record all interventions used to control antibiotic prescribing. The records should contain details of; what the intervention is, how the intervention is implemented, what the aims of the intervention are, who the target audience is, who is responsible for the implementing the intervention, how long the intervention will be used for and the actual presentation of the intervention used.

The improved analysis and recording of interventions will therefore provide a platform to discover the true impact of interventions used nationally to control antibiotic prescribing over an increased duration of time.

7. General Discussion

Overall, the aims and objectives set in section 2 have been achieved throughout the present research through the conduct of a systematic review and qualitative research to explore interventions aimed at improving antibiotic prescribing. As a result, pharmacy intervention and guidelines were considered as two interventions that could improve antibiotic prescribing and were thus incorporated into the development and implementation of the Antibiotic Database within Sandwell PCT. As these two interventions were key within all areas of the present research, pharmacy intervention and guidelines will be discussed further in order to conclude the significance of the present research and how antibiotic prescribing can be improved in the future.

Pastel (1992), Dranitsaris (2001) and Seager (2006) were three review studies that highlighted the impact of pharmacy intervention to improve antibiotic prescribing within the present systematic review (Chapter 4). Pastel (1992) used pharmacy intervention as a sole intervention to improve antibiotic prescribing, with Dranitsaris (2001) and Seager (2006) using pharmacy intervention within a multifaceted intervention. Guidelines were the most commonly used intervention within the review studies and also used by both Dranitsaris (2001) and Seager (2006) within their multifaceted approach.

A key limitation of the present systematic review was the lack of detail necessary to explain how interventions were conducted and thus the variability within studies could not be precisely accounted for. For example, Pastel (1998), Dranitsaris (2001) and Seager (2006) concluded that pharmacy intervention was an effective intervention although caution was needed when generalising these findings to other settings as these studies provided insufficient detail and comparisons in how pharmacy intervention was best achieved.

Studies reporting the use of guidelines also failed to provide the necessary detail of how they were developed and implemented and thus studies producing a low log odds ratio score actually may have used poor “guidelines” and/or failed to implement “guidelines” effectively during the intervention period. Therefore, the use of guidelines may have been incorrectly perceived as an ineffective intervention to improve antibiotic prescribing within these studies. In cases where there have been multiple interventions adopted, little information was provided on how interventions were combined, why certain combinations were chosen and who exactly implemented them. However, the lack of detail provided could have been overcome by contacting the authors of the studies to provide the omitted information.

The semi-structured interviews conducted (Chapter 5) also supported the results of the present systematic review, with two possible successful interventions being the use of pharmacist intervention and the implementation of guidelines. However, interviewees also failed to provide sufficient information in order to determine how pharmacists and guidelines were able to improve antibiotic prescribing. The insufficient detail provided by interviewees was overcome through the conduct of the combined approach (Chapter 5) which allowed the provision of information to determine the target audience, duration of implementation, format and content of guidelines and how the pharmacist was able to influence antibiotic prescribing.

A key finding of the combined approach was that Sandwell PCT did have an antibiotic formulary within the main PCT formulary, although the information had not been updated for two years and had no input from the microbiologists working within the local acute trust. In addition there was no information available at Sandwell PCT to determine how many prescribers actually read the formulary or used it to guide their prescribing and thus the interviewee's views that guidelines influenced prescribing must be questioned when there were no results to support this statement.

A second key finding of the combined approach was the variance in strategies used by pharmacists to improve antibiotic prescribing. Therefore there needs to be a distinction made from whether the pharmacist themselves, or the intervention(s) they use that actually produce the improvement in antibiotic prescribing. Therefore more research is required in order to define what an intervention is and who is required to develop and implement any given intervention. With regards to the Antibiotic Database, the Specialist Antibiotic Pharmacist had sole control over its development and implementation. However, the Specialist Antibiotic Pharmacist may not have had the ability to use the Antibiotic Database effectively in order to produce improvements in antibiotic prescribing and thus not produced significant improvements in antibiotic prescribing.

Overall, the Antibiotic Database proved that there were no significant improvements in antibiotic prescribing in comparison to the West Midlands SHA and national data. Therefore the pharmacy intervention and guidelines used within Sandwell PCT did not influence prescribing in comparison to all other interventions used across the rest of England. However, the development and implementation of the Antibiotic Database within Sandwell may not have maximised pharmacists and guidelines as interventions to improve antibiotic prescribing.

The results obtained at Sandwell PCT, West Midlands SHA and national level suggest that reductions in specific antibiotics (cephalosorins and quinolones) were achieved although reductions in overall antibiotic prescribing were not. This supports this view of Arnold and Straus (2005) who stated that "Interventions aimed at increasing the prescribing of certain recommended first-line antibiotics for specific infections are more likely to produce substantial changes in prescribing than those interventions targeting overall inappropriate antibiotic use."

This present research therefore highlights a key issue that has not been raised through the completed systematic review, semi-structured interviews and combined approach of engaging prescribers into any intervention used, especially in order to reduce overall antibiotic prescribing. Therefore all future research on improving antibiotic prescribing should focus on how to improve prescriber engagement with any chosen intervention or intervention(s) used to improve antibiotic prescribing. This may require particular focus on the abilities of individual(s) employed to develop and implement an intervention, in addition to analysis of the intervention alone.

7.1 How to measure improvements in antibiotic prescribing

The present systematic review highlighted two studies by Van Driel (2007) and Briel (2006) that achieved higher log odds ratio scores when reporting results in terms of compliance rather than number of prescriptions. This may have been the result of both Van Driel (2007) and Briel (2006) using guidelines (as part of a multifaceted intervention) to advise prescribers on what antibiotics to prescribe for any given condition and thus led to increased compliance in prescribing, rather than a reduction in prescribing. A limitation of the present research may have been to determine improvements in antibiotic prescribing in terms of a reduction in antibiotic prescribing and thus there needs to be universal agreement on how the impact of any given intervention is measured.

7.2 Generalisation of results achieved

The present research focused all post-systematic review research within Primary Care, with semi-structured interviews conducted with NHS managers working within Medicines Management departments in the West Midlands and the combined approach utilised within Sandwell PCT. Therefore, limitations of the post-systematic review research were the lack of research conducted within; Secondary Care, Primary Care regions (other than the West Midlands), and other NHS Primary Care departments which also aim to improve antibiotic prescribing (such as Infection Prevention teams). The present research also failed to encompass the conduct of research on an international level. As a result, the analysis of interventions used to improve antibiotic prescribing may not be generalised to these other healthcare departments or sectors. This is possibly owing to; structural differences within departments and sectors, the ability of individuals to improve antibiotic prescribing (i.e. qualifications and experience), the importance placed on improving antibiotic prescribing and differences in patient demand for antibiotics.

The use of the Antibiotic Database, as a tool to analyse prescribing, can be generalised to all healthcare departments or sectors as the contents of the Database can be modified to include other antibiotics and outcome measures to analyse prescribing. The only aspect of the

Antibiotic database that cannot be generalised is how it is used as an intervention to improve antibiotic prescribing.

7.3 Strengths and weaknesses

The present research has highlighted a number of limitations which have restricted the quality of the results obtained. These limitations must be juxtaposed with the potential significance of the results achieved.

The systematic review has successfully reviewed all studies reporting interventions aimed at improving antibiotic prescribing. This provided the platform for the conduct of qualitative research which evaluated the impact of interventions used within the United Kingdom Primary Care arena. The result was the production of an innovative intervention called the Antibiotic Database which can revolutionise the analysis of interventions used to control antibiotic prescribing.

This research has not been previously completed and the results can be used to influence future work and improve how research in this area is conducted, how the findings are presented and how antibiotic prescribing can be improved.

8. Overall Conclusions

In conclusion the present research has identified and determined the effectiveness of all interventions that have been used to improve antibiotic prescribing through the conduct of a systematic review, qualitative research and development and implementation of the Antibiotic Database.

As the present systematic review contained a number of studies analysing interventions with varying scope and intensity, it was essential to pragmatically classify outcome measures and interventions into broad groups. This may be perceived as a limitation within the present research, however adopting this approach has helped to determine the effectiveness of interventions in improving antibiotic prescribing. Overall, the systematic review results suggested that the implementation of interventions actually increased antibiotic prescribing in comparison to baseline and follow-up periods.

Semi-structured interviews with selected NHS managers were conducted in order to determine how antibiotic prescribing could be improved within Primary Care and produced nine separate areas of analysis, with the quality of answers varying greatly for each area and also from each interviewee (horizontal and vertical variability). The answers provided by interviewees have to be balanced qualitatively with factors affecting their openness in answering questions. These include, the working environment where interviews were conducted, the time available to complete interviews, the interviewee interest in antibiotics resistance and the experience of the interviewees in their current roles. All attempts were made to keep the interviews as consistent as possible, however the nature of semi-structured interviews means any bias present may have affected the approach adopted by interviewees.

The most commonly mentioned interventions within the semi-structured interviews were incentive schemes, practice based pharmacists (pharmacy intervention), formularies or guidelines and meeting GPs on a one-to-one basis. However the fact that all interviewees failed to agree on the use of any one intervention to improve antibiotic prescribing highlights the lack of analysis of interventions or lack of interviewees' knowledge of how to improve antibiotic prescribing. The combined approach allowed further elaboration on the key issues highlighted through the systematic review and semi-structured interviews and identified a key intervention that was not even mentioned throughout the semi-structured interviews (audits). Also the combined approach allowed the gathering of explicit detail required to determine how interventions were developed and implemented within Primary Care. This knowledge

identified the need for a database feedback tool (The Antibiotic Database) that provided an intervention to improve antibiotic prescribing as well as improved analysis of antibiotic prescribing.

8.1 Future work

The implementation of the Antibiotic Database failed to provide any significant reductions in antibiotic prescribing when compared to the West Midlands SHA and national antibiotic prescribing figures. Therefore it is essential for future research to focus on how interventions are used by individuals to engage prescribers into improving antibiotic prescribing.

In order to achieve this, future research must define and document intervention(s) and record the effects of baseline, follow-up and during-intervention prescribing, in addition to the inclusion criteria set for this systematic review. The records should contain details of; what the intervention is, how the intervention is implemented, what the aims of the intervention are, who the target audience is, who is responsible for implementing the intervention, how long the intervention will be used for and the actual presentation of the intervention used. The role of individuals who implement interventions must also be analysed in further detail in order to determine how prescribers were engaged to use their chosen interventions and why this strategy was used.

8.2 Recommendations to control antibiotic use

Regardless of the improvements required within future research, the results of the present research do indicate that a combination of three interventions can improve antibiotic prescribing. Firstly an IT based intervention, such as the Antibiotic Database should be used within all sectors of the NHS in order to analyse antibiotic prescribing and provide a platform to discover the true impact of interventions used nationally to control antibiotic prescribing over an increased duration of time.

Secondly, guidelines and finally pharmacists have the greatest potential to improve antibiotic use. Therefore pharmacists should be employed within healthcare systems to achieve appropriate prescribing by educating prescribers with the use of antibiotic guidelines.

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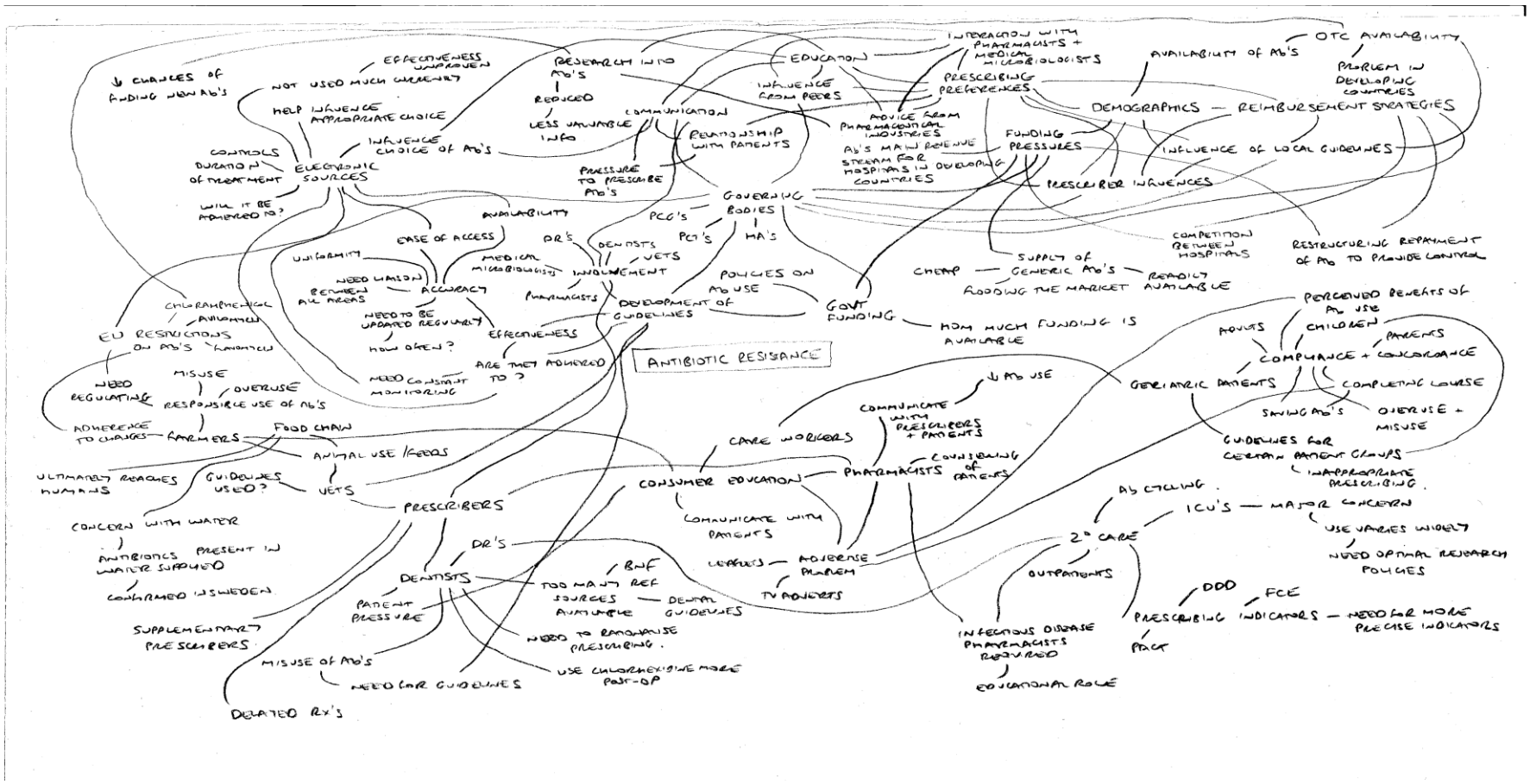
Appendix 1: Mind mapping technique



Appendix 2: Search term combinations used for the present systematic review conducted

	Search Engine used					
Search strategy term combinations	Pharm-line	Med-line	Cochrane			
	Number of abstracts in search results	Number of relevant abstracts	Number of abstracts in search results	Number of relevant abstracts	Number of abstracts in search results	Number of relevant abstracts
Antibiotic + control	299	57	63307	205	253	2
Antibiotic + prescribing + control	95	20	602	111	41	3
Antibiotic + prescribing + control failure	0	0	24	0	5	0
Consequences + antibiotics + control failure	0	0	45	0	2	0
Antibiotic + prescribing + control + mechanisms	1	1	18	0	2	1
Antibiotic + control + mechanism	6	1	2276	0	6	0
Antibiotic + control + effectiveness	19	3	2219	29	95	2

Antibiotic + restriction or control + effectiveness	138	1	45570	0	1444	0
Antibiotic + control + restriction	500	20	656	18	0	0
Antibiotic + restriction	22	3	4752	33	25	0
Antibiotic + prescribing + restriction	15	2	37	9	3	0
Antibiotic + prescribing + restriction + mechanisms	0	0	1	0	0	0
Campaign + antibiotic	16	3	209	17	12	3
Advertisement + antibiotic	0	0	61	3	1	0
Antibiotic + indicators	26	0	8875	1	62	0
Antibiotic + prescribing + indicators	22	0	51	10	12	0
Drivers + antibiotic use	0	0	27	0	2	0
Influences + antibiotic use	8	0	1114	1	16	0
Antibiotic use + patient understanding	0	0	596	1	11	1
Patient + antibiotic + understanding	13	0	596	1	16	0

Education + antibiotic	159	17	3966	49	4	1
Patient + education + antibiotic	58	5	768	8	2	1
Prescriber + education + antibiotics	97	4	39	6	6	3
Prescriber + antibiotic	53	3	101	8	24	6
Prescribing + preferences + antibiotics	7	0	16	0	1	0
Experience + antibiotic + prescribing	11	0	73	4	2	0
Attitude + antibiotic + prescribing	43	2	147	8	8	2
Perception + antibiotics	13	3	1786	0	1	0
Electronic + prescribing + antibiotic	40	6	43	4	6	0
GP + antibiotics	139	3	787	6	41	3
Dentists + antibiotics	34	1	251	0	2	0
Medical microbiologists + antibiotic	2	1	71	1	0	0
Supplementary prescribers + antibiotics	0	0	2	0	1	1
Vets + antibiotics	0	0	4	0	0	0

Animals + antibiotics	83	0	111090	0	7	0
Antibiotics + animal feeds	1	0	2488	0	0	0
Sewage + antibiotics	0	0	506	0	0	0
Influence of demographics + antibiotic prescribing	0	0	9	0	0	0
Demographics + antibiotic prescribing	4	1	177	0	0	0
Measure + social + deprivation + antibiotics	0	0	2	0	0	0
Antibiotic use + deprivation	4	0	659	0	0	0
Antibiotic use + patients	500	2	93972	0	134	2
Antibiotic use + prescriber	53	0	101	8	18	6
Antibiotic + prescribing + international	39	3	99	1	0	0
Antibiotic + prescribing + UK	62	5	319	13	1	0
Primary care + antibiotic prescribing	4	0	347	13	6	1
Community pharmacy + antibiotic	0	0	537	3	12	2

OTC + antibiotic	0	0	351	0	1	0
Generics + antibiotic	0	0	17	0	1	0
Secondary care + antibiotic	1	1	905	3	8	0
Hospitals + antibiotic	24	3	9446	21	57	1

Appendix 3: Quality assessment used for the review studies

1) **ABSTRACT**

DOES EACH SECTION OF THE ABSTRACT ACCURATELY REFLECT THE EQUIVALENT SECTION IN THE REVIEW

- BACKGROUND
- OBJECTIVES
- SEARCH STRATEGY
- SELECTION CRITERIA
- DATA COLLECTION AND ANALYSIS
- MAIN RESULTS
- REVIEWERS' CONCLUSIONS

2) **OBJECTIVES**

WERE THE MAIN OBJECTIVES SPECIFIED IN TERMS OF INTERVENTIONS, CLINICAL PROBLEM, POPULATION AND OUTCOMES

3) **SEARCH STRATEGY**

- WAS THE SEARCH STRATEGY INCLUDED
- WERE THE DATES THAT EACH SOURCE WAS SEARCHED IDENTICATED
- WERE THE FOLLOWING DATA SOURCES SEARCHED?
- COCHRANE
- MEDLINE
- EMBASE
- REFERENCE LISTS OF TEXT BOOKS, REVIEWS (INCLUDING PREVIOUS SYSTEMATIC REVIEWS), AND PREVIOUS TRIALS
- CONFERENCE PROCEEDINGS
- DID THE AUTHOR CONTACT EXPERTS IN THE FIELD
- WERE THE APPROPRIATE KEY WORDS SEARCHES USED
- WERE STUDIES IN LANGUAGES OTHER THAN ENGLISH INCLUDED
- DID THE REVIEWERS IDENTIFY AND DEAL WITH DUPLICATE PUBLICATIONS OF THE SAME TRIAL IN THE WAY THAT THEY SAID THEY WOULD IN THE PROTOCOL

- IF NOT, DID THEY DEAL WITH DUPLICATE PUBLICATIONS IN A WAY THAT WOULD REDUCE BIAS

B) **METHODS OF THE REVIEW**

DID AT LEAST TWO AUTHORS OF THE REVIEW:
- PERFORM THE LITERATURE SEARCH
- DETERMINE STUDY ELIGIBILITY
- ASSESS STUDY QUALITY
- EXTRACT DATA
- ENTER DATA IN REVMAN

- DID REVIEWERS WORK INDEPENDENTLY
- WAS THERE CONSESUS AND/OR LIAISON WITH A THIRD REVIEWER TO RESOLVE DISAGREEMENT BETWEEN THE PRIMARY REVIEWERS
- WERE AUTHORS OF PRIMARY STUDIES CONTACTED FOR CLARIFICATION OF UNCLEAR DATA OR TO OBTAIN MISSING INFORMATION?
- IF SO, WAS THE INFORMATION PROVIDED TO THE REVIEWERS
- DID THE REVIEWERS ATTEMPT TO ANALYSE FOR POSSIBLE PUBLICATION BIAS USING FUNNEL PLOTS OR OTHER METHODS
- IF NOT, DID THE REVIEWERSSTATE WHY THIS COULD NOT BE DONE

C) **DESCRIPTION OF STUDIES, CHARACTERISTICS OF INCLUDED STUDIES/CHARACTERISTICS OF EXCLUDED STUDIES**

- WERE THE IMPORTANT DETAILS OF THE INCLUDED STUDIES SUMMARISED IN THE TEXT OF THE REVIEW
- WERE THE IMPORTANT DETAILS OF STUDY DESIGN, PARTICIPANTS, INTERVENTIONS AND DEFINITION OF OUTCOMES INCLUDED IN THE TABLE "CHARACTERISTICS OF EXCLUDED STUDIES"
- IF STUDIES WERE EXCLUDED, ARE THE REASONS FOR EXCLUSION CONSISTENT WITH THE INCLUSION/EXCLUSION CRITERIA IN THE SECTION ON "CRITERIA FOR CONSIDERING STUDIES FOR THE REVIEW"
- ARE YOU AWARE OF ANY OTHER STUDIES THAT SHOULD HAVE BEEN INCLUDED

D) **METHODOLOGICAL QUALITY OF THE INCLUDED STUDIES**

- WAS THERE A TABLE LISTING THE QUALITY ITEMS FOR EACH INCLUDED STUDY
- WAS A SHORT SUMMARY OF THE QUALITY ASSESSMENT OF THE INCLUDED STUDIES INCLUDED IN THE TEXT

E) **RESULTS/COMPARISON TABLE**

KEY RESULTS

- ARE THE KEY RESULTS OF THE REVIEW PROVIDED IN THE TEXT
- DID THE KEY RESULTS ADDRESS THE OBJECTIVES OF THE REVIEW

META ANALYSIS

- IF THE RESULTS WERE POOLED, WAS THIS APPROPRIATE
- DID HETEROGENECITY BETWEEN STUDIES EXIST, IF YES WAS IT APPROPRIATELY EXPLAINED

OUTCOMES

- WERE ALL OUTCOMES DESCRIBED IN THE PROTOCOL INCLUDED IN THE RESULTS

SUBGROUP ANALYSIS

- WERE PLANNED SUBGROUP ANALYSIS INCLUDED
- IF PLANNED SUBGROUP ANALYSES WERE NOT INCLUDED, DID THE REVIEWERS EXPLAIN THE REASON FOR THIS
- WERE SUBGROUP ANALYSES THAT WERE NOT SPECIFIED IN THE PROTOCOL PERFORMED, IF SO, WERE THESE ANALYSES DESCRIBED AS BEING POST HOC

F) **DISCUSSION**

KEY RESULTS

- WERE THE PRINCIPAL RESULTS SUMMARISED
- WAS THE POTENTIAL IMPORTANCE OF THESE RESULTS DISCUSSED
- ARE THE CONCLUSIONS OF THE STUDY CONSISTENT WITH THE RESULTS

CONSISTENCY OF RESULTS

- WAS THE CONSISTENCY/INCONSISTENCY OF TRIALS DISCUSSED

LIMITATIONS OF THE STUDY

- PUBLICATION BIAS
- TRIAL QUALITY
- IMPRESSION OF RESULTS
- UNCERTAINTY OF HARMS (rigid in research, unwilling to see problem)

COMPARISON WITH OTHER DATA

- WERE THE REVIEW OF FINDINGS DISCUSSED IN RELATION TO RELEVANT EVIDENCE FROM OTHER STUDIES OR REVIEWS

G) **REVIEWERS' CONCLUSION**

IMPLICATIONS FOR PRACTICE

- DID THE REVIEWERS ATTEMPT TO DEMONSTRATE THE APPLICABILITY OF THE RESULTS OF BENEFITS AND RISKS

IMPLICATIONS FOR RESEARCH

- DID THE REVIEWERS DETERMINE WHICH QUESTIONS HAD BEEN ANSWERED BY THE REVIEW, IF SO DO YOU AGREE
- DID THE REVIEWERS DETERMINE WHICH QUESTIONS REQUIRE FURTHER TRIALS, IF SO DO YOU AGREE
- DID THE REVIEWERS SUGGEST NEW STUDIES BASED ON THE REVIEWED RESEARCH, IF SO DO YOU BELIEVE THAT THESE STUDIES ARE APPROPRIATE
- CAN YOU SUGGEST FURTHER STUDIES THAT SHOULD BE DONE

ARE BIASES AND STUDY LIMITATIONS IDENTIFIED AND DISCUSSED

QUALITY ASSESSMENT FOR RANDOMISED CONTROLLED TRIALS

1) **ABSTRACT**

DOES EACH SECTION OF THE ABSTRACT ACCURATELY REFLECT THE EQUIVALENT SECTION IN THE REVIEW

- BACKGROUND
- OBJECTIVES
- METHOD
- DATA COLLECTION AND ANALYSIS
- MAIN RESULTS
- REVIEWERS' CONCLUSIONS

2) **OBJECTIVES**

WERE THE MAIN OBJECTIVES SPECIFIED IN TERMS OF INTERVENTIONS, CLINICAL PROBLEM, POPULATION AND OUTCOMES

3) **TYPES OF PARTICIPANTS**

- WERE THE TYPE OF PARTICIPANTS REQUIRED INCLUDED AND WHY THEY INCLUDED DESCRIBED
- WERE THE POPULATION GROUPS TO BE EXCLUDED SPECIFIED
- WERE THE NUMBER OF PARTICIPANTS USED STATED IN BOTH INTERVENTION AND CONTROL GROUPS
- WERE THE GROUPS COMPARABLE
- IS THE COMPARISON FAIR
- WAS EVERYONE WHO ENTERED THE STUDY ACCOUNTED FOR AT THE END
- WERE THE CRITERIA EQUALLY APPLIED TO ALL GROUPS

4) TYPE OF STUDY

HIERARCHY OF STUDY DESIGNS

H) SYSTEMATIC REVIEW

I) EXPERIMENTAL STUDIES

- RANDOMISED CONTROLLED TRIALS (WITHOUT CONCEALMENT ALLOCATION)
- EXPERIMENTAL STUDY WITHOUT RANDOMISATION E.G. QUASI-EXPERIMENTAL OR QUASI RANDOMISED OR PSEUDO RANDOMISED STUDIES
-

J) OBSERVATIONAL STUDY

- COHORT STUDY
- CASE CONTROLLED STUDIES
- CROSS SECTIONAL STUDY
- BEFORE AND AFTER STUDY
- CASE SERIES
-

K) CASE REPORTS, PATHOPHYSIOLOGICAL STUDIES OR BENCH RESEARCH, EXPERT OPINION OR CONSENSUS

5) TYPES OF INTERVENTION AND COMPARISONS

- WERE THE STUDY INTERVENTIONS DESCRIBED
- WERE THE CONTROL INTERVENTIONS DESCRIBED
- WERE RELEVANT INTERVENTIONS USED TO ANSWER THE QUESTION IDENTIFIED
- WERE THE INTERVENTIONS INCLUDED DESCRIBED AND APPROPRIATE

6) TYPES OF OUTCOMES

- WERE THE OUTCOME MEASURES FOR THE BENEFITS AND HARMS OF INTERVENTION CLEARLY DEFINED IN NATURE AND IN TIMING
- IF SPECIFIC OUTCOMES HAVE BEEN INCLUDED, DID THEY CONFORM WITH THE QUESTION ASKED
- WERE THE MEASUREMENT OF THE OUTCOME THE SAME IN EACH GROUP
- WERE THE PERIOD OF FOLLOW UP LONG ENOUGH FOR IMPORTANT OUTCOMES TO OCCUR

- WERE OTHER FACTORS ACCOUNTED FOR (MEASURED) THAT COULD AFFECT OUTCOMES
-

7) ASSESSMENT OF QUALITY

WERE THE CRITERIA USED TO ASSESS STUDY QUALITY REPORTED?

- ALLOCATION CONCEALMENT
- ***ALLOCATION TO TREATMENT GROUPS CONCEALED***
- ***STUDY BLINDED IF POSSIBLE***
- BLINDING OF PARTICIPANTS
- BLINDING OF INVESTIGATORS
- BLINDING OF OUTCOME ASSESSMENT
- INTENTION TO TREAT ANALYSIS
- ***ALL RANDOMIZED PARTICIPANTS INCLUDED IN THE ANALYSIS (INTENTION TO TREAT)***
- COMPLETENESS OF FOLLOW UP
- RANDOMISATION
- ***METHODS USED TO GENERATE RANDOMISATION SCHEDULES ACCURATE AND UNBIASED***
- DESCRIPTION OF WITHDRAWALS
- ***WITHDRAWAL/DROPOUTS REASONS GIVEN FOR EACH GROUP***
- ***WERE PROTOCOLS DESCRIBED FOR ALL REGIMENS STUDIED***

WERE THESE ITEMS ASSESSED SEPARATELY RATHER COMBINED IN A SCORING SYSTEM

8) STATISTICAL ANALYSIS

- WERE THE STATISTICAL ANALYSES ADEQUATE IN DESCRIBING THE RESULTS
- WERE CORRECT STATISTICAL TESTS USED AND ASSUMPTIONS OF TEST NOT VIOLATED
- WERE STATISTICS REPORTED WITH LEVELS OF SIGNIFICANCE AND/OR CONFIDENCE INTERVALS
- WAS “INTENT TO TREAT” ANALYSIS F OUTCOMES DONE

- WERE ADEQUATE ADJUSTMENTS MADE FOR EFFECTS OF CONFOUNDING FACTORS THAT MIGHT HAVE AFFECTED THE OUTCOMES (E.G. MULTIVARIATE ANALYSES)
- WAS CLINICAL SIGNIFICANCE ASWELL AS STATISTICAL SIGNIFICANCE REPORTED
- IF NEGATIVE FINDINGS, WAS A POWER CALCULATION REPORTED TO ADDRESS TYPE 2 ERROR

QUALITY ASSESSMENT OF COHORT STUDIES

9) ABSTRACT

DOES EACH SECTION OF THE ABSTRACT ACCURATELY REFLECT THE EQUIVALENT SECTION IN THE REVIEW

- BACKGROUND
- OBJECTIVES
- SEARCH STRATEGY
- SELECTION CRITERIA
- DATA COLLECTION AND ANALYSIS
- MAIN RESULTS
- REVIEWERS' CONCLUSIONS

10) OBJECTIVES

WERE THE MAIN OBJECTIVES SPECIFIED IN TERMS OF INTERVENTIONS, CLINICAL PROBLEM, POPULATION AND OUTCOMES

11) TYPES OF PARTICIPANTS

- WERE THE TYPE OF PARTICIPANTS REQUIRED INCLUDED AND WHY THEY INCLUDED DESCRIBED
- WERE THE POPULATION GROUPS TO BE EXCLUDED SPECIFIED
- WERE THE NUMBER OF PARTICIPANTS USED STATED IN BOTH INTERVENTION AND CONTROL GROUPS
- WERE THE GROUPS COMPARABLE
- ***IF GROUPS USED: COMPARABLE AT BASELINE. IF PRE EXISTING DIFFERENCES PRESENT, ARE APPROPRIATE ADJUSTMENTS MADE USING STATISTICAL ANALYSIS***
- IS THE COMPARISON FAIR
- WAS EVERYONE WHO ENTERED THE STUDY ACCOUNTED FOR AT THE END
- WERE THE CRITERIA EQUALLY APPLIED TO ALL GROUPS
- ***>80% AGREED TO PARTICIPATE***
- ***ALL ELIGIBLE SUBJECTS SELECTED OR RANDOM SAMPLE***
- ***SUBJECTS FREE OF OUTCOMES ON INTEREST AT STUDY INCEPTION***

12) TYPE OF STUDY

HIERARCHY OF STUDY DESIGNS

K) SYSTEMATIC REVIEW

L) EXPERIMENTAL STUDIES

- RANDOMISED CONTROLLED TRIALS (WITHOUT CONCEALMENT ALLOCATION)
- EXPERIMENTAL STUDY WITHOUT RANDOMISATION E.G. QUASI-EXPERIMENTAL OR QUASI RANDOMISED OR PSEUDO RANDOMISED STUDIES

M) OBSERVATIONAL STUDY WITHOUT CONTROL GROUP

- COHORT STUDY
- CASE CONTROLLED STUDIES

N) OBSERVATIONAL STUDIES WITHOUT CONTROL GROUPS

- CROSS SECTIONAL STUDY
- BEFORE AND AFTER STUDY
- CASE SERIES

O) CASE REPORTS, PATHOPHYSIOLOGICAL STUDIES OR BENCH RESEARCH, EXPERT OPINION OR CONSENSUS

13) TYPES OF INTERVENTION AND COMPARISONS

- WERE THE STUDY INTERVENTIONS DESCRIBED
- WERE THE CONTROL INTERVENTIONS DESCRIBED
- WERE RELEVANT INTERVENTIONS USED TO ANSWER THE QUESTION IDENTIFIED
- WERE THE INTERVENTIONS INCLUDED DESCRIBED AND APPROPRIATE

14) TYPES OF OUTCOMES

- WERE THE OUTCOME MEASURES FOR THE BENEFITS AND HARMS OF INTERVENTION CLEARLY DEFINED IN NATURE AND IN TIMING
- IF SPECIFIC OUTCOMES HAVE BEEN INCLUDED, DID THEY CONFORM WITH THE QUESTION ASKED
- WERE THE MEASUREMENT OF THE OUTCOME THE SAME IN EACH GROUP
- WERE THE PERIOD OF FOLLOW UP LONG ENOUGH FOR IMPORTANT OUTCOMES TO OCCUR
- WERE OTHER FACTORS ACCOUNTED FOR (MEASURED) THAT COULD AFFECT OUTCOMES
- ***MEASUREMENT OF OUTCOMES UNBIASED (BLINDED TO GROUP)***

15) ASSESSMENT OF QUALITY

WERE THE CRITERIA USED TO ASSESS STUDY QUALITY REPORTED?

- ALLOCATION CONCEALMENT
- BLINDING OF PARTICIPANTS
- BLINDING OF INVESTIGATORS
- BLINDING OF OUTCOME ASSESSMENT
- INTENTION TO TREAT ANALYSIS
- COMPLETENESS OF FOLLOW UP – ***FOLLOW UP SUFFICIENT DURATION***
- ***FOLLOW UP COMPLETE AND EXCLUSIONS ACCOUNTED FOR (>80% INCLUDED IN FINAL ANALYSIS)***
- RANDOMISATION
- DESCRIPTION OF WITHDRAWALS
- ***POTENTIAL CONFOUNDERS(astounding results) ACCOUNTED FOR***

WERE THESE ITEMS ASSESSED SEPARATELY RATHER COMBINED IN A SCORING SYSTEM

16) STATISTICAL ANALYSIS

- WERE THE STATISTICAL ANALYSES ADEQUATE IN DESCRIBING THE RESULTS
- WERE CORRECT STATISTICAL TESTS USED AND ASSUMPTIONS OF TEST NOT VIOLATED
- WERE STATISTICS REPORTED WITH LEVELS OF SIGNIFICANCE AND/OR CONFIDENCE INTERVALS
- WAS “INTENT TO TREAT” ANALYSIS F OUTCOMES DONE
- WERE ADEQUATE ADJUSTMENTS MADE FOR EFFECTS OF CONFOUNDING FACTORS THAT MIGHT HAVE AFFECTED THE OUTCOMES (E.G. MULTIVARIATE ANALYSES)
- WAS CLINICAL SIGNIFICANCE ASWELL AS STATISTICAL SIGNIFICANCE REPORTED
- IF NEGATIVE FINDINGS, WAS A POWER CALCULATION REPORTED TO ADDRESS TYPE 2 ERROR

QUALITY ASSESSMENT OF CASE CONTROL STUDIES

17) ABSTRACT

DOES EACH SECTION OF THE ABSTRACT ACCURATELY REFLECT THE EQUIVALENT SECTION IN THE REVIEW

- BACKGROUND
- OBJECTIVES
- SEARCH STRATEGY
- SELECTION CRITERIA
- DATA COLLECTION AND ANALYSIS
- MAIN RESULTS
- REVIEWERS' CONCLUSIONS

18) OBJECTIVES

WERE THE MAIN OBJECTIVES SPECIFIED IN TERMS OF INTERVENTIONS, CLINICAL PROBLEM, POPULATION AND OUTCOMES

19) TYPES OF PARTICIPANTS

- WERE THE TYPE OF PARTICIPANTS REQUIRED INCLUDED AND WHY THEY INCLUDED DESCRIBED
- WERE THE POPULATION GROUPS TO BE EXCLUDED SPECIFIED
- WERE THE NUMBER OF PARTICIPANTS USED STATED IN BOTH INTERVENTION AND CONTROL GROUPS
- WERE THE GROUPS COMPARABLE
- ***GROUPS COMPARABLE WITH RESPECT TO POTENTIAL CONFOUNDERS***
- IS THE COMPARISON FAIR
- WAS EVERYONE WHO ENTERED THE STUDY ACCOUNTED FOR AT THE END
- WERE THE CRITERIA EQUALLY APPLIED TO ALL GROUPS
- ***ELIGIBLE SUBJECTS DIAGNOSED AS CASES OVER A DEFINED PERIOD OF TIME OR DEFINED CATCHMENT AREA OR A RANDOM SAMPLE OF SUCH CASES***
- ***CASE CONTROLS DEFIFNITIONS ADEQUATE AND VALIDATED***
- ***CONTROLS SELECTED FROM SAMPLE POPULATION AS CASES***

- ***CONTROLS REPRESENTATIVE (INDIVIDUALLY MATCHED) <80% AGREED TO PARTICIPATED***

20) TYPE OF STUDY

HIERARCHY OF STUDY DESIGNS

O) SYSTEMATIC REVIEW

P) EXPERIMENTAL STUDIES

- RANDOMISED CONTROLLED TRIALS (WITHOUT CONCEALMENT ALLOCATION)
- EXPERIMENTAL STUDY WITHOUT RANDOMISATION E.G. QUASI-EXPERIMENTAL OR QUASI RANDOMISED OR PSEUDO RANDOMISED STUDIES

Q) OBSERVATIONAL STUDY WITHOUT CONTROL GROUP

- COHORT STUDY
- CASE CONTROLLED STUDIES

R) OBSERVATIONAL STUDIES WITHOUT CONTROL GROUPS

- CROSS SECTIONAL STUDY
- BEFORE AND AFTER STUDY
- CASE SERIES

E) CASE REPORTS, PATHOPHYSIOLOGICAL STUDIES OR BENCH RESEARCH, EXPERT OPINION OR CONSENSUS

21) TYPES OF INTERVENTION AND COMPARISONS

- WERE THE STUDY INTERVENTIONS DESCRIBED
- WERE THE CONTROL INTERVENTIONS DESCRIBED
- WERE RELEVANT INTERVENTIONS USED TO ANSWER THE QUESTION IDENTIFIED
- WERE THE INTERVENTIONS INCLUDED DESCRIBED AND APPROPRIATE

22) TYPES OF OUTCOMES

- WERE THE OUTCOME MEASURES FOR THE BENEFITS AND HARMS OF INTERVENTION CLEARLY DEFINED IN NATURE AND IN TIMING
- IF SPECIFIC OUTCOMES HAVE BEEN INCLUDED, DID THEY CONFORM WITH THE QUESTION ASKED
- WERE THE MEASUREMENT OF THE OUTCOME THE SAME IN EACH GROUP
- WERE THE PERIOD OF FOLLOW UP LONG ENOUGH FOR IMPORTANT OUTCOMES TO OCCUR

- WERE OTHER FACTORS ACCOUNTED FOR (MEASURED) THAT COULD AFFECT OUTCOMES
- ***OUTCOME STATUS ASCERTAINED OBJECTIVELY***
- ***WAS CASE DEFINITION EXPLICIT AND CASE ASCERTAINMENT NOT INFLUENCED BY EXPOSURE STATUS***
- ***POTENTIAL CONFOUNDERS CONTROLLED FOR***
- ***MEASUREMENT OF EXPOSURE UNBIASED (BLINDED TO GROUP)***

23) ASSESSMENT OF QUALITY

WERE THE CRITERIA USED TO ASSESS STUDY QUALITY REPORTED?

- ALLOCATION CONCEALMENT
- BLINDING OF PARTICIPANTS
- BLINDING OF INVESTIGATORS
- BLINDING OF OUTCOME ASSESSMENT
- INTENTION TO TREAT ANALYSIS
- COMPLETENESS OF FOLLOW UP
- RANDOMISATION
- DESCRIPTION OF WITHDRAWALS
- >80% SELECTED SUBJECTS INCLUDED IN ANALYSIS

WERE THESE ITEMS ASSESSED SEPARATELY RATHER COMBINED IN A SCORING SYSTEM

24) STATISTICAL ANALYSIS

- WERE THE STATISTICAL ANALYSES ADEQUATE IN DESCRIBING THE RESULTS
- ***WAS AN APPROPRIATE STATISTICAL ANALYSIS USED (I.E. MATCHED OR UNMATCHED)***
- WERE CORRECT STATISTICAL TESTS USED AND ASSUMPTIONS OF TEST NOT VIOLATED
- WERE STATISTICS REPORTED WITH LEVELS OF SIGNIFICANCE AND/OR CONFIDENCE INTERVALS
- WAS “INTENT TO TREAT” ANALYSIS F OUTCOMES DONE
- WERE ADEQUATE ADJUSTMENTS MADE FOR EFFECTS OF CONFOUNDING FACTORS THAT MIGHT HAVE AFFECTED THE OUTCOMES (E.G. MULTIVARIATE ANALYSES)

- WAS CLINICAL SIGNIFICANCE ASWELL AS STATISTICAL SIGNIFICANCE REPORTED
- IF NEGATIVE FINDINGS, WAS A POWER CALCULATION REPORTED TO ADDRESS TYPE 2 ERROR

QUALITY ASSESSMENT OF CROSS SECTIONAL SURVEY

25) ABSTRACT

DOES EACH SECTION OF THE ABSTRACT ACCURATELY REFLECT THE EQUIVALENT SECTION IN THE REVIEW

- BACKGROUND
- OBJECTIVES
- SEARCH STRATEGY
- SELECTION CRITERIA
- DATA COLLECTION AND ANALYSIS
- MAIN RESULTS
- REVIEWERS' CONCLUSIONS

26) OBJECTIVES

WERE THE MAIN OBJECTIVES SPECIFIED IN TERMS OF INTERVENTIONS, CLINICAL PROBLEM, POPULATION AND OUTCOMES

27) TYPES OF PARTICIPANTS

- WERE THE TYPE OF PARTICIPANTS REQUIRED INCLUDED AND WHY THEY INCLUDED DESCRIBED
- ***SELECTED SUBJECTS ARE REPRESENTATIVE (ALL ELIGIBLE OR A RANDOM SAMPLE)***
- WERE THE POPULATION GROUPS TO BE EXCLUDED SPECIFIED
- WERE THE NUMBER OF PARTICIPANTS USED STATED IN BOTH INTERVENTION AND CONTROL GROUPS
- WERE THE GROUPS COMPARABLE
- IS THE COMPARISON FAIR
- WAS EVERYONE WHO ENTERED THE STUDY ACCOUNTED FOR AT THE END
- WERE THE CRITERIA EQUALLY APPLIED TO ALL GROUPS

28) TYPE OF STUDY

HIERARCHY OF STUDY DESIGNS

S) SYSTEMATIC REVIEW

T) EXPERIMENTAL STUDIES

- RANDOMISED CONTROLLED TRIALS (WITHOUT CONCEALMENT ALLOCATION)
- EXPERIMENTAL STUDY WITHOUT RANDOMISATION E.G. QUASI-EXPERIMENTAL OR QUASI RANDOMISED OR PSEUDO RANDOMISED STUDIES

U) OBSERVATIONAL STUDY WITHOUT CONTROL GROUP

- COHORT STUDY
- CASE CONTROLLED STUDIES

V) OBSERVATIONAL STUDIES WITHOUT CONTROL GROUPS

- CROSS SECTIONAL STUDY
- BEFORE AND AFTER STUDY
- CASE SERIES

E) CASE REPORTS, PATHOPHYSIOLOGICAL STUDIES OR BENCH RESEARCH, EXPERT OPINION OR CONSENSUS

29) TYPES OF INTERVENTION AND COMPARISONS

- WERE THE STUDY INTERVENTIONS DESCRIBED
- WERE THE CONTROL INTERVENTIONS DESCRIBED
- WERE RELEVANT INTERVENTIONS USED TO ANSWER THE QUESTION IDENTIFIED
- WERE THE INTERVENTIONS INCLUDED DESCRIBED AND APPROPRIATE

30) TYPES OF OUTCOMES

- WERE THE OUTCOME MEASURES FOR THE BENEFITS AND HARMS OF INTERVENTION CLEARLY DEFINED IN NATURE AND IN TIMING
- IF SPECIFIC OUTCOMES HAVE BEEN INCLUDED, DID THEY CONFORM WITH THE QUESTION ASKED
- WERE THE MEASUREMENT OF THE OUTCOME THE SAME IN EACH GROUP
- WERE THE PERIOD OF FOLLOW UP LONG ENOUGH FOR IMPORTANT OUTCOMES TO OCCUR
- WERE OTHER FACTORS ACCOUNTED FOR (MEASURED) THAT COULD AFFECT OUTCOMES
- ***EXPOSURE/OUTCOME STATUS ASCERTAINED STANDARDISED WAY***

31) ASSESSMENT OF QUALITY

WERE THE CRITERIA USED TO ASSESS STUDY QUALITY REPORTED?

- ALLOCATION CONCEALMENT
- BLINDING OF PARTICIPANTS
- BLINDING OF INVESTIGATORS
- BLINDING OF OUTCOME ASSESSMENT
- INTENTION TO TREAT ANALYSIS
- COMPLETENESS OF FOLLOW UP
- RANDOMISATION
- DESCRIPTION OF WITHDRAWALS
- ***WAS THE NUMBER, CHARACTERISTICS OF WITHDRAWALS (I.E. DROPOUTS, LOST TO FOLLOW UP, ATTRITION RATE) AND OR RESPONSE RATE DESCRIBED FOR EACH GROUP (>80% AGREED TO PARTICIPATE)***

WERE THESE ITEMS ASSESSED SEPARATELY RATHER COMBINED IN A SCORING SYSTEM

32) STATISTICAL ANALYSIS

- WERE THE STATISTICAL ANALYSES ADEQUATE IN DESCRIBING THE RESULTS
- WERE CORRECT STATISTICAL TESTS USED AND ASSUMPTIONS OF TEST NOT VIOLATED
- WERE STATISTICS REPORTED WITH LEVELS OF SIGNIFICANCE AND/OR CONFIDENCE INTERVALS
- WAS “INTENT TO TREAT” ANALYSIS F OUTCOMES DONE
- WERE ADEQUATE ADJUSTMENTS MADE FOR EFFECTS OF CONFOUNDING FACTORS THAT MIGHT HAVE AFFECTED THE OUTCOMES (E.G. MULTIVARIATE ANALYSES)
- WAS CLINICAL SIGNIFICANCE ASWELL AS STATISTICAL SIGNIFICANCE REPORTED
- IF NEGATIVE FINDINGS, WAS A POWER CALCULATION REPORTED TO ADDRESS TYPE 2 ERROR

QUALITY ASSESSMENT OF CASE SERIES

33) ABSTRACT

DOES EACH SECTION OF THE ABSTRACT ACCURATELY REFLECT THE EQUIVALENT SECTION IN THE REVIEW

- BACKGROUND
- OBJECTIVES
- SEARCH STRATEGY
- SELECTION CRITERIA
- DATA COLLECTION AND ANALYSIS
- MAIN RESULTS
- REVIEWERS' CONCLUSIONS

34) OBJECTIVES

WERE THE MAIN OBJECTIVES SPECIFIED IN TERMS OF INTERVENTIONS, CLINICAL PROBLEM, POPULATION AND OUTCOMES

35) TYPES OF PARTICIPANTS

- WERE THE TYPE OF PARTICIPANTS REQUIRED INCLUDED AND WHY THEY INCLUDED DESCRIBED
- WERE THE POPULATION GROUPS TO BE EXCLUDED SPECIFIED
- ***ARE CRITERIA FOR EXCLUSION EXPLICIT***
- WERE THE NUMBER OF PARTICIPANTS USED STATED IN BOTH INTERVENTION AND CONTROL GROUPS
- WERE THE GROUPS COMPARABLE
- IS THE COMPARISON FAIR
- WAS EVERYONE WHO ENTERED THE STUDY ACCOUNTED FOR AT THE END
- WERE THE CRITERIA EQUALLY APPLIED TO ALL GROUPS
- ***IS THE STUDY BASED ON A REPRESENTATIVE SAMPLE FROM A RELEVANT POPULATION***

36) TYPE OF STUDY

HIERARCHY OF STUDY DESIGNS

W) SYSTEMATIC REVIEW

X) EXPERIMENTAL STUDIES

- RANDOMISED CONTROLLED TRIALS (WITHOUT CONCEALMENT ALLOCATION)
- EXPERIMENTAL STUDY WITHOUT RANDOMISATION E.G. QUASI-EXPERIMENTAL OR QUASI RANDOMISED OR PSEUDO RANDOMISED STUDIES

Y) OBSERVATIONAL STUDY WITHOUT CONTROL GROUP

- COHORT STUDY
- CASE CONTROLLED STUDIES

Z) OBSERVATIONAL STUDIES WITHOUT CONTROL GROUPS

- CROSS SECTIONAL STUDY
- BEFORE AND AFTER STUDY
- CASE SERIES

E) CASE REPORTS, PATHOPHYSIOLOGICAL STUDIES OR BENCH RESEARCH, EXPERT OPINION OR CONSENSUS

37) TYPES OF INTERVENTION AND COMPARISONS

- WERE THE STUDY INTERVENTIONS DESCRIBED
- WERE THE CONTROL INTERVENTIONS DESCRIBED
- WERE RELEVANT INTERVENTIONS USED TO ANSWER THE QUESTION IDENTIFIED
- WERE THE INTERVENTIONS INCLUDED DESCRIBED AND APPROPRIATE

38) TYPES OF OUTCOMES

- WERE THE OUTCOME MEASURES FOR THE BENEFITS AND HARMS OF INTERVENTION CLEARLY DEFINED IN NATURE AND IN TIMING
- IF SPECIFIC OUTCOMES HAVE BEEN INCLUDED, DID THEY CONFORM WITH THE QUESTION ASKED
- WERE THE MEASUREMENT OF THE OUTCOME THE SAME IN EACH GROUP
- WERE THE PERIOD OF FOLLOW UP LONG ENOUGH FOR IMPORTANT OUTCOMES TO OCCUR
- WERE OTHER FACTORS ACCOUNTED FOR (MEASURED) THAT COULD AFFECT OUTCOMES
- ***WERE OUTCOMES ASSESSED USING OBJECTIVE CRITERIA***

39) ASSESSMENT OF QUALITY

WERE THE CRITERIA USED TO ASSESS STUDY QUALITY REPORTED?

- ALLOCATION CONCEALMENT
- BLINDING OF PARTICIPANTS
- BLINDING OF INVESTIGATORS
- BLINDING OF OUTCOME ASSESSMENT
- INTENTION TO TREAT ANALYSIS
- COMPLETENESS OF FOLLOW UP
- RANDOMISATION
- DESCRIPTION OF WITHDRAWALS

WERE THESE ITEMS ASSESSED SEPARATELY RATHER COMBINED IN A SCORING SYSTEM

40) STATISTICAL ANALYSIS

- WERE THE STATISTICAL ANALYSES ADEQUATE IN DESCRIBING THE RESULTS
- WERE CORRECT STATISTICAL TESTS USED AND ASSUMPTIONS OF TEST NOT VIOLATED
- WERE STATISTICS REPORTED WITH LEVELS OF SIGNIFICANCE AND/OR CONFIDENCE INTERVALS
- WAS “INTENT TO TREAT” ANALYSIS F OUTCOMES DONE
- WERE ADEQUATE ADJUSTMENTS MADE FOR EFFECTS OF CONFOUNDING FACTORS THAT MIGHT HAVE AFFECTED THE OUTCOMES (E.G. MULTIVARIATE ANALYSES)
- WAS CLINICAL SIGNIFICANCE ASWELL AS STATISTICAL SIGNIFICANCE REPORTED
- IF NEGATIVE FINDINGS, WAS A POWER CALCULATION REPORTED TO ADDRESS TYPE 2 ERROR

QUALITY ASSESSMENT FOR QUALITATIVE STUDIES

41) ABSTRACT

DOES EACH SECTION OF THE ABSTRACT ACCURATELY REFLECT THE EQUIVALENT SECTION IN THE REVIEW

- BACKGROUND
- OBJECTIVES
- SEARCH STRATEGY
- SELECTION CRITERIA
- DATA COLLECTION AND ANALYSIS
- MAIN RESULTS
- REVIEWERS' CONCLUSIONS

42) OBJECTIVES

WERE THE MAIN OBJECTIVES SPECIFIED IN TERMS OF INTERVENTIONS, CLINICAL PROBLEM, POPULATION AND OUTCOMES

43) TYPES OF PARTICIPANTS

- WERE THE TYPE OF PARTICIPANTS REQUIRED INCLUDED AND WHY THEY INCLUDED DESCRIBED
- WERE THE POPULATION GROUPS TO BE EXCLUDED SPECIFIED
- WERE THE NUMBER OF PARTICIPANTS USED STATED IN BOTH INTERVENTION AND CONTROL GROUPS
- WERE THE GROUPS COMPARABLE
- IS THE COMPARISON FAIR
- WAS EVERYONE WHO ENTERED THE STUDY ACCOUNTED FOR AT THE END
- WERE THE CRITERIA EQUALLY APPLIED TO ALL GROUPS
- ***CRITERIA FOR SELECTING SAMPLE CLEARLY DESCRIBED***

44) TYPE OF STUDY

HIERARCHY OF STUDY DESIGNS

AA) SYSTEMATIC REVIEW

BB) EXPERIMENTAL STUDIES

- RANDOMISED CONTROLLED TRIALS (WITHOUT CONCEALMENT ALLOCATION)
- EXPERIMENTAL STUDY WITHOUT RANDOMISATION E.G. QUASI-EXPERIMENTAL OR QUASI RANDOMISED OR PSEUDO RANDOMISED STUDIES

CC) OBSERVATIONAL STUDY WITHOUT CONTROL GROUP

- COHORT STUDY
- CASE CONTROLLED STUDIES

DD) OBSERVATIONAL STUDIES WITHOUT CONTROL GROUPS

- CROSS SECTIONAL STUDY
- BEFORE AND AFTER STUDY
- CASE SERIES

E) CASE REPORTS, PATHOPHYSIOLOGICAL STUDIES OR BENCH RESEARCH, EXPERT OPINION OR CONSENSUS

45) TYPES OF INTERVENTION AND COMPARISONS

- WERE THE STUDY INTERVENTIONS DESCRIBED
- WERE THE CONTROL INTERVENTIONS DESCRIBED
- WERE RELEVANT INTERVENTIONS USED TO ANSWER THE QUESTION IDENTIFIED
- WERE THE INTERVENTIONS INCLUDED DESCRIBED AND APPROPRIATE

46) TYPES OF OUTCOMES

- WERE THE OUTCOME MEASURES FOR THE BENEFITS AND HARMS OF INTERVENTION CLEARLY DEFINED IN NATURE AND IN TIMING
- IF SPECIFIC OUTCOMES HAVE BEEN INCLUDED, DID THEY CONFORM WITH THE QUESTION ASKED
- WERE THE MEASUREMENT OF THE OUTCOME THE SAME IN EACH GROUP
- WERE THE PERIOD OF FOLLOW UP LONG ENOUGH FOR IMPORTANT OUTCOMES TO OCCUR
- WERE OTHER FACTORS ACCOUNTED FOR (MEASURED) THAT COULD AFFECT OUTCOMES
- ***ANALYSIS METHODS USED RIGOROUS***
- ***EVIDENCE OF EFFORTS TO ESTABLISH VALIDITY/RELIABILITY***

47) ASSESSMENT OF QUALITY

WERE THE CRITERIA USED TO ASSESS STUDY QUALITY REPORTED?

- ALLOCATION CONCEALMENT
- BLINDING OF PARTICIPANTS
- BLINDING OF INVESTIGATORS
- BLINDING OF OUTCOME ASSESSMENT
- INTENTION TO TREAT ANALYSIS
- COMPLETENESS OF FOLLOW UP
- RANDOMISATION
- DESCRIPTION OF WITHDRAWALS
- ***METHODS OF DATA COLLECTION ADEQUATELY DESCRIBED***
- ***RESPONDENT VALIDATION (FEEDBACK OF DATA/RESEARCHER'S INTERPRETATION TO PARTICIPANTS)***
- ***INTERPRETATION SUPPORTED BY DATA***

WERE THESE ITEMS ASSESSED SEPARATELY RATHER COMBINED IN A SCORING SYSTEM

48) STATISTICAL ANALYSIS

- WERE THE STATISTICAL ANALYSES ADEQUATE IN DESCRIBING THE RESULTS
- WERE CORRECT STATISTICAL TESTS USED AND ASSUMPTIONS OF TEST NOT VIOLATED
- WERE STATISTICS REPORTED WITH LEVELS OF SIGNIFICANCE AND/OR CONFIDENCE INTERVALS
- WAS "INTENT TO TREAT" ANALYSIS F OUTCOMES DONE
- WERE ADEQUATE ADJUSTMENTS MADE FOR EFFECTS OF CONFOUNDING FACTORS THAT MIGHT HAVE AFFECTED THE OUTCOMES (E.G. MULTIVARIATE ANALYSES)
- WAS CLINICAL SIGNIFICANCE ASWELL AS STATISTICAL SIGNIFICANCE REPORTED
- IF NEGATIVE FINDINGS, WAS A POWER CALCULATION REPORTED TO ADDRESS TYPE 2 ERROR

Appendix 4: Studies meeting inclusion criteria and eligible for quantitative analysis

							PRIMARY OUTCOME IN INTERVENTION GROUP			PRIMARY OUTCOME IN CONTROL GROUP		
	AUTHOR/ PUBLICATION YEAR	COUNTRY	INTERVENTION/ OUTCOME MEASURE	STUDY POPULATION	DISEASE TARGET	STUDY DESIGN	NUMBER OF POPULATION ACHIEVING DESIRED OUTCOME	TOTAL	% PATIENTS ACHIEVING DESIRED OUTCOME	NUMBER OF POPULATION ACHIEVING DESIRED OUTCOME	TOTAL	% PATIENTS ACHIEVING DESIRED OUTCOME
BASELINE	ALTINER (2007)	GERMANY	T+PL+ P/AP	GPs	NOT SPECIFIED	CLUSTER RANDOMISED CONTROLLED TRIAL	274	753	36.4	491	898	54.7
	ANGUNAW ELA (1991)	SRI LANKA	W/AP	ALL PATIENTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	273	867	31.5	363	1127	32.2
	ANGUNAW ELA (1991)	SRI LANKA	W+S/A P	ALL PATIENTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	442	1121	39.4	363	1127	32.2
	ARNOLD (2006)	USA	AMT+ G/AP	PHYSICIA NS	NOT SPECIFIED	COHORT STUDY	1147	1550	74.0	880	1257	70.0
	BJERRUM (2006)	SPAIN	G/AP	ALL PATIENTS	RESPIRATOR Y TRACT INFECTIONS	PROSPECTIVE BEFORE AND AFTER STUDY	401	1114	36.0	788	2462	32.0

	DE SANTIS (1994)	AUSTRALIA	E+MB +G+A D/AP	NOT SPECIFIE D	TONSILITIS	RANDOMISED CONTROLLED TRIAL	389	1032	37.7	417	1357	30.7
	GONZALES (1999)	USA	PEM+ PP/AP	ADULTS	BRONCHITIS	PROSPECTIVE NON RANDOMISED CONTROLLED STUDY	2019	2462	82.0	1920	2462	78.0
	GONZALES (1999)	USA	PCE+P P/AP	ADULTS	BRONCHITIS	PROSPECTIVE NON RANDOMISED CONTROLLED STUDY	1822	2462	74.0	1920	2462	78.0
	HICKMAN (2003)	USA	E+PR+ SM+O TC+P+ N/AP	CLINICIA NS	BRONCHITIS	NON RANDOMISED CONTROLLED TRIAL	142	446	31.8	888	1840	48.3
	MAINOUS (2000)	USA	PEM/A P	CHILDRE N	ACUTE RESPIRATOR Y TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	9430	29562	31.9	11663	37622	31.0
	MAINOUS (2000)	USA	F/AP	CHILDRE N	ACUTE RESPIRATOR Y TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	9886	34810	28.4	11663	37622	31.0
	MAINOUS (2000)	USA	PEM+ F/AP	CHILDRE N	ACUTE RESPIRATOR Y TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	7818	22728	34.4	11663	37622	31.0
	MELANDER (1999)	SWEDEN	A/AP	GPs	ACUTE RESPIRATOR Y TRACT INFECTION	COHORT STUDY	618	1124	55.0	788	1313	60.0

	MOLSTAD (1989)	SWEDEN	E/AP	NOT SPECIFIED	ACUTE RESPIRATORY TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	146	216	67.6	466	663	70.3
	MONETTE (2007)	CANADA	E/AP	PHYSICIANS	NOT SPECIFIED	PROSPECTIVE PAIR MATCHED CLUSTER RANDOMISED CONTROLLED TRIAL	156	274	56.9	89	157	56.7
	SMABREKKE (2002)	NORWAY	E+G/AP	CHILDREN	OTITIS MEDIA	CONTROLLED BEFORE-AND-AFTER STUDY	318	355	89.6	126	133	94.7
INTERVENTION	ALTINER (2007)	GERMANY	T+PL+P/AP	GPs	NOT SPECIFIED	CLUSTER RANDOMISED CONTROLLED TRIAL	198	675	29.3	526	885	59.4
	ANGUNAWELA (1991)	SRI LANKA	W/AP	ALL PATIENTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	524	2039	25.7	1238	2866	43.2
	ANGUNAWELA (1991)	SRI LANKA	W+S/AP	ALL PATIENTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	1138	3135	36.3	1238	2866	43.2
	ARNOLD (2006)	USA	AMT+G/AP	PHYSICIANS	NOT SPECIFIED	COHORT STUDY	1441	1550	93.0	1131	1257	90.0

	BRIEL (2006)	SWITZERLAND	T+E+G+S/AP	ADULTS	ACUTE RESPIRATORY TRACT INFECTION	CLUSTER RANDOMISED CONTROLLED TRIAL	46	293	15.7	61	285	21.4
	BRIEL (2006)	SWITZERLAND	T+E+G+S+F/AP	ADULTS	ACUTE RESPIRATORY TRACT INFECTION	CLUSTER RANDOMISED CONTROLLED TRIAL	35	259	13.5	61	285	21.4
	BRIEL (2006)	SWITZERLAND	T+E+G+S/C	ADULTS	ACUTE RESPIRATORY TRACT INFECTION	CLUSTER RANDOMISED CONTROLLED TRIAL	26	293	8.9	30	285	10.5
	BRIEL (2006)	SWITZERLAND	T+E+G+S+F/C	ADULTS	ACUTE RESPIRATORY TRACT INFECTION	CLUSTER RANDOMISED CONTROLLED TRIAL	21	259	8.1	30	285	10.5
	BUISING (2008)	AUSTRALIA	AD/AP	DOCTORS	COMMUNITY ACQUIRED PNEUMONIA	PRE-TEST-POST TEST COHORT STUDY	143	208	68.8	211	341	61.9
	BUISING (2008)	AUSTRALIA	CDSS/AP	DOCTORS	COMMUNITY ACQUIRED PNEUMONIA	PRE-TEST-POST TEST COHORT STUDY	13	126	10.3	211	341	61.9

	DE SANTIS (1994)	AUSTRALIA	E+MB +G+A D/AP	NOT SPECIFIE D	TONSILITIS	RANDOMISED CONTROLLED TRIAL	214	567	37.7	265	708	37.4
	DRANITSAR IS (2001)	CANADA	A/AP	ALL PATIENTS	NOT SPECIFIED	PROSPECTIVE RANDOMISED PROSPECTIVE STUDY	122	162	75.3	102	147	69.4
	GONZALES (1999)	USA	PEM+ PP/AP	ADULTS	BRONCHITIS	PROSPECTIVE NON RANDOMISED CONTROLLED STUDY	1662	2027	82.0	1581	2027	78.0
	GONZALES (1999)	USA	PCE+P P/AP	ADULTS	BRONCHITIS	PROSPECTIVE NON RANDOMISED CONTROLLED STUDY	1500	2027	74.0	1581	2027	78.0
	HADI (2008)	INDONESIA	G+PB+ TSPD/ AP	ALL PATIENTS	FEVER	PROSPECTIVE INTERVENTION	56	103	54.4	187	212	88.2
	HADI (2008)	INDONESIA	G+PB+ TSPT/ AP	ALL PATIENTS	FEVER	PROSPECTIVE INTERVENTION	20	110	18.2	187	212	88.2
	HADI (2008)	INDONESIA	G+PB+ TSPRC /AP	ALL PATIENTS	FEVER	PROSPECTIVE INTERVENTION	16	76	21.1	187	212	88.2

	HADI (2008)	INDONESIA	G+PB+ TSPB/ AP	ALL PATIENTS	FEVER	PROSPECTIVE INTERVENTION	206	289	71.3	187	212	88.2
	HICKMAN (2003)	USA	E+PR+ SM+O TC+P+ N/AP	CLINICIA NS	BRONCHITIS	NON RANDOMISED CONTROLLED TRIAL	102	321	31.8	924	2392	38.6
	MAINOUS (2000)	USA	PEM/A P	CHILDRE N	ACUTE RESPIRATOR Y TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	13155	29562	44.5	20128	37622	53.5
	MAINOUS (2000)	USA	F/AP	CHILDRE N	ACUTE RESPIRATOR Y TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	15177	34810	43.6	20128	37622	53.5
	MAINOUS (2000)	USA	PEM+ F/AP	CHILDRE N	ACUTE RESPIRATOR Y TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	11296	22728	49.7	20128	37622	53.5

	MCGREGOR (2006)	USA	ASP+CDS/AP	ALL PATIENTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	1325	2270	58.4	1315	2237	58.8
	MELANDER (1999)	SWEDEN	A/AP	GPs	ACUTE RESPIRATORY TRACT INFECTION	COHORT STUDY	417	926	45.0	838	1309	64.0
	MOLSTAD (1989)	SWEDEN	E/AP	NOT SPECIFIED	ACUTE RESPIRATORY TRACT INFECTION	RANDOMISED CONTROLLED TRIAL	93	212	43.9	359	576	62.3
	MONETTE (2007)	CANADA	E/AP	PHYSICIANS	NOT SPECIFIED	PROSPECTIVE PAIR MATCHED CLUSTER RANDOMISED CONTROLLED TRIAL	205	351	58.4	211	348	60.6
	NG (2008)	HONG KONG	ASP+L+F+G/AP	ALL PATIENTS	NOT SPECIFIED	PRE-TEST-POST-TEST ANALYSIS	293	2385	12.3	693	3537	19.6
	PASTEL (1992)	USA	PI/AP	PHYSICIANS	NOT SPECIFIED	PROSPECTIVE STREAMLINE STUDY	18	28	64.3	12	41	29.3
	PAUL (2006)	ISRAEL, GERMANY, ITALY	CDS/AP	ALL PATIENTS	BACTERIAL INFECTION	PROSPECTIVE COHORT STUDY	216	297	72.7	176	273	64.5

	RAUTAKORPI (2006)	NORWAY	G+EM/AP	ALL PATIENTS	UPPER RESPIRATORY TRACT INFECTIONS	RANDOMISED CONTROLLED TRIAL	2099	4881	43.0	13868	29043	47.7
	SCHWARTZ (2007)	USA	E/AP	NOT SPECIFIED	NOT SPECIFIED	PROSPECTIVE PAIR MATCHED BEFORE AND AFTER CLUSTER RANDOMISED CONTROLLED TRIAL	30	77	39.0	8	73	11.0
	SEAGER (2006)	WALES	G+E/AP	DENTISTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	131	451	29.0	157	490	32.0
	SEAGER (2006)	WALES	E+AD/AP	DENTISTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	128	556	23.0	157	490	32.0
	SEAGER (2006)	WALES	G+E/AP	DENTISTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	383	451	84.9	402	490	82.0
	SEAGER (2006)	WALES	E+AD/AP	DENTISTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	517	556	93.0	402	490	82.0
	SMABREKKE (2002)	NORWAY	E+G/AP	CHILDREN	OTITIS MEDIA	CONTROLLED BEFORE-AND-AFTER STUDY	318	355	89.6	126	133	94.7

	VAN DRIEL (2007)	BELGIUM	G+AD +PR+S G/AP	GPs	ACUTE RHINOSINUSI TIS	CLUSTER RANDOMISED CONTROLLED TRIAL	116	204	56.9	119	204	58.3
	VAN DRIEL (2007)	BELGIUM	G+AD +PR+S C/C	GPs	ACUTE RHINOSINUSI TIS	CLUSTER RANDOMISED CONTROLLED TRIAL	70	204	34.3	60	204	29.4
	WALKER (1998)	USA	PI/AP	PATIENTS	COMMUNITY ACQUIRED PNEUMONIA	OPEN LABEL, RANDOMISED STUDY	9	25	36.0	22	25	88.0
FOLLOW-UP	ALTINER (2007)	GERMANY	T+PL+ P/AP	GPs	NOT SPECIFIED	CLUSTER RANDOMISED CONTROLLED TRIAL	289	787	36.7	596	920	64.8
	ANGUNAW ELA (1991)	SRI LANKA	W/AP	ALL PATIENTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	870	2762	31.5	879	2764	31.8
	ANGUNAW ELA (1991)	SRI LANKA	W+S/A P	ALL PATIENTS	NOT SPECIFIED	RANDOMISED CONTROLLED TRIAL	870	2762	31.5	879	2764	31.8

	BJERRUM (2006)	SPAIN	G/AP	ALL PATIENTS	RESPIRATORY TRACT INFECTIONS	PROSPECTIVE BEFORE AND AFTER STUDY	402	1674	24.0	788	2462	32.0
	DE SANTIS (1994)	AUSTRALIA	E+MB+G+AD/AP	NOT SPECIFIED	TONSILITIS	RANDOMISED CONTROLLED TRIAL	341	730	46.7	286	685	41.8
	MONETTE (2007)	CANADA	E/AP	PHYSICIANS	NOT SPECIFIED	CLUSTER RANDOMISED CONTROLLED TRIAL	207	309	67.0	89	154	57.8

Appendix 5: Semi-structured interview transcripts

Interviewee 1

Location: Private office desk

Time: 26 minutes and 7 seconds

Interviewer

I just have to ask a few basic questions first…the first question is...what is your role within the pct?

Interviewee 1

I am assistant director for the professional services responsible for medicines management

Interviewer

The second question is…is there an antimicrobial specialist that you use within the pct?

Interviewee 1

Not a pharmacist...not an antimicrobial pharmacist. There is one in the local acute trust. There was a government initiative a few years ago to fund antibiotic pharmacist in secondary care and there is one at the local acute trust who we can call upon.

Interviewer

Do you use any other initiatives or incentives at the moment?

Interviewee 1

We don't use incentives as such here. We have a lot of prescribing initiatives, which we determine every year. What those target things are, and antibiotics feature again this year. The huge emphasis now is due to MRSA and C DIFF infections and these are much more prevalent and can be fatal...you can have dire consequences so there is a huge push on infection prevention control and also decreased amount of antibiotics prescribed. We have been trying to identify a link between antibiotic prescribed and C DIFF, but it is very difficult.

Interviewer

You haven't been successful?

Interviewee 1

No you would have to do it on a much larger scale because the incidences are terrible when they happen, but are few and far between. You can't prove cause and link.

Interviewer

When you follow an avenue like that do you get someone to lead that area of investigation?

Interviewee 1

If we are having a look we have…the set up we have here…we have pharmacists working (our own team) in every GP practice, so whenever we want to just have a quick look, we've got the facility to do so.

Interviewer

Who controls what is implemented and what's not?

Interviewee 1

Our ideas, our initiatives come from what is topical in the press and what we know in the evidence and stuff that comes through. We put an emphasis on it, but of course we can't control prescribers. The best you can do is influence them positively. So In terms of those initiatives that's me I suppose...here! In terms of what we are doing in the practices and what initiatives we take on you know...we have campaigns from time to time around antibiotic prescribing.

Interviewer

Mainly leaflets?

Interviewee 1

Errm...yes…we have done. What we are doing in this moment in time is every practice every month gets a very detailed report of the antibiotic prescribing. Well actually it goes to the localities. The practices are arranged into six localities in this pct, and that's groups of practices together in the locality, and so the locality gets a very detailed report with all of the figures for all the practices presented in lots of different ways, so that they can actually benchmark themselves, each other against national average, the England err the local average…if you like pct…and that is to bring it to their attention. We also do leaflets and we have different language leaflets and we also do pads which are non prescription pads so they can actually write on it cold and flu symptoms, these are what you do…tear one off and give it to the patient so they go away with a piece of paper, but its not a prescription. Other methods, we do post dated scripts, or some surgeries do one ready and the save it and if the symptoms are not cleared in three days come back and get a prescription and so if people

are still ill they can come back and get a prescription and take it away otherwise they will find it not collected.

Interviewer

Have you found any of them to be successful?

Interviewee 1

Well ALL OF THESE HAVE BEEN INITIATIVES WHICH WE SUGGESTED PEOPLE DO AND THEY HAVE BEEN DONE LOCALLY that we haven't measured in any practice to say…

the only measure we have is the overall measure of antibiotic prescribing and err when it was high on the agenda a few years ago there was a national list of where your place was and the highest number of prescriptions and this pct at that time was the highest prescriber of antibiotics, and through a series of badgering GPs, putting out information, leaflets, I think some training events they got that down to 80th out of 300..or whatever it was!

In PCT X we were also fairly reasonably high to the top and we got it down, however it was approached from a different way, well the emphasis was different, but I think we approached it slightly differently...there may have been an incentive scheme at that time in north. Other measures we done, we have PAM Birmingham antibiotic formulary that's agreed and updated every year with the local microbiologists and clinicians obviously, and that goes out and is available on our website on out intranet and that supports GP's and their prescribing and it is a guideline and formulary, you know…this is 1st line, this is second line…

And why, so I am fairly confident we do prescribe pretty much to formulary but we are not sure if that is all appropriate and that is a very difficult thing to do to go out into the practice and go and look at each individual one (prescription) and even then you might not because people come in and it depends on what they put down on their notes really

Interviewer

True…do you get government funding at all for each pct?

Interviewee 1

Not for antibiotics...no...There is government funding coming down for infection prevention control but not for antibiotics, nothing related to prescribing.

Interviewer

Ok, do you get clear directives from the government on how to control antibiotic use? As in do they give you any ideas on how best to control?

Interviewee 1

No I think its quite established, the methods you can use, there are only certain things you can do, you know its education, providing supporting materials, and you know its making them aware of their prescribing habits are all the things we are doing. There is a national campaign at the moment on antibiotic prescribing, so nationally there have been produced leaflets and posters, unfortunately that seems to have bypassed us so I don't know if they have gone straight out to contractors

Interviewer

From what I am aware of, it has come out but has been a damp squib.

Interviewee 1

I think what they need is some national advertising, something to grip the nation sort of thing.

Interviewer

Do you have any figures available?

Interviewee 1

I saw that (in the e-mail of questions I would be asking). Now the thing is what is it you are looking for, you need to be a bit more specific about what you are looking for!! We don't normally release, because I don't hold them as such, I would have to go in and do a research on it on a national database which is not at this pct to get our data from but we don't normally do our practice figures because that would be unfair really. The amount of scripts you write is only one indicator of what the situation is in relation to the prescribing. Somebody might be high and it might be highly appropriate and they may have patients on long term antibiotics for chronic UTI infections, depending on how you drill down on the detail; they may be nebulised antibiotics, cystic fibrosis. Items of antibiotics prescribed don't give you the full picture! So a certain amount of data is ok to release, some others it depends on the detail...what exactly are you looking for?? Just to get a figure doesn't mean much!

Interviewer

Yes

Interviewee 1

there was a national one that did the err what's it called the defined daily doses per star-pu patient unit, have you heard of the measures

Interviewer

Yes

Interviewee 1

So that is a comparator, but you still don't know the detail, it is only an indicator, so its hard to draw conclusions. There's lots of different things that need to be taken into account.

Interviewer

Ok. The reason why I left it that broad was because I know accessing such information could be a problem and issue as well, so it was my way of stating that any data that you may have and can supply would be very welcome, but if you cant then that's fine!

Interviewee 1

Right

Interviewer

Because I have an idea of actual current prescribing in your pct and others in the area

Interviewee 1

Ok I will because mark is in Monday, no Tuesday errm so we will have a chat a think about

(Exchanged contact details but no reply as yet)

Interviewee 1

So yes it would be what is useful to you really, and its no use if you look everywhere if you know what I mean.

Interviewer

Finding such data on the internet is very difficult but I was told that such information should be available if you go to the pct's themselves.

Interviewee 1

But you have got to tell me what you see, when you say figures its just, what are you looking for

Interviewer

Basically I don't mind what data you have because I know you may use different measures compared to other pct's, so if antibiotic data is present in number of items, DDD's, whatever...I don't mind!

(long pause)

Interviewee 1

Ok

Interviewer

Its just so I can get a picture of prescribing in the area!

Interviewee 1

There is the formulary although it is very generic, I'll check these things through and see how easy or what it is available ok

Interviewer

Do you know of any previous policies that you have used, which may have been recorded

Interviewee 1

The campaign they had in east was very, well greatly publicised and unfortunately they have all gone now (pointing to an empty shelf on her cabinet), and I don't know where all of those figures and work was. I could have a look to see, I did look before and I can't actually find the data. They have been prescribing initiatives really, such as raising awareness and having leaflets and posters to go out to community pharmacists and to be put up in surgeries. It was quite successful but the biggest success is having a pharmacist in the practice so they can nag the GP's really. But there is also now our non medical prescribers which makes it much more difficult to contain because they are scattered around the organisation and there aren't that many of them so where within a practice there is an entity and you can see what is…you can capture everybody...you know you know targeted in one location, with the non medical prescribers its sort of all over the teams here or the physios over there you know, so we are starting programmes in getting larger numbers of training, and the one thing they have asked for is antibiotics and antibiotics training so that's good!

Interviewer

Do you think it would be more beneficial if we brought in incentives rather than initiatives?

Interviewee 1

There are a number of things we have to put funding into and there are safety issues like the non steroidals this year so what do you, what do you fund and where does the funding come from so yes incentives always help but you have to get the funding for it! I think the road to go to to make the difference is...because the reason you are asking around all this is because of over prescribing and potential resistance developing and the problems we are having now with MRSA and C DIFF presumably, that's what the end game is isn't it? So it would be really good to focus some attention onto MRSA and C DIFF and read papers around the cause and effect and well association is what they have at the moment but if you could find something that has a causal link erm you could put it back to the number of exposures to antibiotics in the past or you know the most recent exposure. I'm sure there could be a load of work that could be done and that would be really useful and important to all of us really because we seem to be doing what we can around antibiotics. I'm sure errm the things we are doing we seem to have thought of everything although there is scope for improvement no doubt but what is really driving the agenda are C DIFF and MRSA with the incidence of it and the growing concerns around that, so if you can focus on that link and demonstrate some association there that's really important.

Interviewer

When you do introduce an initiative into practice, how long does it take to implement? And how long do you keep it running for

Interviewee 1

We do them in yearly blocks, so if you have an initiative going, we've got priorities this year and antibiotics is up there we will continue to monitor and feeding stuff throughout the year and we will monitor prescribing feedback from our team and our team continue to drip feed and the reports will go out monthly and whatever support we can do locally we can e.g. posters, leaflets, prescription things we will. We are tying some of the practices into the QUOF (quality and outcome framework) that GP's have. There is med6 medicines management and 10 and they get points if they meet with us and agree 3 initiatives for the year and more points if they actually implement them if they have shown some improvement or achievement by the end of the year. So we are targeting the highest prescribing practices in antibiotics to include that agreement, so they will do some work and based on points mean prizes, so I guess it's an incentive in a way but using the framework that is already there.

Interviewer

Just for example if something is successful, do you try and run it for as long as possible, or is there a certain point where you would have to cut it.

Interviewee 1

If it is successful it becomes superseded by other priorities because there are always other priorities in prescribing that you need to address. There might be safety issues, there may be cost issues, there may be quality stuff, NICE guidance, whatever. If you've been successful in something it never goes away totally you just monitor it until it comes again like with antibiotics, which is generally good, but there is all this concern and you always have to be on the ball, as it starts to creek you have to blitz again and we have taken a more targeted approach this year to get the highest prescribing practices to see what is happening there

Interviewer

Do you communicate with other PCT's about what is being done, what has been good or bad?

Interviewee 1

It has been done because certainly east did their campaign, they did presentations around the other PCT's. You know if there was something really innovative we would but what we are doing is standard stuff because really it is identifiable what you can do within our structure and framework in the NHS its quite well known what you can do. We are all doing what we know has to be done.

Interviewee 2

Location: Desk within open plan office

Time: 37 minutes and 23 seconds

Interviewee 2
The complicated factor at the moment is that some of the questions and answers are related to other people in the pct at the moment, I don't know all the answers on that perspective. I will tell you the bits I know, but I don't know all of the answers if that's fine?

Interviewer
Yes that's fine

Interviewer
What is your role within the pct

Interviewee 2
Head of medicines management in this pct responsible for commissioning of medicine services

Interviewer
Do you have a specialist pharmacist or microbiologist that helps with antibiotics?

Interviewee 2
We don't have a specialist pharmacist in the PCT, the PCT does have a contract for consultant microbiologist from university trust hospital, and I also believe there is an infection control team contracted in, so we have expert consultants who lend their support to the PCT

Interviewer
Do they have quite a big involvement then with what is done within the PCT?

Interviewee 2
Well basically we are in primary care, well basically as a PCT we are quite a large PCT with a big provider arm, I don't know if you know what I mean, but basically we have got 4 GP's, community pharmacies or primary care services. We've got 1000 odd nurses, district nurses and all that lot and they are part of a provider unit. We have also got the dental hospital which is a major hospital, rehab

unit with rehabilitation, learning distribution directorate, we've got elderly care hospitals, so that is all part of the provider part all within this PCT, and they may be turning into a foundation trust in the future. So one of the reasons of why its complex to say what does the PCT have, actually I have no idea what the board manages and what it does, but basically I know we have infection control teams that work in the pct employed, basically use the expertise at university trust that has a large microbiology department, we contract them to provide it. So if there is an outbreak in the community, then microbiologists and community disease control team come and take control and work with our public health and people like that to deal with it. So the simple answer is we have the resources contracted and funded to deal with…

Interviewer

Ok and they are the ones who deal with the formulary…

Interviewee 2

Ok formulary is a good one errm…yes with the formulary, we don't have a formulary. That was flagged up by..I think the healthcare commission errm so errm so that's an area, we do have a formulary but its well out of date. We are actually developing that at the moment with the consultant microbiologist, the antibiotic pharmacist at the acute trus who you know is part of the joint working, joint contract I suppose errm and this team here and it will go into consultation in the next two three weeks errm and it fits into the primary care target and incentives that we do. So in other words we are developing a formulary and using expertise from our joint partnerships or contracts.

Interviewer

Ok so if there was a certain incentive, initiative or directives, is that past down from the directors, or who is responsible for

Interviewee 2

Err well from the government yes, well there is isn't there, we have a 30% decrease
in C Diff or whatever they are at the moment, so yes there are different people in charge through chief exec directors and head of governance responsible for the C Diff targets and MRSA, and obviously I have got tasks like the formulary needs sorting out, we have got the children formulary in place, the adult one hasn't been done yet and that is what we are doing at the moment, also targets around use of Quinolones have been developed, we have already benchmarked the data of every practice so that will be going out at the end of this month. So yes different roles, so that's my role so obviously the directors and different managers do different roles, so the governance team are actually monitoring actual C Diff and MRSA in the community, so yes everyone has different roles in this system. It is certainly cascaded.

Interviewer

Have you heard of the new government target for antibiotic using the campaign of advertising?

Interviewee 2

Oh about clean hands and all that stuff

Interviewer

Yes, and he was saying there were problems at the moment of actually getting the message across

Interviewee 2

Yes well the clean hospitals, there has been a lot of money, millions of pounds for this area, which involves more than just prescribing, but also deep clean and clean hospitals, and that relates to hospitals we have and the hospitals we contact like the university trust hospital, and our own contracted health centres and pharmacies and so yes there is a big focus on that and that's a whole different area, a whole different teams, it doesn't relate to me so much. So I am aware of some of that, I am aware of national campaigns, but they would know about that.

Interviewer

So the government funds…

Interviewee 2

I don't know how it works exactly, basically the…we've always had microbiology input, infection control…its a statutory requirement anyway, I thought pretty well, maybe not statutory but its certainly, you know healthcare commission requirement and it has been for years. The media has changed it all now but we've always had that and we couldn't run our hospital without that, you know if we had an outbreak in a care home what would we do about it if we didn't have a consultant microbiologist or expert input so that's always been there, that hasn't changed. I know there has been money that has gone to hospitals I think, I don't know the routes…that's not my area so…

Interviewer

So are there any policies at the moment that are being used

Interviewee 2

Around..

Interviewer

Around antibiotics

Interviewee 2

Locally

Interviewer

Either locally or nationally

Interviewee 2

I'll show you some stuff (shows me figures off computer). So In terms of policies errm I don't know if this is what you mean errrm. Like I said for adults we are doing the joint formulary so around medicines we are making sure that not only does primary care know what to prescribe but it's jointly done with secondary care. Hospitals have done their own formulary so we are doing; we have got standard methods that we use. Not only do we have the formulary but we have the data on prescribing rates and different methods that will target the high and low end in comparison to PCT's in west midlands. And that's some of the tools that we would use. It's a standard technique used in changing behaviour, so in terms of policies we'll have the formularies, things like that, the community pharmacists working in practices. We've also got the local health service who will pay primary of GP prescibers through various priorities and actions and we also use quality of outcomes frameworks and in there is three actions related to prescribing, you know the QUOF

Interviewer

Yes I do

Interviewee 2

These are all incentives that make things happen and we use that in areas where practices want to make use of, they get all the data and analysis from us. If they have a problem around antibiotic prescribing, so lets say they prescribe a lot of Quinolones for Prostatitis and you know that's the main area really, and they only prescribe it on that, which the top two or three might do, then they've got to change their practice. We will allow them to select it as their key target for this year in practice. Is that what you meant by policies?

Interviewer

Yes. Do you have any figures available that you can provide

Interviewee 2

Yes I wouldn't give you the practice level comparison as the GP's haven't had those feedback to them at all. They're under development at the moment so we have to make sure the presentation is exactly right and there is no misleading etc. But we know the benchmark, as a PCT we are joint third or fourth lowest prescribers in volume. So that is your benchmark for the West Midlands. In relative to the England average we are good, if low is considered good. No-one has benchmarks Quinolones. They haven't done it so we have done it locally. So we are trying to sort that out because even though we are low, you know as far antibiotics go, as far as targets go we don't need to look at it. We are low prescribers, our GP's are good prescribers, consultants tell us there is no problem but we haven't got formularies so we have to do that. We know there is clinical practice that needs to be updated in terms of antibiotic prescribing, you know it is a good piece of work to do, but we want to take it to the next level with C Diff and Quinolone and Cephalosporin targets and things. Some of the evidence is woolly but we have done bits of areas of advice with consultants around that

Interviewer

Is there a reason why this pct is so good?

Interviewee 2

That's a separate study isn't it? I am not saying we are good prescribers, I am just saying we are low prescribers in the west midlands, we have always been that way. I mean our GP's are low on non steroidals are low on you know we are good at lots of areas but not every area. There are lots of reasons but that's a separate study. It could be the patient population it could be hospitals and the way they influence the public it could be GP training in the area, I don't know, it could be anything.

Interviewer

Actually we were hoping to do was to compare PCT's. For example this is a good prescriber, so I want to know why this area is so good compared to another PCT.

Interviewee 2

Ok the first thing is we are assuming that low prescribing is good, for all we know we may people with raging infections being omitted which would be horrendous, that would be the worst scenario. So we are assuming they are good. We have obviously done historical things as pharmacy advisors around otitis media and sore throat but generally we've generally been low prescribers. We don't know why that is, that's just the way it is

Interviewer

So it has always been that way?

Interviewee 2

Well yes for seven years, we have generally been low compared to PCT X and those that have merged, generally going from south always being low prescribers but we don't know why that is

Interviewer

Is there a good communication between the PCT's in this area, for example successful methods used to control antibiotics, is that spread across all PCT's?

Interviewee 2

I mean there is certainly shared practice, errm I mean we as advisors meet up and share practice, I mean there are avenues to do that. For antibiotic prescribing it is difficult to...errm what works in one place doesn't necessarily work in another because the whole approach varies so much in different areas. There are standard methods used to change prescribing behaviour and there's published evidence about those so like academic detailing, the newsletter type thing that doesn't work. There's different ways of doing it like electronic systems used to change behaviour errm so any of those may work in your area you know paying people in some areas helps to change behaviour. There's different methods isn't there. For us, given our position we're specifically focusing on C Diff, only because that's our main area of focus. I know there will be some GP's out there who are outdated in practice in some other areas, they will have a formulary and they will look at that but we will focus on C Diff and the potential areas that may impact on that because that's the national target and that's our local target with consultants. We'll look at firstly giving them that information, sticking in some incentives monitoring every month so they get their position fed back to them errm if they have got clinical questions, we and the consultant microbiologist at that hospital be able to deal with those in terms of prescribing practice and clinical practice. We may run a workshop if that's deemed suitable. You know there are different methods, we wont just use on thing send that out and say there you go, we will go out there and talk to those who want advice you know there are many methods. I'm sure all those PCT's use those methods to various degrees. Its nothing unusual just standard stuff really.

Interviewer

If a method of intervention is seen as successful, is there a cut off point. For example if the government use advertising will they give a stop date or do they say this is what we are putting in place and let it run

Interviewee 2

My impression is...basically the evidence around campaigns if you like is not particularly strong and is a problem in public health. So if you tell people to give up smoking, they don't give up smoking.

If you use more pro active measures like clinics offering free NRT you have people knocking on their doors you know clinics in retail centres, whatever it is, yeah people start to come forward, but if you just say quit smoking they don't do it, and that's my understanding of public health. So basically the idea of community pharmacies running six campaigns a year as they are contracted to do. If they are just going to run poster campaigns, there is no evidence that it will change public behaviour bar one or two percent, but the evidence is really poor for that, so my view is that is not that you shouldn't use that, but should recognise that it is not the only thing you can do. That is the start of it to get public awareness but it doesn't change behaviour. People become aware that cough and colds ooh I mustn't turn up. But if they get a cough and cold they will still turn up to the GP, so if the GP hasn't changed their behaviour then they will get their antibiotics. So to create the change you have to do different things. So the government can do their campaign, it will raise public awareness, fine. But that won't affect the volume of antibiotics prescribed. So you need other systems, whether it be electronic, security guards, GP's saying you are not going to get a script now, if you still have the problem in three days time come back and it will be there for you a delayed prescription. All those different techniques change prescribing.

Interviewer

The other thing I was getting to grips with is that the government only seems to get involved when there is a problem rather than staying on top of it

Interviewee 2

Yes the antibiotics stuff and C Diff, well I was doing C Diff when I was a junior hospital pharmacist back in the early nineties, what's different now. Okay the rates have gone up a bit but suddenly it hits the media and that's what's pushing it. That relates to the deep clean. I'm not saying it's a negative thing and they shouldn't be doing it but its great and a really good piece of work but that collective national approach will have an impact on one area then that's a bit like what we do, we choose one area. So that's a good thing but you know is it the absolute priority in clinical care, you know. Is preventing C Diff going to reduce hospital admissions or really improve national care of patients

Interviewer

Do you think there are other areas that are more important

Interviewee 2

Well cardiovascular disease and elderly care and all sorts of things, you know it is just one area that has been put into the top 5-10 topics within PCT's, you know if you took the media and public view away...if that's what they want then that's fine, if they are worried about getting C Diff that's fine but

I don't know how many cases we get nationally but you know I'm not worried about it. If I was in hospital I wouldn't worry about it because I'm a young fit healthy guy.

Interviewer

I thought it would be higher on the agenda…

Interviewee 2

Well yes it is in the top 5-10 and is in the healthcare acquired section and that's absolutely appropriate from a resistance point of view it has always been important and from a C Diff point of view and also MRSA..dont get me wrong it is important. It is in the top 5-10 I just wonder if other areas are of higher priority!

Interviewer

Just say you get a message from the SHA that you have to implement this, who is in charge of implementing it in the PCT

Interviewee 2

Well the SHA, I think in their role they don't tell us to implement, the government in their role comes out with their national policy, the SHA monitor that we deliver, not sure but that's what I think they do, they don't tell us!

Interviewer

Say you get a list of things to do from the government...

Interviewee 2

Well they produce white papers don't they, and the white paper, and there's lot of different types every week, and they will lead to a number of different policy directives. We get the money from the government and then we commission services to deliver on certain areas, and we can set on national areas like infections and 18 weeks wait and things like that. And we can set our local objectives based on our local needs, so all those processes happens through different mechanisms. We talk to clinicians about what the issues are locally. But ultimately if it is a national directive then it is a must do and there are mechanisms to make it happen from the board.

Interviewer

Do you have any audits that you carry out?

Interviewee 2

That's a part of what we are doing at the moment, development of the formulary will be audited, previously for antibiotics we have used items per star-pu and the number of scripts per patient, and we have used that as a measure in many incentive schemes and so that brings volume down a bit because people take notice of it. That's what we have done before, we haven't done a clinical audit at a patient and practice level, like we have done with non-steroidals, and I think that will be where we will be moving to this year.

Interviewer

Do you have any suggestions of what avenues I could take from here...as in what could be an interesting area for PCT's in general?

Interviewee 2

Aren't you better off looking at PCT's that have changed, at the end of the day we have been low prescribers for the past seven years and there isn't anything we have done locally to do that, I have to hold my hands up and say. How do we make the highest prescribing GP's change their practice, that's interesting?

Interviewer

But that's what interests me in this area. Why do GP's prescribe less antibiotics in this are compared to others?

Interviewee 2

You can do a questionnaire but they won't know!

Interviewer

Is there some kind of message being relayed to those GP's

Interviewee 2

No. I'm more interested at looking at individual drug categories where actually it could be those five practices on the bar chart that are actually the highest prescribers in the west midlands, no one has done a benchmark on Quinolones so we may be high prescribers of Quinolones, we just don't know. So that is how we are going to look at it. Patient demand is a real issue, at the end of the day you have got to look at the type of populations I think our public are just not as demanding. If you put our GP's into a high prescribing PCT area they may resist to prescribing more because they are not used to it and think hang on this isn't right, however their volume would go up more because demand is more. It maybe more a public issue rather than a prescribing issue.

Interviewee 3

Location: Desk within open plan office

Time: 38 minutes and 21 seconds

Interviewer

What is your job title within the PCT

Interviewee 3

I am the head of medicine's management

Interviewer

With regards to antibiotics, do you have any specialist microbiologists or pharmacists that deal with…?

Interviewee 3

We don't within this PCT, but we have access to that from PCT X…because we work very closely with them and have a joint formulary with them and the other PCT's so if we need that we can access it.

Interviewer

Is that with PCT Y?

Interviewee 3

No that is with PCT X because it is the same acute provider

Interviewer

Do you have good communication with other PCT's as well?

Interviewee 3

Yes we work with the other 2 Birmingham PCT's quite closely, but we meet as a group...the heads of medicines management

Interviewer

But you work very closely with PCT X

Interviewee 3

Yes because the patients visiting the hospitals are the same

Interviewer

Have you got any initiatives or schemes that are being used at the moment?

Interviewee 3

I will tell you what we are doing at the moment, we are doing nothing in particular with antibiotics at the moment, and the reason for that is we've done it! I have been in post for five years and when I came back to work for this PCT we were incredibly bad at prescribing antibiotics. Historically Birmingham always was really high users of antibiotics in general practice, when I say bad I mean in volume, but not in what they use because it's all simple things like amoxicillin, pen v, erythromycin. It's not the ciprofloxacins and quinolones and these sorts of things. So that was my top priority for the first couple of years. At that time there were 304 PCT's and at that time we were the 4th highest prescribers of antibiotics, 300th out of 304! Within two years we had moved from 300th to 62nd and going from 20% above the national average to 10% below in prescribing antibiotics. And since then we have consistently been at that level. Because of the way we work as a small team we focus on a few things. And this is the first time that antibiotics have not been a priority because it is under control.

Interviewer

So what can you say was the reason for why you were successful?

Interviewee 3

Main reason is because of the way we work. If you looked at the whole medicines management agenda and tried to cover everything, you will never achieve anything because there is too much to do. So if you prioritise and say right in the next year these are the 3 things we are going to focus on and just go after them, then that is successful. We've done it statins, antibiotics and clopidogrel, and benzodiazepines…just different things every year. What you find is that we carry some over, so with antibiotics it was a high priority in the first few years and then we kept it as a low priority over the next few years, it's only this year we have dropped it for the first time. Statins and clopidogrel have been in there for 3 years. We keep a consistent picture by maybe bringing one thing in and taking one thing out every year, and we work on a model that's very much like industry, where you need to deliver your message at least 6 times to a prescriber that changes behaviour and that maintains that change. So my team, originally I and then another pharmacist, and we built on it slowly with a couple of part time pharmacists. They will meet the practice twice a year on a one-to-one basis to discuss, and even if they weren't high prescribers of antibiotics we would still talk antibiotics with them

although a lot of them were high prescribers. We do newsletters, we do learning events, we do six of those a year where we sit all the practices down and they all get together and we do a learning event and we've always got a medicine management team within that with antibiotics in there. So there's lots of way of keeping the message going, we don't just say don't prescribe antibiotics but try to be more subtle about it. If you keep telling them the same thing, eventually the will change their behaviour. If you tell them that thing at the start of the year and then don't mention it again all year, it wont happen

Interviewer

Now that antibiotics are not a priority this year, do you expect prescribing of antibiotics to rise this year?

Interviewee 3

I'm not simply because of the way we work! Antibiotics are a really good example because you cant put pharmacists into practice to change antibiotic prescribing because they are directly on acute basis, so you cant expect a pharmacist to sit over the GP's shoulder…you just cant. If you go and change all prescriptions for statins from atorvastatin to simvastatin you won't change behaviour, you will just change prescriptions. As soon as you take pharmacists out of that practice the GP's will just carry on with their same behaviour. What we have done is change patient and GP's behaviour towards antibiotics. We still have the odd one that is a high prescriber but most are now low, I can show you all the figures when we go upstairs. Because we have changed behaviour it is not common practice for them to write sore throat…antibiotics, cold…antibiotics! Now they are going the other way. We also have one of the biggest minor ailments schemes in the country, certainly in terms of turnover, and certainly in terms of cash wise. We have around 120000 hits a year with the minor ailments scheme and the majority of that is for cough, colds and sore throats, stuff that the GP might have given antibiotics for. Now they go directly to the pharmacy. Okay they get their cough medicine and paracetamol, they probably don't need it most of the time, but we now take them away from their GP's, so that will help maintain that.

Interviewer

Minor ailments are quite interesting…

Interviewee 3

Well they have to change behaviour first, and it's not easy, it's a lot of work for the GP to change their ways, but it does help change patients perceptions as well. If the GP says right I am not going to prescribe you antibiotics because there is no point, and we also have literature which we can give patients which say why we are not prescribing antibiotics today, and we concentrate on upper

respiratory infections and urinary tract infections. At then end of the day the line we give to GP's is that if you think its appropriate, we will think its appropriate, but you have to be happy it is appropriate. And there was a great article out there, probably from 1998 stating that if patients went to their GP expecting antibiotics, they were four times more likely to get it, but if the GP thinks the patient wants antibiotics, they are ten times more likely to get it. So we had 2 change both perceptions. I remember going to one of our practices and mentioning all this stuff and say this will be six months hard work for you, but once those patients stop coming in because they know you are not going to prescribe any, you are going to reduce your workload.

Interviewer

So do you try and educate your patients through your doctors

Interviewee 3

Yes there have been some campaigns locally but mainly we do it through the GP because it's the GP that has to refuse antibiotics and state the reasons why

Interviewer

So you took it on your own head to make these changes, rather than waiting for a message above

Interviewee 3

Yes

Interviewer

Did you have to put any finance towards that

Interviewee 3

No we only originally had me in the team, and then a few extra. You have to remember changing antibiotics isn't about cost, but because we have done it we've probably saved around 250000 pounds a year on reduced prescribing within this pct, so you can justify doing it anyway. We've spent a bit on GP supporting material and information to patients, but not a lot.

Interviewer

We were interested in this pct because we were aware of how antibiotic prescribing reduced a lot over the past few years…

Interviewee 3

Yes we use a model called "selling the salami". It's not just for antibiotics but used for everything. If you think of salami and you cut it up into pieces, every slice looks slightly different. It's still salami! So you have got to decide on what your message is going to be to reduce antibiotic prescribing and then just use slightly different ways to get that message across. So In a newsletter you would write something like, countries with the lowest level of antibiotic prescribing have the lowest incidence of MRSA. In the next newsletter you would put something like the detail mentioned from the article I mentioned earlier, and then when you see GP's you talk about that and you talk about appropriateness. So each time you add another layer on layer, but ultimately you are saying the same thing each time. And that's how the industry works very successfully and that's why they invest millions of pounds on GP reps each year.

Interviewer

So what is your background? Have you always been involved with medicines management all the way through?

Interviewee 3

I did 10 years of community pharmacy originally. And after being qualified for five years, there was a programme run by the then FHSA in Birmingham where they were looking six community pharmacists to deliver prescribing advice. So I came into this that way. So that was part-time one day a week. And then I worked for the health authority doing something similar when that finished. And then I left this field for a couple of years and worked in the prison service, but actually it is very much a primary care setting in the prison because the message is still the same. I came back into this when the primary care groups were formed and I worked for the PCG in small heath, and then I went to work in industry for a few years. I worked for Lilly for three years in sales and marketing, and then I came back here in 2003.

Interviewer

What is your relationship like with other PCT's?

Interviewee 3

No, you have got to look…it's very easy to do all the flowery work saying we are doing this, this and this, but actually we are here to deliver efficient healthcare. You have got to decide what we want to do and we have made the decision we will work on prescribing efficiency and allow that resource to do all the other work..errm they've not, because we work independent…no… we've certainly had the SHA have me talk to other PCT's. I did a workshop on what we did and how we delivered it, some take it on board and some don't. what we are finding more and more, and this year especially the

prescribing efficiencies are built into our overall and other PCT's ask how we have done it because there is money involved and we have had tangible results. More and more people are, but a lot aren't interested.

Interviewer

well I went to see a Interviewee 1 a few weeks back, who stated that their antibiotic prescribing was low, although the figures suggest different, and when I asked if you are open to change to improve, her answer was very much we are doing what we can, we have been told what to do and we are not going to do much more.

Interviewee 3

You have to pick your own priorities and I understand where Interviewee 1 is coming from. When we were 301st out of 304, east was 304th! So they were the highest prescriber of antibiotics in the country. But they have done a lot of old work in the old team. I know they did a lot of work on reducing, with a lot of community involvement by going to schools, that was successful then but I don't think they will take it on now!

Interviewer

Do you have any funding at all from the government at all? So let's say they want to implement an advertising scheme, will they filter down money for each PCT?

Interviewee 3

Not really, no. They might do for other bits and pieces that we can bid for but they will never be that specific. We are fairly lucky because we are a fairly cash rich PCT, and because of the work my team has done, if I wanted another post to do something specific, I can always get funding for that from this PCT. Other PCT's are not so lucky! I can go to the board and say that the work that my team has done has probably saved 2 million pounds last year. It's not really saved because it is invested as well but we can be more efficient. Our staff last year went up by 16%, but our cost went down by 30%. So I can usually get the board to agree with what I want to do.

Interviewer

What is the relationship like between the SHA and PCT's…do you think that's a good relationship you have there?

Interviewee 3

The problem is that it has never been that well-established of exactly what their role is. It's been easy for us because we have all worked with Nigel one way or another, when he was at Walsall…etc. So

there are good relationships there. Are they performance managers, supporters, are they meant to be strategic for us, we don't really know.

Interviewer

Are you aware of the new government campaign to reduce antibiotic prescribing

Interviewee 3

Yes. We've had people from the health department come here end of last year talking around C Diff and MRSA, and they specifically asked for medicines management because of the work we have done of medicines management. They already made their mind up about what they wanted to do before they had asked us. They said surely you have got a formulary for antibiotics. And I said no you shouldn't have a formulary for antibiotics because GP's are very simple creatures. If you say to them use amoxicillin for simple chest infections, they will hear it is okay to use amoxicillin. What you have got to say is this is when it is appropriate to prescribe, and that's the only time you should prescribe, and that will reduce prescriptions. You have to be careful how you communicate with GP's because they will hear one thing…formularies is hospitals is a good, but in primary care? Yes formularies in other areas such as cardiovascular…fine because it involves choosing the most cost effective drug to improve outcome. From my point of view why would you have atorvastatin 10mg on your formulary when you have simvastatin 40mg doing a far better job, better evidence base at the fraction of the cost. But for antibiotics, it doesn't work.

Interviewer

When you started talking to those doctors about antibiotics, did you have a target in mind?

Interviewee 3

Two years...we also have a prescribing incentive scheme, which has been knocked around in the last couple of years. But if you get it right it is probably the best way to get changes in prescribing. If you are very direct with what you want from it, you can get very good outcomes. We run an incentive scheme over three months, the GP's know that between January and March every year we will be monitoring. And we have a maximum of four targets and they get prizes for achievement. Normally antibiotics are in there, but it isn't this year. What you see in those three months is a state change in prescribing, because you are doing it in a concentrated time where they have to think about what they are doing you start to see maintenance of that. I'll show you the graph upstairs but usually you see a drop then levelling, a drop then levelling again.

Interviewer

What does an incentive scheme actually involve?

Interviewee 3

First of all there is an audit, all the practices that want to be involved, and we usually get a 90% response rate who say do the audit. Last year it was on clopidogrel prescribing. All we said is here is the NICE guidance on clopidogrel. Here's all the patients, they should have a diagnosis, as start and stop date, if appropriate, unless there is a reason for them not to. How many patients have you got, how many are on clopidogrel and how many have a stop date. And if not, why not, you need to find out. And that's all we had to do. We didn't have to put standards or criteria in. GP's came back and actually said it's the best audit we have done since we have been in general practice because it made them look at their practice. We did the audit, the figures went down and then plateau's. So hopefully that means that the patients coming onto it are equivalent to those coming off it. Then we do points for prizes scheme. Depending on our priorities, we have up to four targets, when it was antibiotics we said right we are going to reward those practices that are already good, why shouldn't they be rewarded for doing good. Any practice that is below the national average I'm happy with. So if you're below the national average you will get 10 points. If you are above the national average within that three month time period, you need to be showing a reduction. So if you show a 10% reduction you will get 2 points, if you show 10-20% reduction you will get 4 points…etc. If you show greater than 20% you will get 6 points. If you are within 5% of the national average then you get 1 point. So there was an incentive for those guys who were never going to get below because of how high the prescribing was, there was an incentive for them. The number of points is completely arbitrary because if there is 40 points total for the whole scheme and two practices get all the points, they get all the money. If 100 practices do it then they all get that same amount of money, but split 100 ways instead of 2. We have a certain amount of money each year that the board will agree on. The maximum pay out last year was £4000. For a big practice that is nothing, but they are delighted because it allows them to buy those bits a pieces for the practice that they wouldn't buy themselves. There are certain criteria they can't use it to pay for staff because they should be doing that anyway. Anything to improve patient experience is fine, e.g. medical equipment.

Interviewer

Do other pct's use incentive schemes in this area?

Interviewee 3

There are a few and they are using our model, I know that because they have asked us for it.

Interviewer

Are antibiotics a priority at other PCT'S?

Interviewee 3

I don't know, you would have to ask them. Antibiotics were a big priority in the first two years so you got more points for that than anything else. In the first year antibiotics would be worth 20 points and benzo's worth 10 points. So we prioritise by going after what we want by giving the most points. The only problem with certain incentive schemes is that they are too complicated. I come back to GP's are simple creatures, they have got so much going on that they need simplicity. If you make it too complicated it wont bring about change. That's why we never have more than 4 targets, and I'd rather have it to three.

Interviewer

Is there a mentality where you say this area is a problem so let's deal with this, rather than let's keep these existing figures low?

Interviewee 3

Yes there is. You have to be brave to say I am going to only go after three or four targets this year. It would be too easy to say I am going to target everything, and that's where people make the mistake.

Interviewer

Do you think you can take what you know and step into another PCT and get similar results.

Interviewee 3

Pretty much yes. Because the model works, industry has proved the model works. I think the only problem would be going into an interview and proving that, although I have the figures, it is such a step change for the NHS. I really believe in this model.

Interviewer

Are there opportunities to help…?

Interviewee 3

Yes sure, antibiotics are still one of my six markers and so we check figures every month to make sure figures are not rising. You always get seasonal variations, but if I see the trend going up I will intervene. But I will also check those figures against national figures.

Interviewer

There has been a lot said about industry taking more responsibility with antibiotic production. Do you think they can do more in that area, given your industry background?

Interviewee 3

They are not going to develop antibiotics, not interested because why develop a drug that is only used short term when you can produce one that is used for five or six years. Where's the profit? They're just not going to do it. It's all about long term conditions. What they are really good at is marketing and marketing to the target population. And I actually said to the department of health when they came down that they should ask industry how can we deliver this message, and the health department said what is in it for them, they're are not going to want us to stop prescribing their drugs. They are not interested; there are no new antibiotics out there. They couldn't get their head around it. It would be a way for industry to work closer with the department of health.

Interviewer

The lack of communication seems to be such a barrier…

Interviewee 3

Yes it's the most important thing we do. You can have all the ideas, unless you communicate well and implement them, what is the point! I know the vast majority of our GP's know what medicine management is and know where to contact us, and are happy to do so. And see medicines management as a useful resource because many don't see the pct as a useful resource, and that's been due to communication as much as anything.

Interviewee 4

Location: Desk within open plan office

Time: 27 minutes and 2 seconds

Interviewer

What is your role within the PCT?

Interviewee 4

I am assistant director of medicines management, I have only been so for two weeks.

Interviewer

Did you work in community pharmacy before that?

Interviewee 4

Yes I did. I was a community pharmacist for quite a few years, and then I was invited to go work in a local practice actually. After doing a bit of both they asked me whether I would like to work three days a week. This fits in a lot better around children.

Interviewer

Do you have a special antimicrobial pharmacist?

Interviewee 4

I have a job description for one. We have just secured funding for one to start in October. Funnily enough I have organised a meeting tomorrow with one of my dental colleagues, and they have offered us funding to bring it forward so we can start by addressing antibiotic prescribing in dentists as well.

Interviewer

Ok. Other PCT's have antimicrobial specialists that work in hospitals rather than onsite at the PCT. Are you looking for someone to specifically work within the PCT?

Interviewee 4

Yes, two antimicrobial pharmacists and that's why we are appointing one here, who can look at the use in primary care, nursing homes, that kind of thing. And it will close the loop.

Interviewer

Who is in charge of developing the initiatives, incentives or formulary guidance that you may use?

Interviewee 4

That would be me I imagine

Interviewer

Have you got anything running at the moment for antibiotic use?

Interviewee 4

We have got prescribing incentive scheme this year, which has got in it a little about cephalosporins and ciprofloxacin. Basically if the practice has got a greater than average antibiotic use, they must agree to reduce the use of those antibiotics as part of their QUOFF target. If they don't, they will have their reward reduced by 50%. So it is fairly tough. If they are below average then they won't have to address it because they are not too bad. It is just the top few practices that tend to use them.

Interviewer

So if a practice is doing well then you wouldn't reward them?

Interviewee 4

Only if they are doing well on those particular antibiotics because those have been identified as being related to C Diff. Because we did have high use on both of those, so they have come down quite a bit.

Interviewer

Is your incentive scheme similar to the one being used at PCT Z?

Interviewee 4

Yes it will be similar because PCT Z uses City (hospital).

Interviewer

(Explain the process used by Interviewee 3 for incentive schemes)

Interviewee 4

Yes it will be similar to that…but I am waiting to see because there is supposed to be some national promotional campaign so I am waiting to see what will happen with that.

Interviewer

I don't think much is going to happen with that.

Interviewee 4

Really? That's disappointing actually! I don't understand why when the government are looking at MRSA and C Diff in hospitals so bad that and that there is a link to antibiotic use, why they don't they get the message out to the public and the GP's. I know there is a perception that the public are requesting it, but in some of our areas it actually is!

Interviewer

It is confusing. Before I thought that the PCT would have messages sent from the SHA on what to do, who in turn receive a message from the government on what to do. However it feels as though you are just left to it.

Interviewee 4

Yes we are. You need a concerted TV campaign and not just leaflets. I mean people that live in the leafy suburbs that are well educated realise that most things are viral and antibiotics are not needed to treat them. Whereas when you come into an area like this that's not the case. When people feel ill they think antibiotics will treat them, and if they always get it from their GP it is very hard to break that. It's the die hard older GP's in Sandwell that keep that momentum. And if they do try to stop, patients jump ship to GP's that will provide them.

Interviewer

So Is there an issue there that GP's are being told not to prescribe antibiotics, but the pressure is so great from patients that they feel they have to?

Interviewee 4

(nods her head)

Interviewer

Okay is that still something you are trying to address?

Interviewee 4

Yes well being a pharmacy prescriber, when you are actually sitting in front of the patient it is very difficult.

Interviewer

Yes I have got a lot of family around here so I know what it can be like…

Interviewee 4

Yes it is very endemic in the south Asian population actually because there is that perception of being given something. It does require a cultural shift, but we are aware that's there, but we are kind of addressing that. It is very difficult for me, a white middle class British woman to do.

Interviewer

Do you have the same kind of population that they have in the PCT Y area as well?

Interviewee 4

Yes it is very similar.

Interviewer

Do you think that if you initiated the same schemes they have that it would be beneficial…?

Interviewee 4

What have PCT Y been up to?

Interviewer

They try and educate patients through their doctors…

Interviewee 4

Well we have done quite a lot in that we have. We did do a campaign when I first started, that kept rolling. We were one of the worst in the country, and don't think we are quite as bad as now as we used to be…I haven't looked at the figures for a while…

Interviewer

No your figures are quite good actually

Interviewee 4

When I first came the questions I was asked in my interview were around addressing antibiotic use. We did a lot of work with the GP's but we also provided a lot of information leaflets for GP's to use for patients. I think a lot of our bigger practices have got the message, often it is practice staff or practice nurses, practice nurses and also community pharmacists and their staff… I have been in a lot of situations where they have sold something and said if you don't feel better you will need to go see your GP to get antibiotics, and the boxes do say if you don't feel better within three days go and see your doctor.

Interviewer

What is your minor ailment scheme like in this area?

Interviewee 4

Very well use. Unfortunately we have no data to prove that it reduces antibiotic prescriptions. We've actually got one very well used service next to a GP practice, and even that doesn't show a reduction. And we haven't got the time or the resources to look, and that was a one-off to see if it odes reduce antibiotic prescriptions…and it probably does actually.

Interviewer

It may be a nice way to get the patients out of the GP surgeries and demanding…

Interviewee 4

It would nice to have more funding for minor ailments as well. It does get patients out of GP surgeries. There are a couple of issues that we have with it: Patients tend to use it as a free medication service and GP's use is as a prescribing service to stop it coming off their budget. So the patient will already be sitting with the GP and the GP will say you can go and get Calpol from the pharmacy for free. That's not the point of it, the point of it is next don't come to see me go to the pharmacy. So there is a little bit of that going on as well. In an area like this it's a good thing to have…its just about making sure pharmacists can police it. I suspect it has got the potential to reduce antibiotic prescribing.

Interviewer

What are your priorities for the coming year…is antibiotics one of your priorities for the coming year.

Interviewee 4

Yes it is, and hence why we are recruiting an antimicrobial pharmacist. Errm there are no priorities as such, we are covering all the major areas. It will mainly be the CV type, diabetes and antibiotics, obviously because of our patient population.

Interviewer

If you were to introduce a certain incentive scheme or initiative, how long would you run it for?

Interviewee 4

12 months

Interviewer

And do you assess it after those 12 months

Interviewee 4

Yes it has already gone out for this year so they have plenty of time to look at it, and then we will analyse the last quarter figures between January and March, so we are just waiting for the last quarterly figures for this year to come in and then they get allocated their funding and then they have two years to spend the money on whatever they want.

Interviewer

Is it done on a voluntary basis (Interviewee 4s shakes her head)…is it done on a mandatory basis

Interviewee 4

Yes. We top slice it off the budget. If they don't do, they won't get any money. But most of them will get some. We are being quite generous this year so that they get a feel of what it is like to get money. We will be a bit harder next year. the other thing is we devolved into three smaller clusters, similar to the old PCT's that are clusters of surgeries that work together, and they agreed to split the funding 50-50. So if a practice got £5000, they will get £2500 and split the rest with the rest of the cluster.

Interviewer

Do you control what they spend their money on?

Interviewee 4

We give them guidelines, but basically it is for patient benefit.

Interviewer

So you have got government funding this year for antibiotic specialists?

Interviewee 4

No

Interviewer

So who is funding it?

Interviewee 4

We don't have any government funding, it has come out of our own PCT. We are given a pot of money and we put bids in. My predecessor and infection team put a bid in for an antimicrobial pharmacist and were successful. The Department of Health decide how much money the PCT's get. The prescribing budget is allocated based upon the ASTRO-PU's and then each director will allocate the money.

Interviewer

Do you know if there have been any successful initiatives or incentives used in the past?

Interviewee 4

Around two or three years ago we ran the antibiotic campaign and did the patient leaflets, and that's when we started to drop off. But we are also starting to replace some of the old GP's who are retiring, and the younger GP's are coming in, so there is less emphasis on the locums who prescribe the Floxapen and amoxicillin, and the younger GP's are saying no you don't need antibiotics. And there is that chart from 1960's something that you have probably seen which they can show, which tells them that they can have antibiotics now and feel better in X amount of days, or not take antibiotics and still feel better in that same time.

Interviewer

Do you have figures readily available every month?

Interviewee 4

For antibiotic use we use EPACT. We can use that monthly if wanted, but we check it quarterly. Because EPACT provide a quarterly toolkit. We look at the Ceph's and Ciprofloxacins on a monthly basis. So yes, we know exactly what is going on.

Interviewer

Is there high prescribing of ciprofloxacin then?

Interviewee 4

Not particularly, there are a few practices that are using it, but they may have individualised patients, and there is no problem in using it if microbiology have said yes you need to use this. So we just go to that practice and say have you got any specific patients?

Interviewer

Is there a certain way you communicate with GP's…do you send representatives down…?

Interviewee 4

No we have practice pharmacists and pharmacist technicians, we work differently to PCT Y in that way. We have four senior pharmacists and then pharmacist support in nearly every practice. Then we have got five pharmacy technicians as well and so they go around and do data collection as well. Practice pharmacists are very much clinical and so they can look at an individual practice basis and they can go to a practice meeting and say look antibiotic prescribing is rubbish, what are we going to do to improve it.

Interviewer

So they communicate between the two sides?

Interviewee 4

Yes. So if I saw one practice that was particularly high, I would literally e-mail that person and say can you make an appointment with so and so and talk to them about their antibiotic prescribing.

Interviewer

How long have you had practice pharmacists?

Interviewee 4

Ages

Interviewer

If you wanted to introduce a new initiative etc, who would you need to talk to in order to get permission?

Interviewee 4

No-one. I might talk to our infection control types about how to reduce it and then talk to the team about how to introduce it and get their input on what could work and how it could be implemented, based on what has worked before.

Interviewer

Do you have any particular ideas on how you are going to tackle it over the coming year?

Interviewee 4

I am hoping an experienced antimicrobial pharmacist will come in and sort it out. Hopefully we can use what they have learned, for example from hospitals, and implement it in primary care.

Interviewer

So what is your view on the use of formularies in primary care, do you think they are required?

Interviewee 4

Yes, a lot of our GP's love formularies. Although it depends on your GP's actually, many of ours need a formulary frankly!

Interviewer

What's your relationship like with other PCT's?

Interviewee 4

Very good actually. It's very good amongst this strategic health authority actually. We do work a lot together.

Interviewer

Do you know what the exact role of the SHA is?

Interviewee 4

It is a strategic role. Nigel Barnes isn't there any more so we are just waiting for the pharmacy side to be appointed.

Interviewer

Could you contact Nigel when needed? Was he readily available?

Interviewee 4

Oh god yes.

Interviewer

Do they offer guidance?

Interviewee 4

They are liaison between the department and PCT level, so it's that kind of cascade of information, and also knowing what is best for the West Midlands as a whole. Then it kind of breaks down with us knowing what is best for our population.

Interviewer

So do you readily meet up with other heads of PCT's?

Interviewee 4

Yes.

Interviewer

How often do you meet?

Interviewee 4

Every other month usually.

Interviewer

And you discuss topics like these?

Interviewee 4

Yes

Interviewer

If you were in my position in looking within PCT's, what kind of avenues would you find beneficial or interesting?

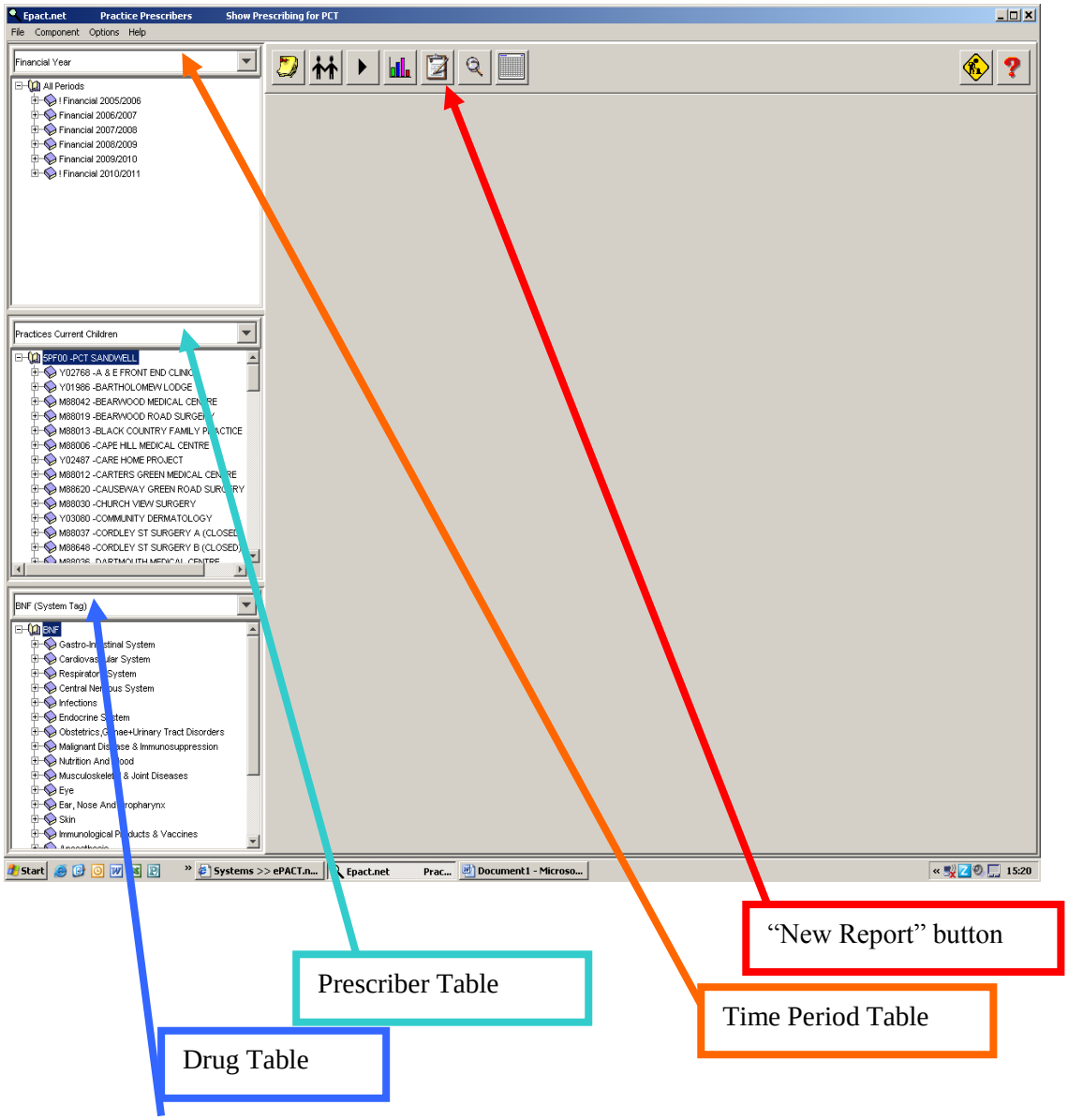
Interviewee 4

It's difficult because we are addressing where we have seen gaps by bringing the antibiotic pharmacist in. I do think we need some kind of public awareness campaign nationally. A bit like the immunisation campaign actually to stop use, and link it into hospitals and hospital acquired infections because the public have a perception that it is a dirty hospital that causes MRSA and C Diff, and actually it is only part of the problem.

Appendix 6: Steps required to download the required data from ePACT and produce the prescribing analysis tool.

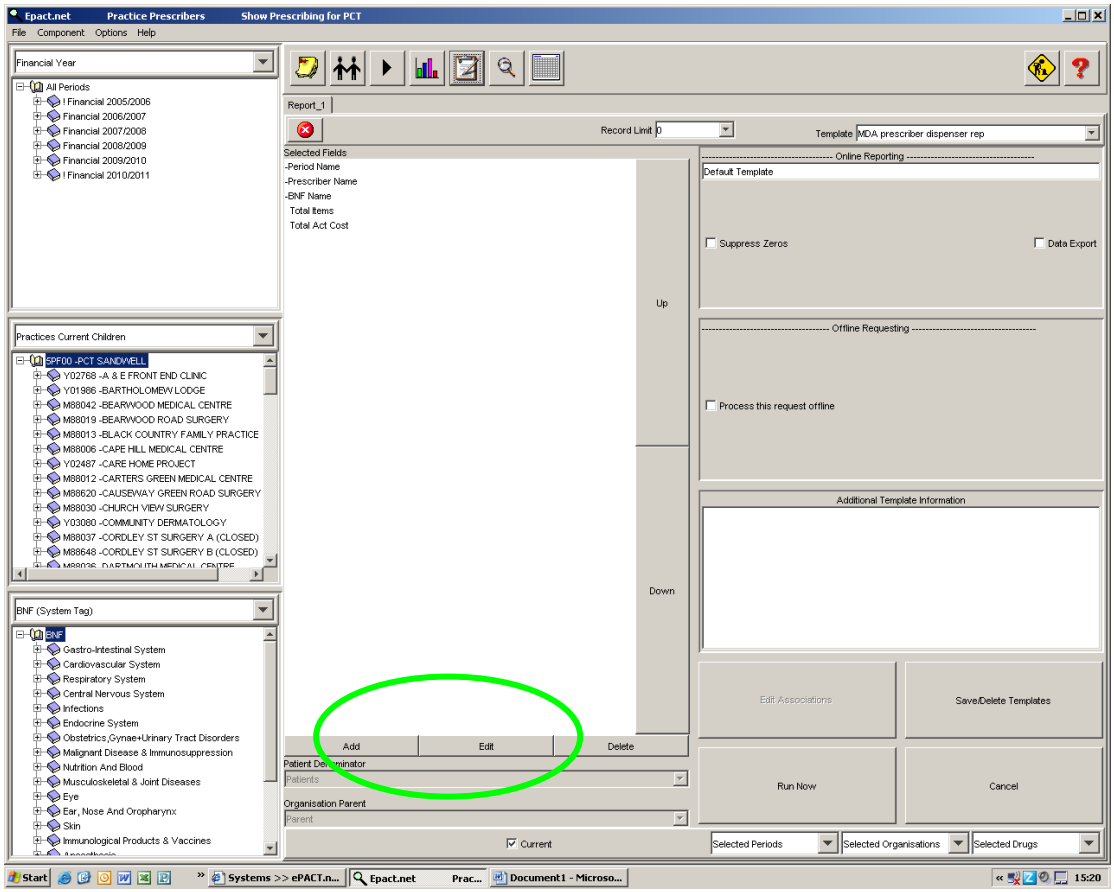
ePACT was available for use within Sandwell PCT and the following steps were used to retrieve the required data.

Figure 1: Screen capture of the ePACT opening screen



The ePACT opening screen allows the user to select the time period for analysis, prescriber and drug of interest on the left hand side of the window. The "New Report" button allows the user to personalise the report page required to download data as shown in Figure 2 below.

Figure 2: Screen capture of the "Selected Fields" window within ePACT



The selected criterion within the report page was used as a template for the presentation of the required data. The “Add” and “Edit” buttons (circled green) were used to change the selected fields.

Figure 3: Screen capture of the "Edit Fields" window within ePACT

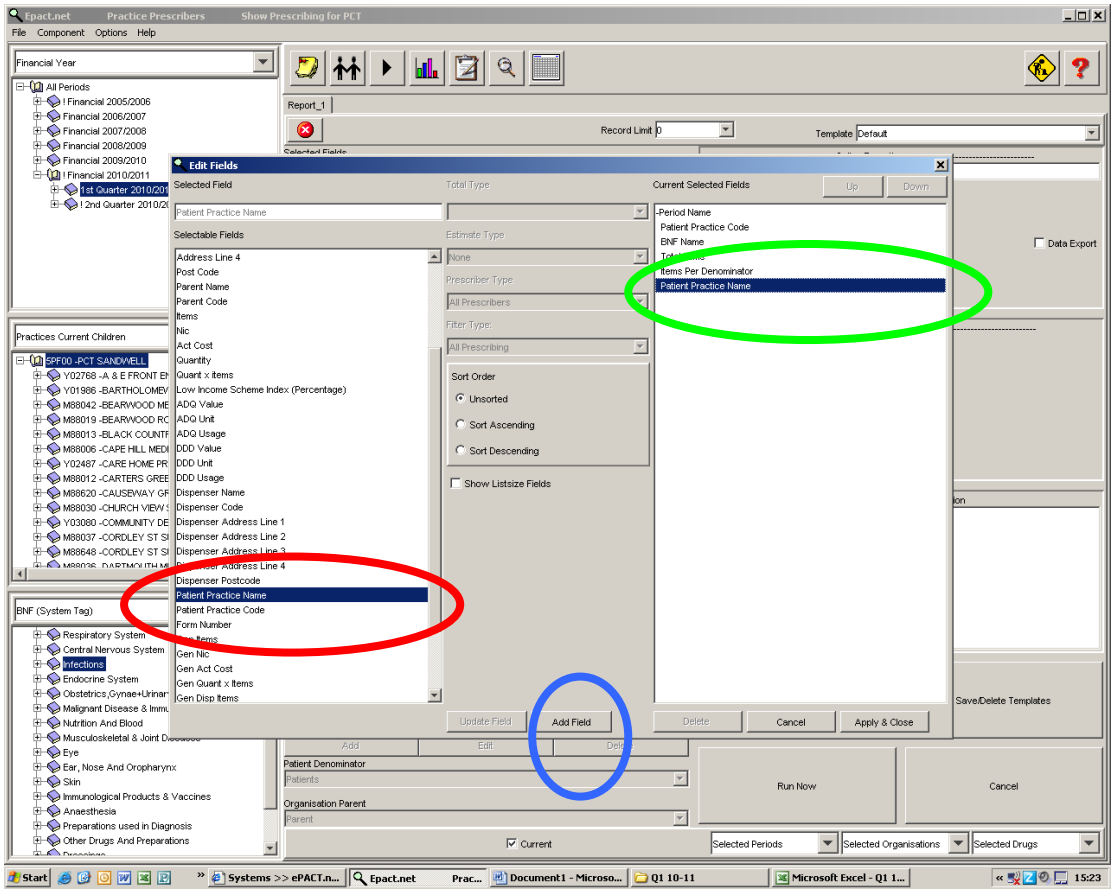


Figure 3 shows how the Current Selected Fields" section (circled green) was updated by selecting Patient Practice Name (circled red) and then selecting the Add Field button (circled blue). The fields required for the production of the database were the:

- Period Name.
- BNF name.
- Total Items.
- Items per STAR-PU.

The "Apply and Close" button can be pressed once the required fields have been selected to close the "Edit Fields" window.

Figure 4: Screen capture of the "Financial Year Summary Table"

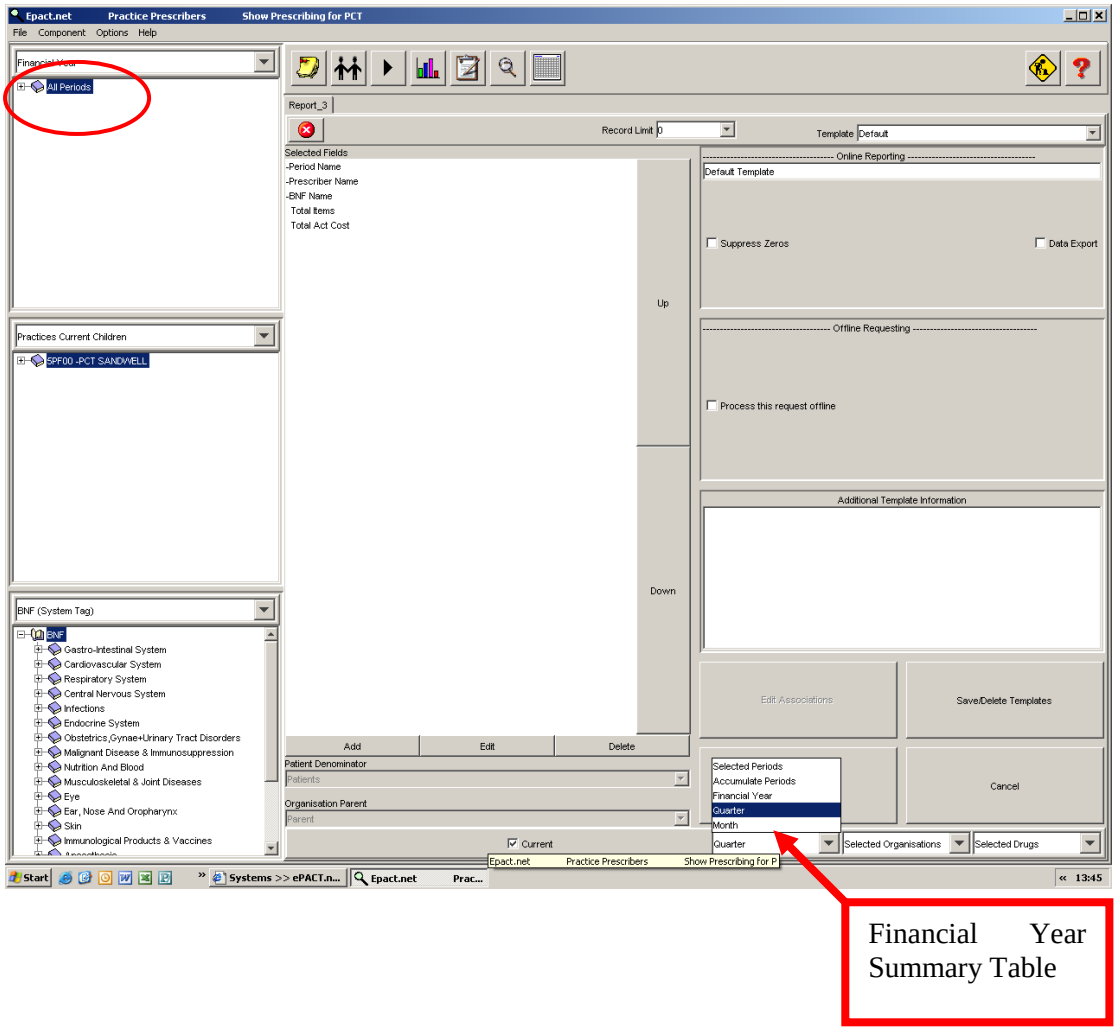


Figure 4 shows the updated “Selected Fields” window. The time period was selected by highlighting “All Periods” (circled red) and then modified the degree to which the data within the quarter was analysed by using the Financial Year Summary Table. This search required results to be displayed to “Quarter” level.

Figure 5: Screen capture of the "Practice Summary Level Table"

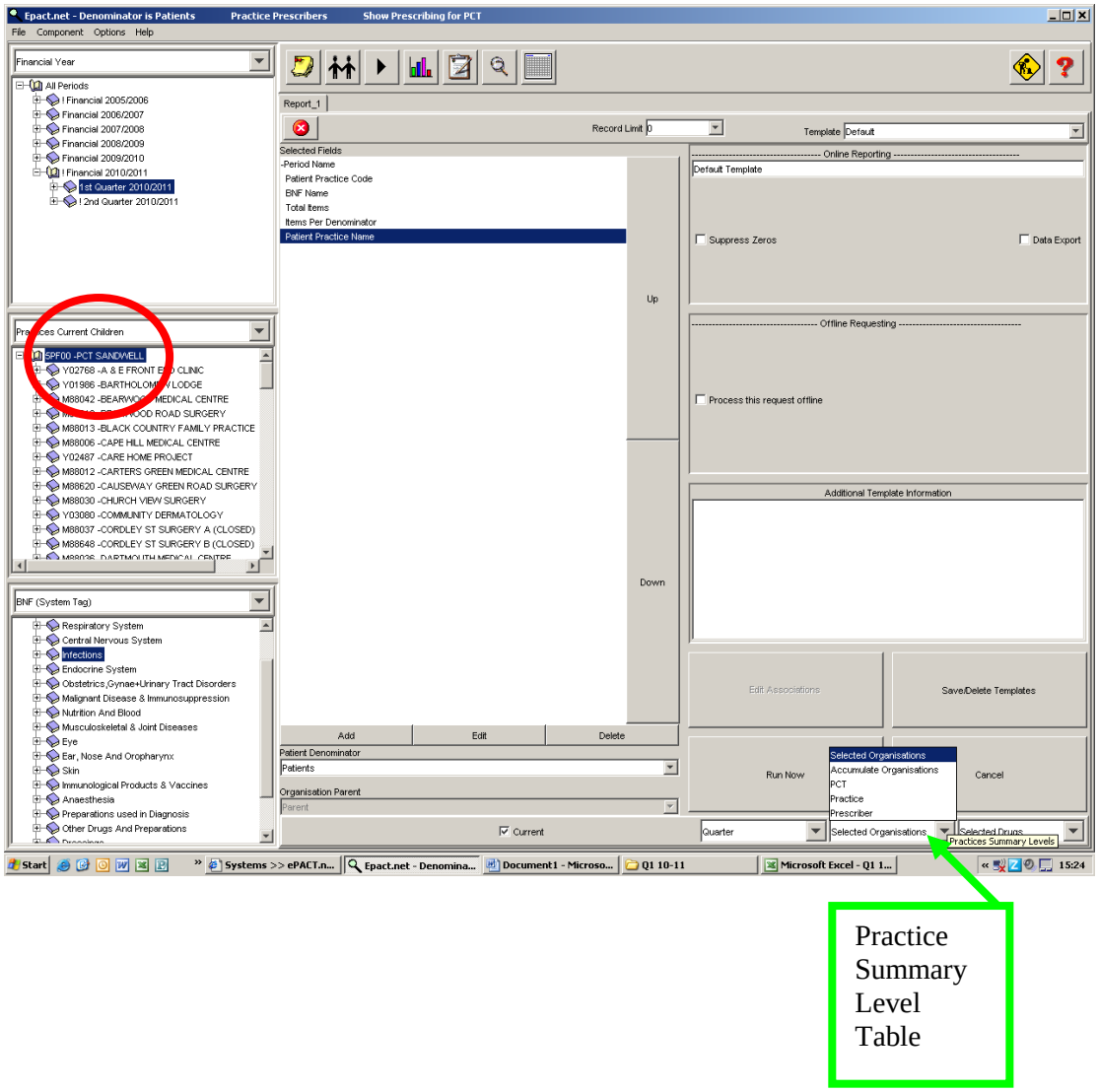


Figure 5 shows the updated "Selected Organisation" window. The level of prescribing data was selected by highlighting the required PCT or practice (circled red) and then selecting the detail required using the Practice Summary level Table. This search required results to be displayed to "Practice" level.

Figure 6: Screen capture of the "BNF Summary Level Table"

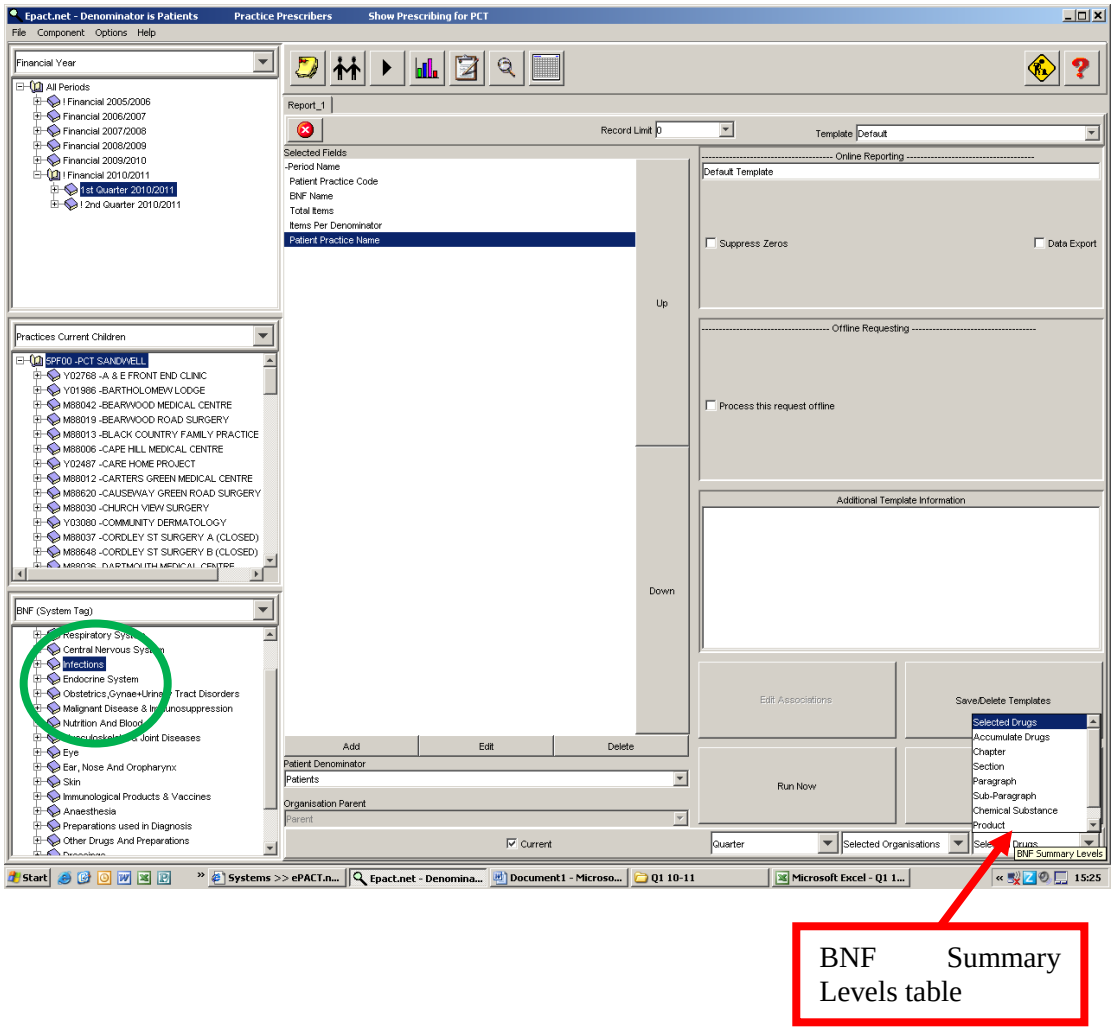


Figure 6 shows the updated “Selected drug” window. The medication category was chosen within the Drug Table, which in this case was “Infections” (circled green). The level to which medication was then analysed was modified using the BNF Summary Levels Table. This search required results to be displayed to the “Chemical Substance” level. Once all the criteria were chosen, the “Run Now” button was selected to upload the required data.

Figure 7: Screen capture of the "Default Template" window within ePACT

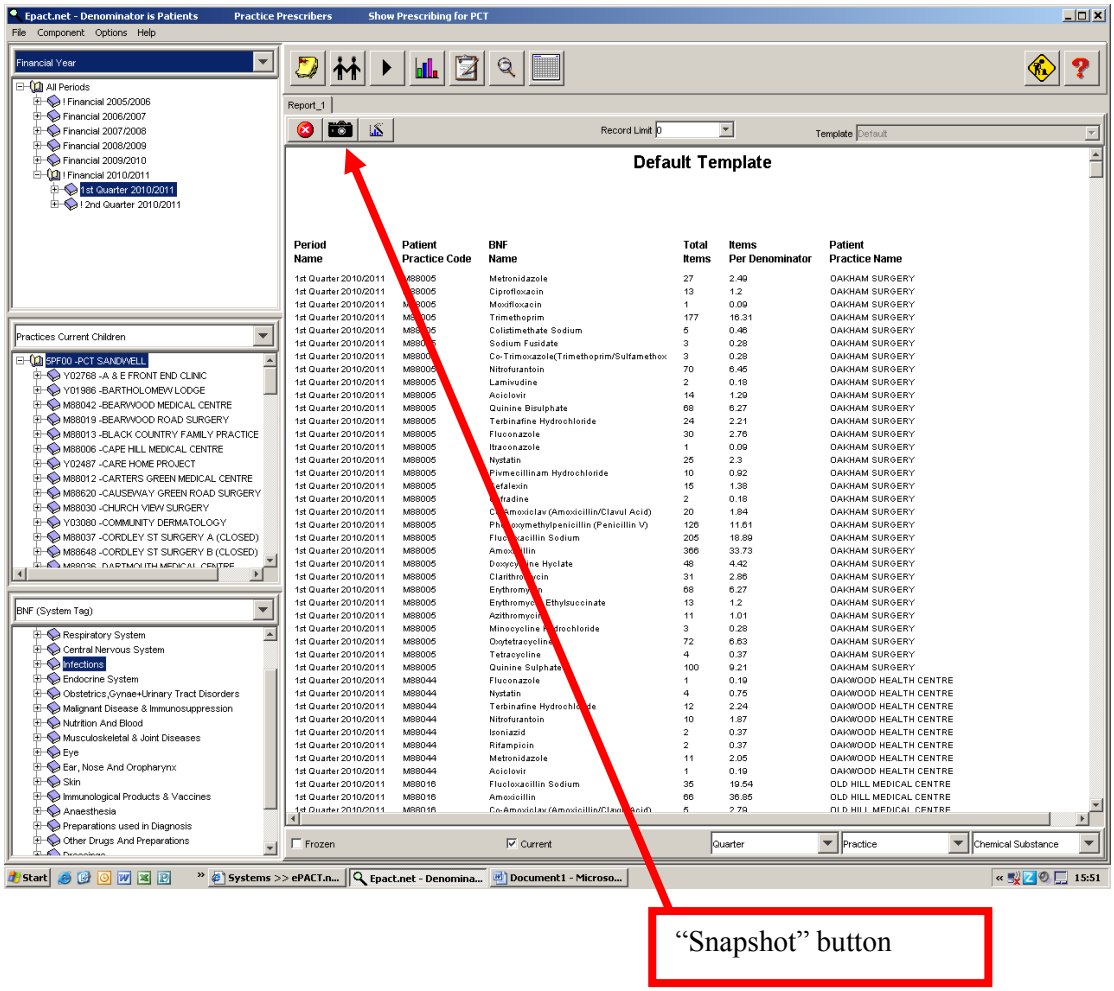


Figure 7 shows the Default Template, containing the selected data. The "Snapshot" button allowed the transport of selected data to a modifiable window.

Figure 8: Screen capture of the "Default Template"

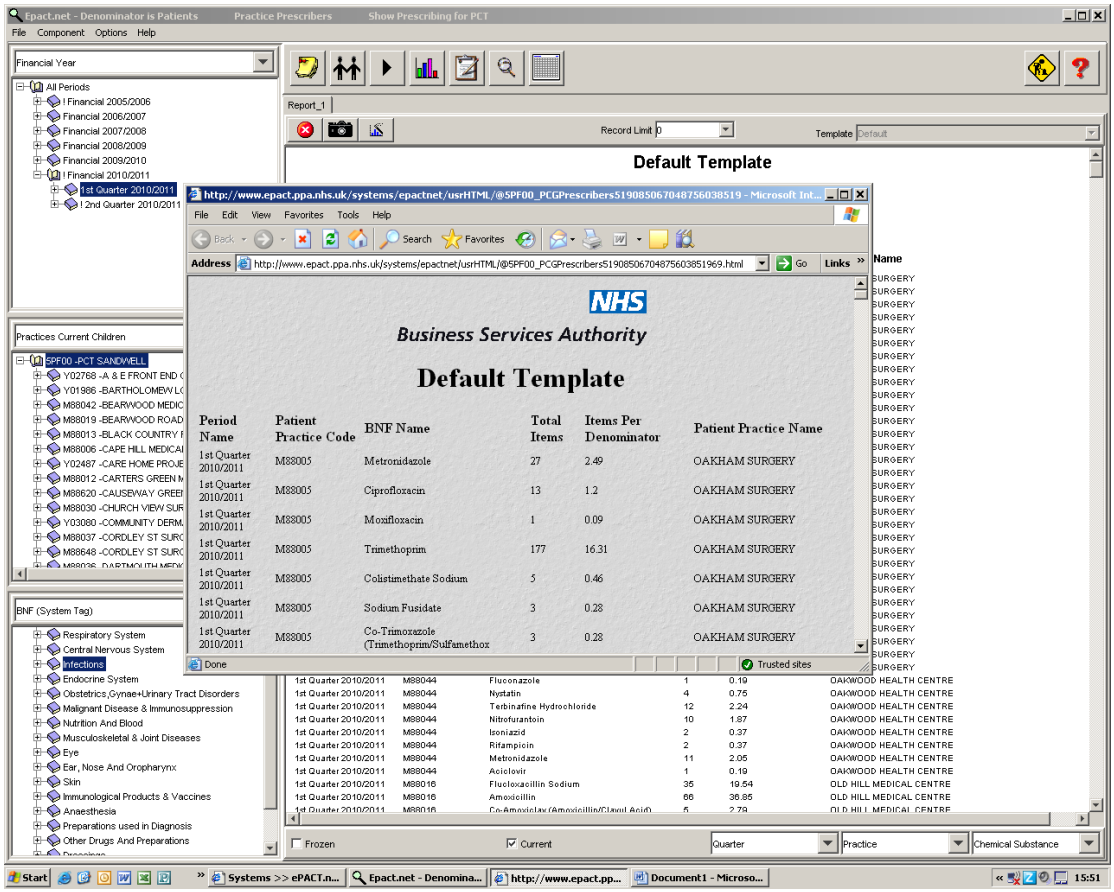
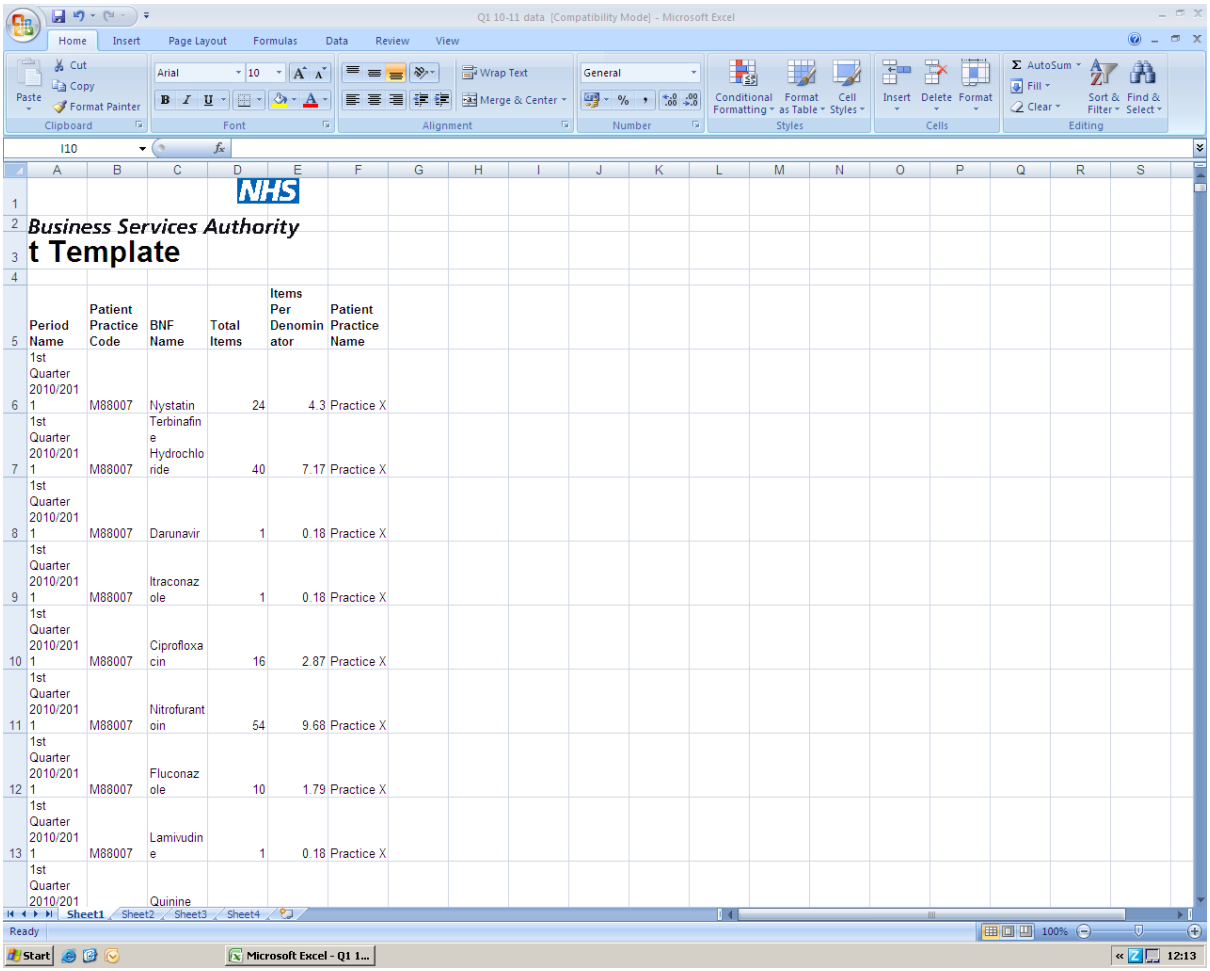


Figure 8 shows how the data could be selected and copied from the window to a Microsoft Excel sheet as shown in Figure 9 below.

Figure 9: Screen capture of the downloaded data from ePACT to Microsoft Excel



Business Services Authority

t Template

Period Name	Patient Practice Code	BNF Name	Total Items	Items Per Denominator	Patient Practice Name
1st Quarter 2010/2011	M88007	Nystatin	24	4.3	Practice X
1st Quarter 2010/2011	M88007	Terbinafine Hydrochloride	40	7.17	Practice X
1st Quarter 2010/2011	M88007	Darunavir	1	0.18	Practice X
1st Quarter 2010/2011	M88007	Itraconazole	1	0.18	Practice X
1st Quarter 2010/2011	M88007	Ciprofloxacin	16	2.87	Practice X
1st Quarter 2010/2011	M88007	Nitrofurantoin	54	9.68	Practice X
1st Quarter 2010/2011	M88007	Fluconazole	10	1.79	Practice X
1st Quarter 2010/2011	M88007	Lamivudine	1	0.18	Practice X
1st Quarter 2010/2011		Quinine			

This dataset could then be copied and pasted directly into the database without the need to modify the content.

Visual electronic outputs required within the prescribing analysis tool

The downloaded data from ePACT was then used to design the visual electronic outputs in order to achieve the objectives of analysing trends in prescribing using drop down menus and used a number of visual electronic outputs with different visual displays. The outputs included:

- A trend analysis graph to measure any of the 117 drugs downloaded from ePACT use in items per STAR PU and/or prescription numbers for any given financial year.
- Visual summaries for key antibiotics which are specific for Sandwell PCT and show prescribing over a 3 year period.
- A table to provide an overview of the number of times all antibiotics have been prescribed within a given practice.

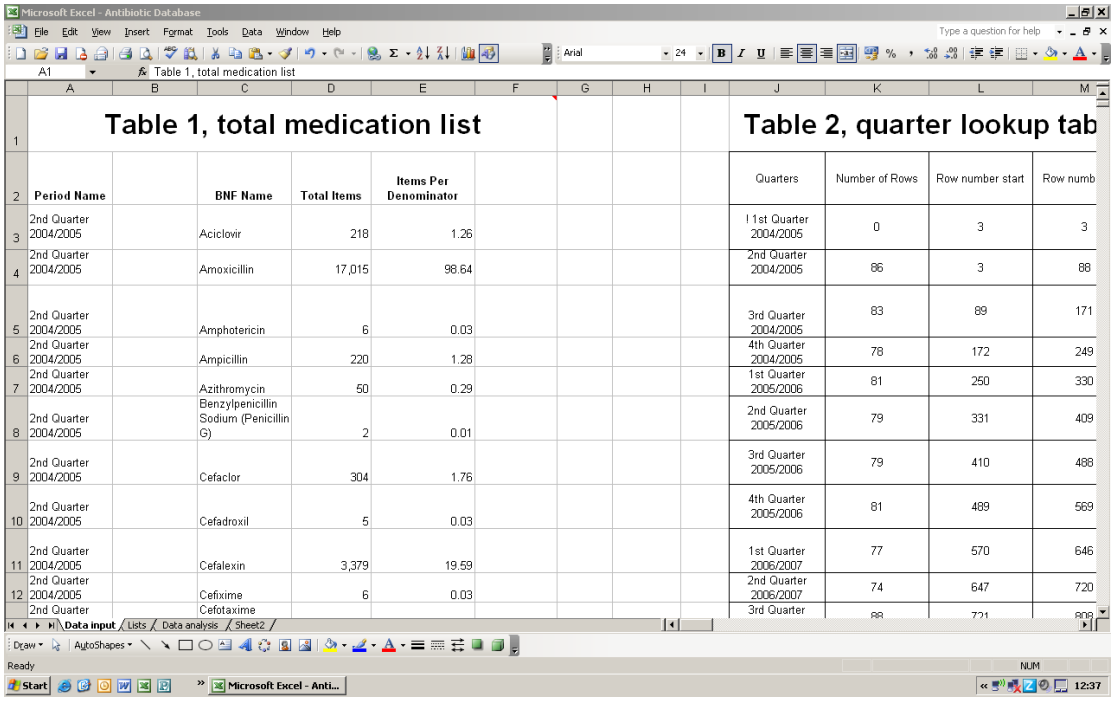
Pilot Database production

To improve the efficiency in producing the visual electronic outputs a direct link between the data downloaded from ePACT to the visual electronic outputs was achieved by producing a "Data Entry" worksheet within the database. The Data Entry worksheet comprised of five sections called, (1) Table 1, Total Medication List (2) Table 2, Quarter Lookup Table (3) Table 3, Main Lookup Table (4) Table 4, Quarterly Total Prescriptions (5) Offset Graphs.

Total Medication List

The Total Medication List contained data specific to one GP practice and was designed in order to copy and paste all the relevant data from ePACT into the Total Medication List, as shown in Figure 10.

Figure 10: Screen capture of the Total Medication List used within the Antibiotic Database



Microsoft Excel - Antibiotic Database

File Edit View Insert Format Tools Data Window Help

A1 Table 1, total medication list

Table 1, total medication list

Period Name	BNF Name	Total Items	Items Per Denominator
2nd Quarter 2004/2005	Aciclovir	218	1.26
2nd Quarter 2004/2005	Amoxicillin	17,015	98.64
2nd Quarter 2004/2005	Amphotericin	6	0.03
2nd Quarter 2004/2005	Ampicillin	220	1.28
2nd Quarter 2004/2005	Azithromycin	50	0.29
2nd Quarter 2004/2005	Benzylpenicillin Sodium (Penicillin G)	2	0.01
2nd Quarter 2004/2005	Cefaclor	304	1.76
2nd Quarter 2004/2005	Cefadroxil	5	0.03
2nd Quarter 2004/2005	Cefalexin	3,379	19.59
2nd Quarter 2004/2005	Cefixime	6	0.03
2nd Quarter	Cefotaxime		

Table 2, quarter lookup tab

Quarters	Number of Rows	Row number start	Row numb
1st Quarter 2004/2005	0	3	3
2nd Quarter 2004/2005	86	3	88
3rd Quarter 2004/2005	83	89	171
4th Quarter 2004/2005	78	172	249
1st Quarter 2005/2006	81	250	330
2nd Quarter 2005/2006	79	331	409
3rd Quarter 2005/2006	79	410	488
4th Quarter 2005/2006	81	489	569
1st Quarter 2006/2007	77	570	646
2nd Quarter 2006/2007	74	647	720
3rd Quarter			

Data input | Lists | Data analysis | Sheet2

Draw AutoShapes

Ready NUM

Start Microsoft Excel - Anti... 12:37

The most current quarterly data could be downloaded and pasted to the bottom of the current list to save the time taken to update graphs.

Quarter Lookup Table

The Quarter Lookup Table identified the start and end row of each quarterly dataset pasted into the total items column within the total medication list with use of the COUNTIF function. The Quarter Lookup Table was used as a reference table to facilitate the creation of VLOOKUP formula for each quarter, as shown in Figure 11.

Figure 11: A screen capture of the Quarter Lookup Table

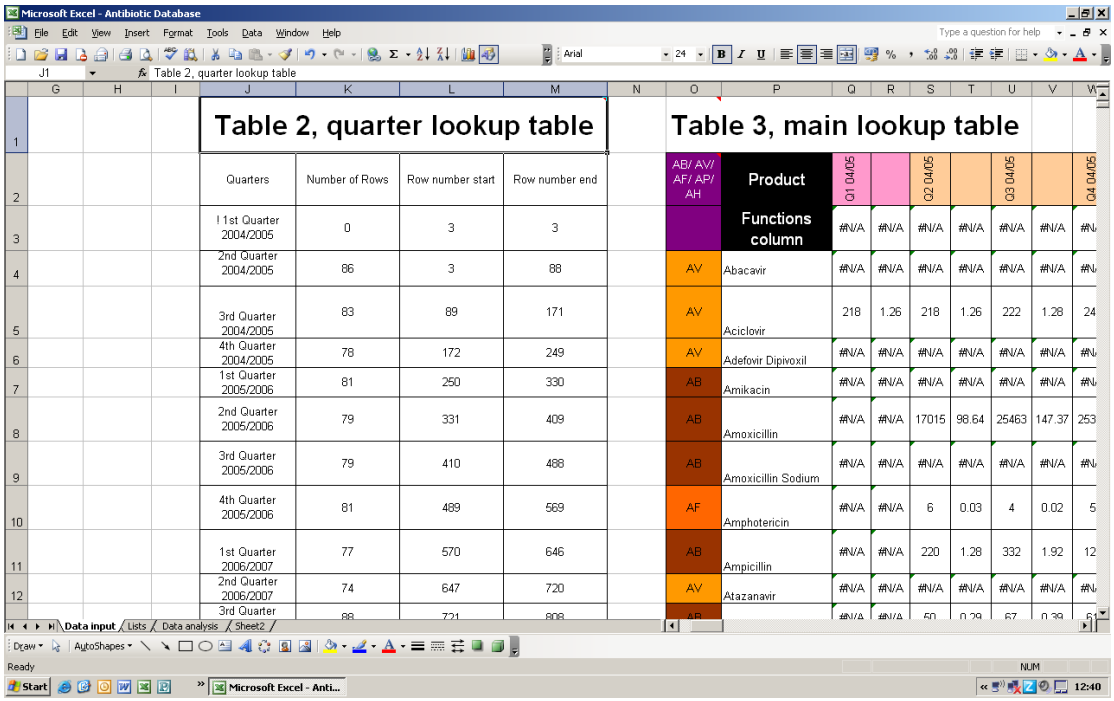
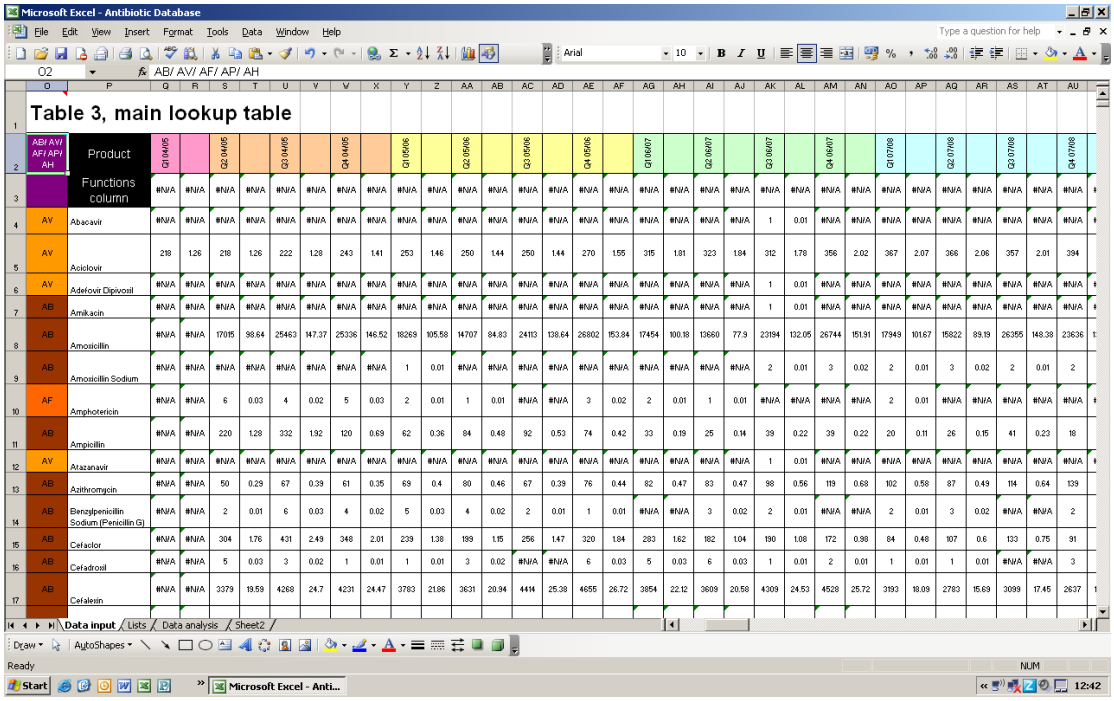


Figure 11 shows that the Quarter Lookup Table lists data in chronological order. Once new data was pasted into the Total Items Column, the Quarter Lookup Table updated automatically. The number of rows pasted into the Total Items column for each financial quarter was calculated using the COUNTIF function.

Main Lookup Table

The Main Lookup Table contained data for every medication type using two outcome measures, PRESCRIPTION NUMBERS (Total items) and Items per STAR-PU for each quarter in the database (refer to section 1.12.3.4.1 for further explanation of the outcome measures used), as shown in Figure 12.

Figure 12: A screen capture of the Main Lookup Table

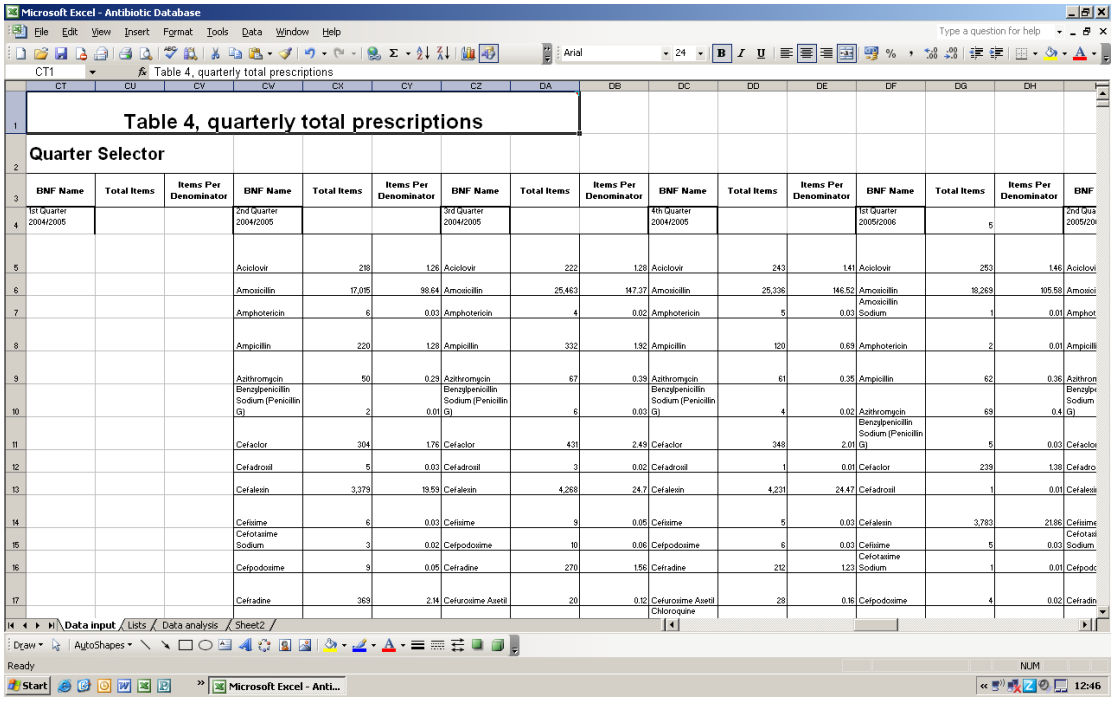


The Total Medication List, Quarter and Main Lookup Tables were used to produce the Summary Graphs present in the database, as shown in Figure 19, section 6.4. This was achieved through the use of the VLOOK-UP functions within Microsoft Excel.

Quarterly Total Prescriptions

The Quarterly Total Prescription Table required the user to paste the downloaded data into the corresponding financial year column. The financial year columns were divided, the first being used for the BNF name of the chemical substance prescribed and the second column being used for the number of times the chemical substance had been prescribed within a given quarter, see Figure 13.

Figure 13: Screen capture of the Quarterly Total Prescriptions Table

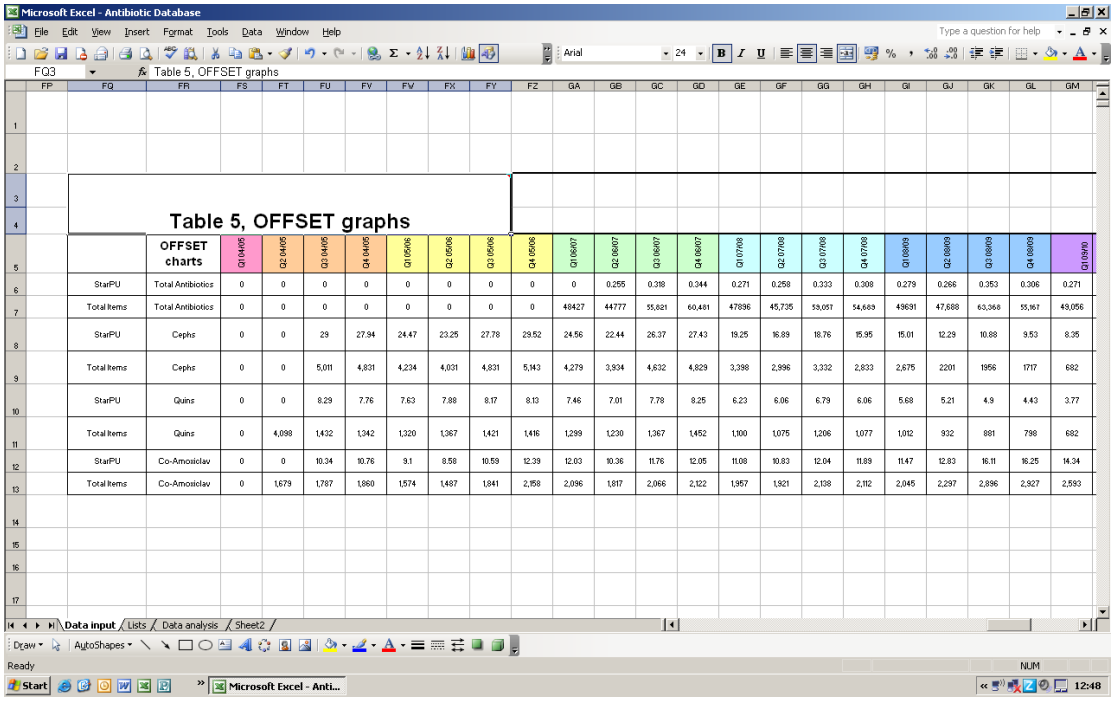


The Quarterly Prescriptions Table was used to display the data within the Prescribing Table of the Database (see Figure 19, section 6.4) and allowed the user to select between different quarters through the use of VLOOKUP, OFFSET and COUNT functions.

Offset Graphs

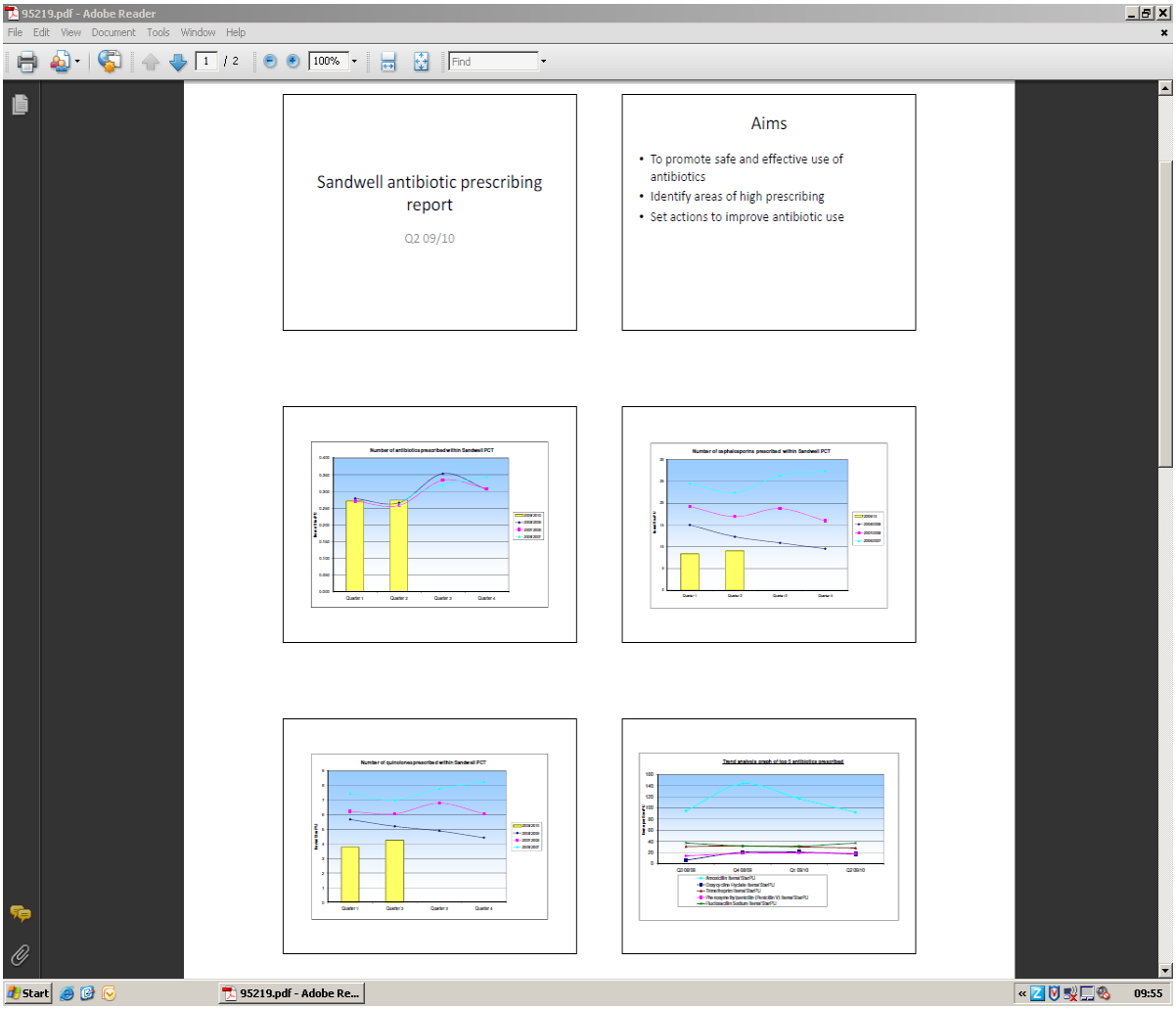
The Offset table contained data for total antibiotics, cephalosporins, quinolones and co-amoxiclav in terms of prescription numbers and Items per STAR-PU. The graphs used an OFFSET function and required the user to paste the required data from ePACT into the table in order to automatically update graphs. See Figure 14 below.

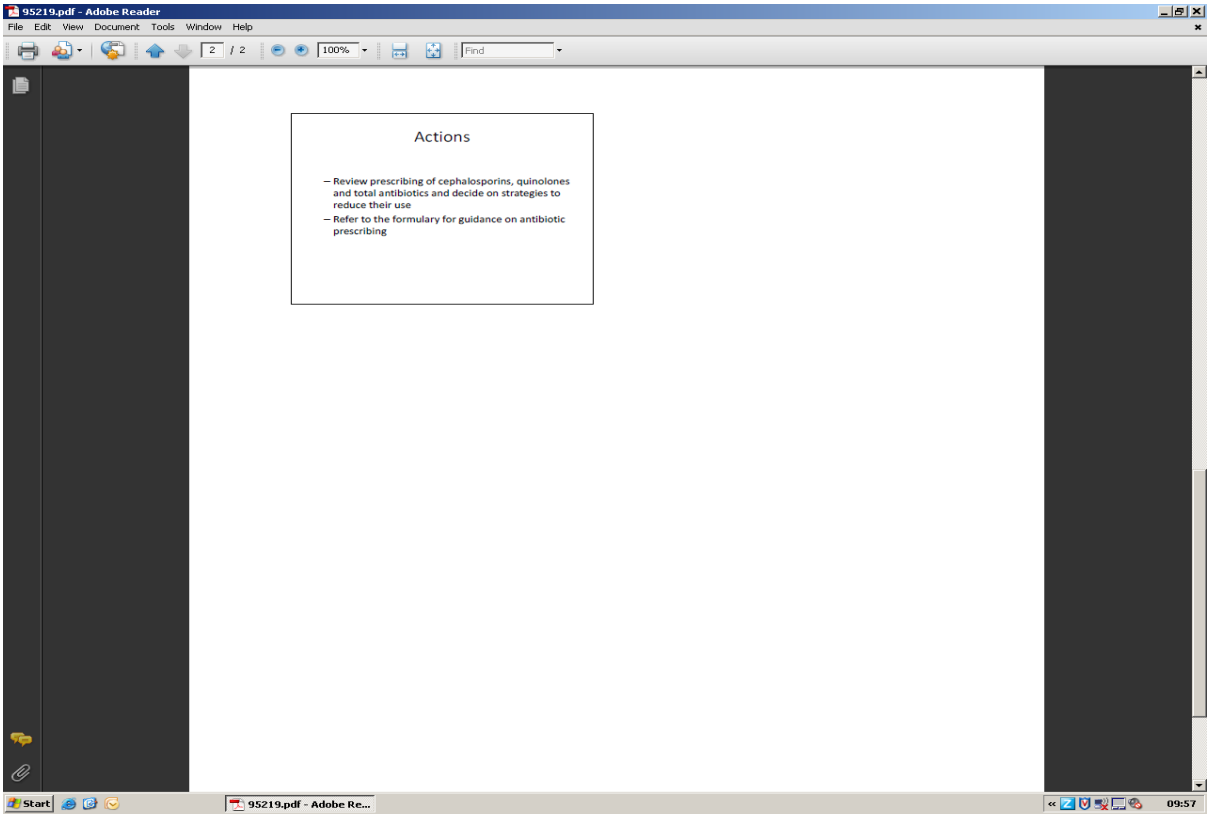
Figure14: Screen capture of the Offset graphs



	OFFSET charts	Q1 04/05	Q2 04/05	Q3 04/05	Q4 04/05	Q1 05/06	Q2 05/06	Q3 05/06	Q4 05/06	Q1 06/07	Q2 06/07	Q3 06/07	Q4 06/07	Q1 07/08	Q2 07/08	Q3 07/08	Q4 07/08	Q1 08/09	Q2 08/09	Q3 08/09	Q4 08/09	Q1 09/10
StarPU	Total Antibiotics	0	0	0	0	0	0	0	0	0	0.255	0.318	0.344	0.271	0.259	0.333	0.308	0.279	0.266	0.353	0.306	0.271
Total Items	Total Antibiotics	0	0	0	0	0	0	0	0	46427	44777	55,821	60,481	47896	45,735	59,051	54,669	49691	47,688	63,368	55,167	49,056
StarPU	Cephs	0	0	29	27.94	24.47	23.25	27.78	29.52	24.56	22.44	26.37	27.43	19.25	16.89	18.76	15.95	15.01	12.29	10.88	9.53	8.35
Total Items	Cephs	0	0	5,011	4,831	4,234	4,031	4,831	5,143	4,279	3,934	4,632	4,829	3,398	2,996	3,332	2,833	2,675	2201	1956	1717	682
StarPU	Quins	0	0	8.29	7.76	7.63	7.88	8.17	8.13	7.46	7.01	7.78	8.25	6.23	6.06	6.79	6.06	5.68	5.21	4.9	4.43	3.77
Total Items	Quins	0	4,098	1,432	1,342	1,320	1,367	1,421	1,416	1,299	1,230	1,367	1,452	1,100	1,075	1,206	1,077	1,012	932	881	798	682
StarPU	Co-Amoxiclav	0	0	10.34	10.76	9.1	8.58	10.59	12.39	12.03	10.36	11.76	12.05	11.08	10.83	12.04	11.89	11.47	12.83	16.11	16.25	14.34
Total Items	Co-Amoxiclav	0	1,679	1,787	1,860	1,574	1,487	1,841	2,158	2,096	1,817	2,066	2,122	1,957	1,921	2,138	2,112	2,045	2,297	2,896	2,927	2,593

Appendix 7: Presentation provided to prescribers at the PLT event




95219.pdf - Adobe Reader
File Edit View Document Tools Window Help
2 / 2
100%
Find
Actions
– Review prescribing of cephalosporins, quinolones and total antibiotics and decide on strategies to reduce their use
– Refer to the formulary for guidance on antibiotic prescribing
Start
95219.pdf - Adobe Re...
09:57

Appendix 8: A standard template of presentation used for surgery visits during Quarter 3 (Autumn/Winter) Financial year 2009/2010

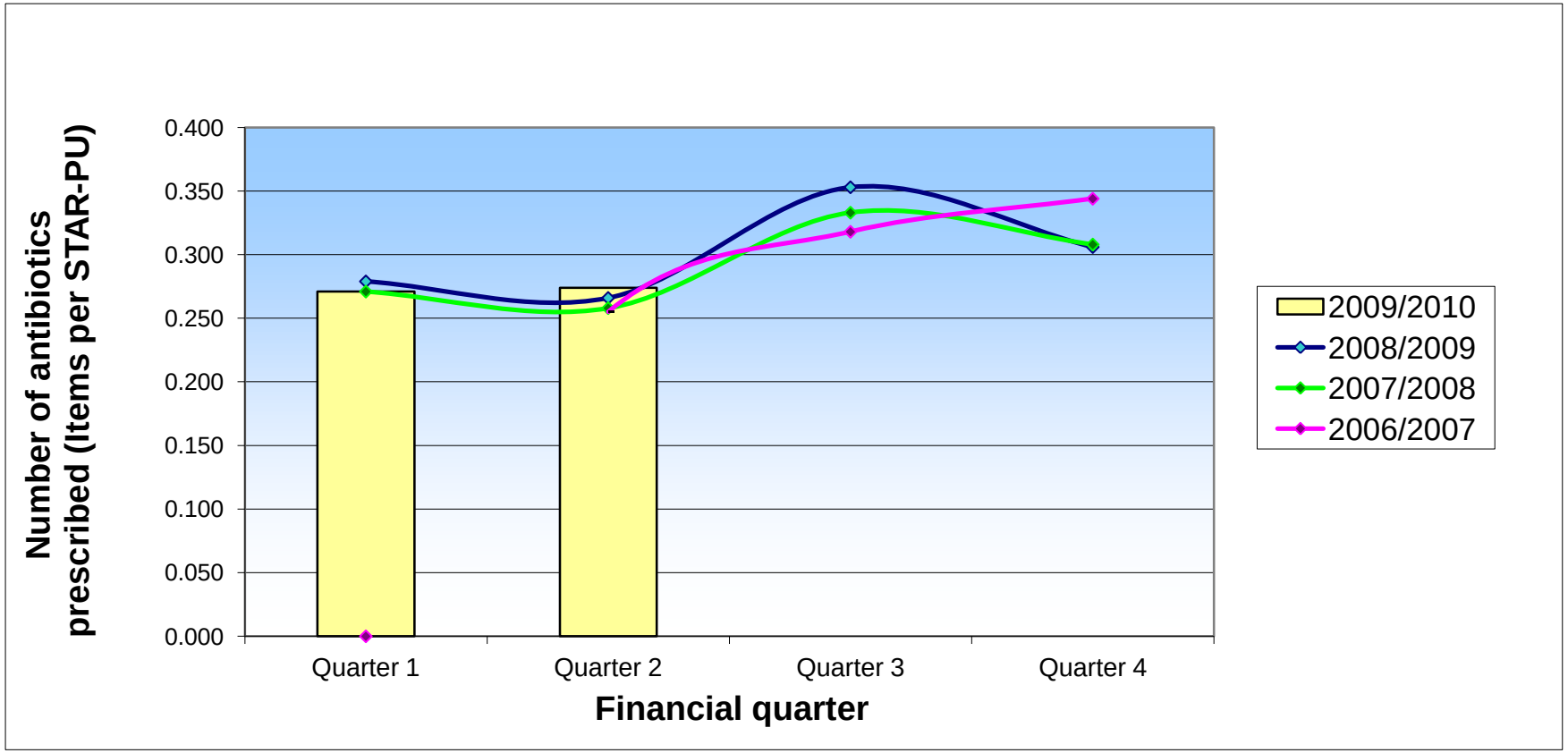
Comparison of Sandwell PCT to SHA and national antibiotic prescribing data

Comparison of Sandwell PCT to SHA and national cephalosporin and quinolone prescribing data

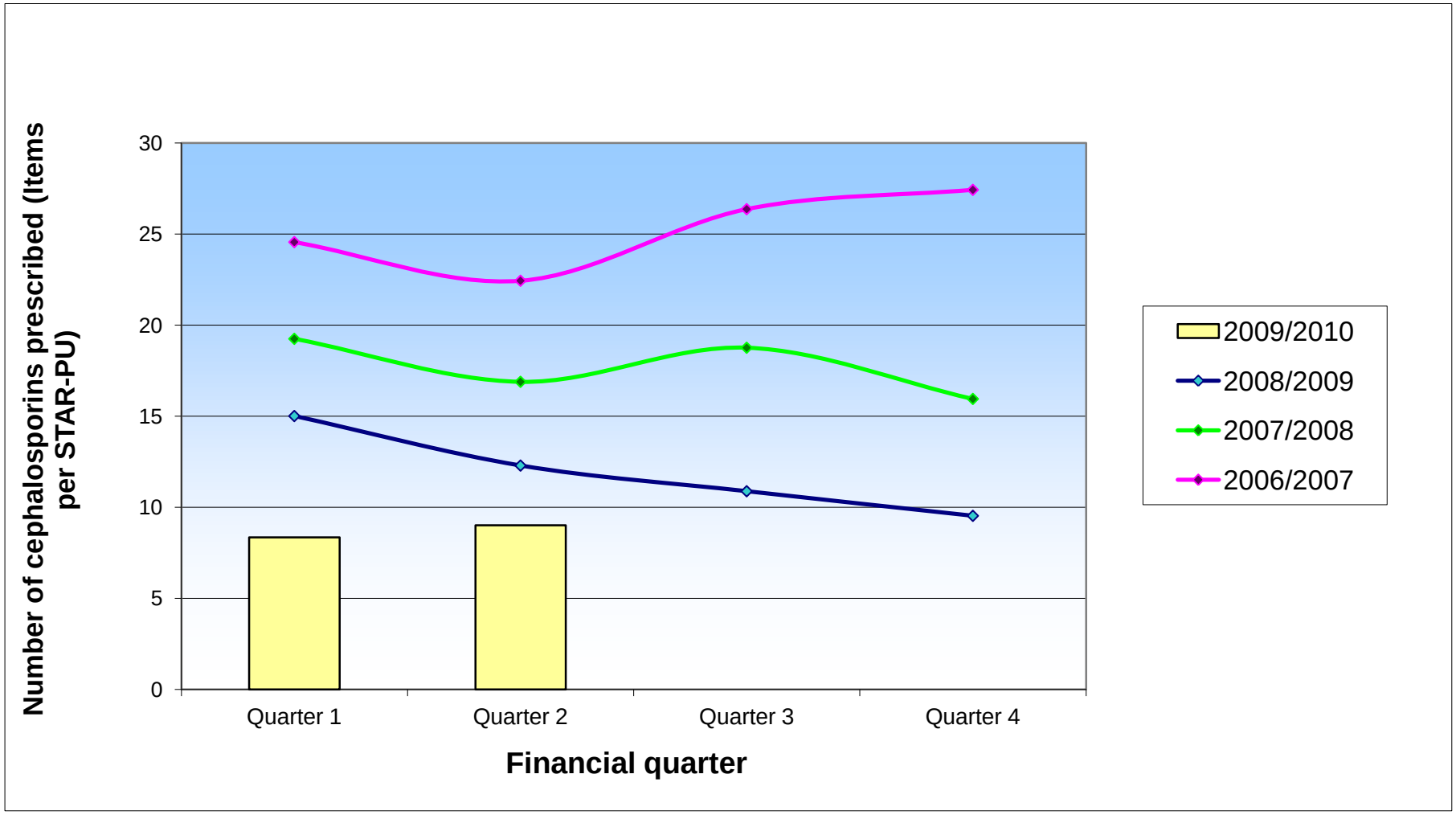
Comparison of antibiotic prescribing data for all Surgeries within Sandwell PCT

Comparison of cephalosporin and quinolone prescribing data for all Surgeries within Sandwell PCT

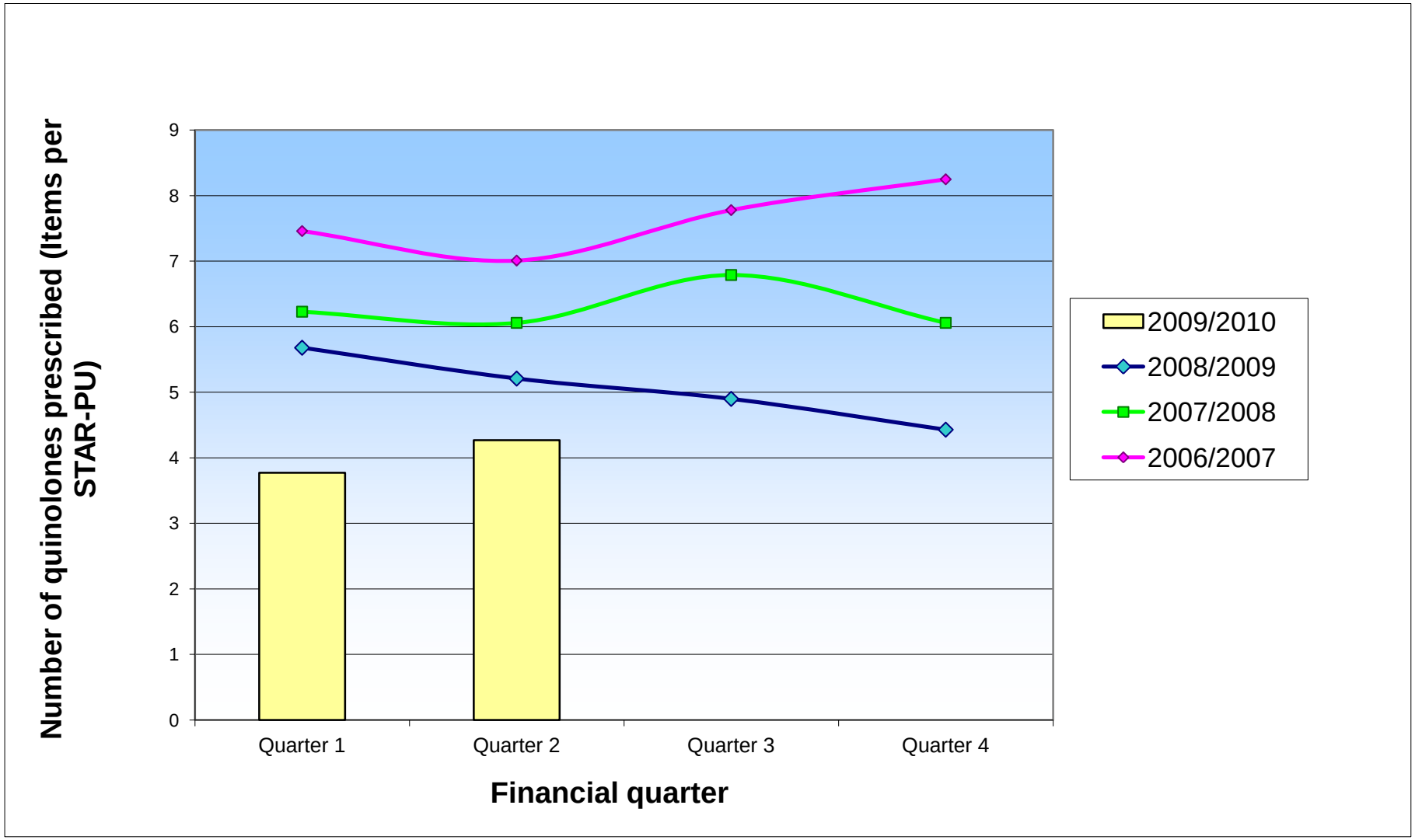
Quarter 3 surgery antibiotic trend analysis graph



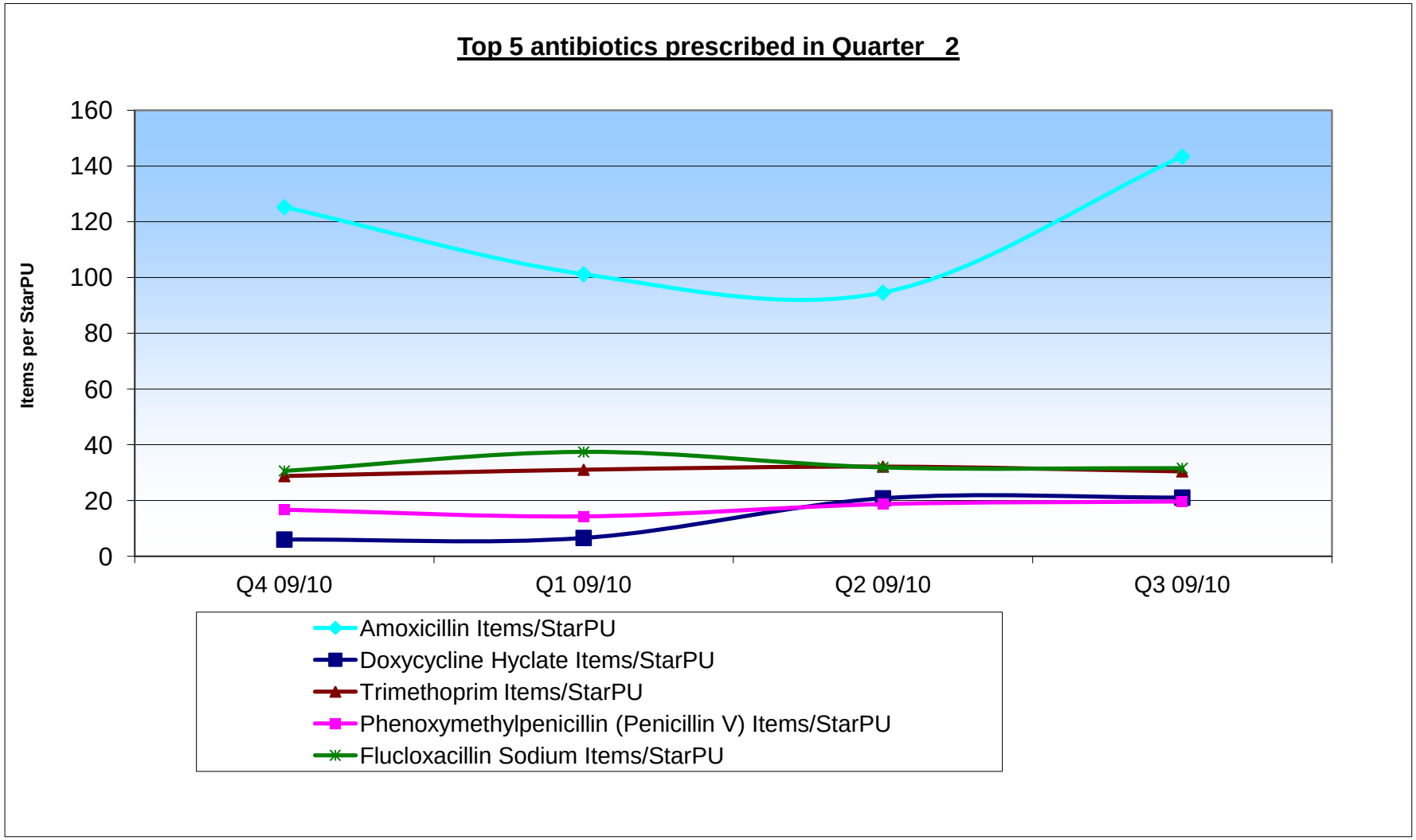
Quarter 3 surgery cephalosporin trend analysis graph



Quarter 3 surgery quinolone trend analysis graph



Top 5 antibiotics prescribed at Surgery X during Quarter 2



Agreed actions

1.

2.

3.