An investigation into the effect of the decision-making process and human factors in prescribing errors within an inpatient mental health setting.

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Abstract

Introduction

Research on the prevalence and causes of prescribing errors has concentrated on the acute sector, with little published in relation to mental health. Studies into dual process theory in healthcare have tended to concentrate on its role in diagnosis and no studies have looked at whether there is a relationship between thinking style and prescribing errors.

The purpose of this research was to investigate the effect of rational and experiential thinking and other human factors on the occurrence of prescribing errors.

Methods

The research was carried out in one mental health trust and consisted of four interrelated elements. Firstly, a prospective, quantitative study investigated the prevalence and nature of prescribing errors. Secondly, semi-structured qualitative interviews were undertaken with a sample of clinicians who had made errors to explore the causes and factors contributing to them. Thirdly, prescribers' decision-making characteristics were profiled using validated scales and the relationship with prescribing errors explored. Finally, the impact of an educational intervention about clinical decision making on prescribing errors was measured.

Key Findings

The overall error rate was 4.6%, with significantly higher rates of prescribing errors observed at those stages in the patient's journey involving transitions of care, (on admission 6.2%; discharge 7.7%), and for early career prescribers, with foundation, core and GP trainees having the highest error rates (≥ 5.6%). A weak, but significant, inverse relationship was found between experience and error rates. Nearly two-thirds of errors (61.1%) were intercepted before any dose was administered and few errors were considered to be potentially severe.

Rule-based mistakes were the most common, and all prescribers reported that they were unaware of their error(s) until contacted as part of the research. Factors cited by interview participants were generally similar to those found in previous studies, however some factors raised had not been identified in previous research. Electronic

prescribing is more commonly used in acute trusts, particularly teaching hospitals; as a result, junior doctors may enter a psychiatry rotation with little or no experience of using paper drug charts. Furthermore, despite the recommendation of the EQUIP study for a standard national drug chart across the NHS, individual trusts continue to use drug charts that vary widely which can contribute to errors due to both design and lack of familiarity. Lack of access to information about a patient's primary care medication regimen, compounded by the tendency of community pharmacists to label the secondary, outer container of medicines such as inhalers, also contributed to prescribing errors. Access to the Summary Care Record for all prescribers would help prevent such errors, particularly out-of-hours, when other resources such as the GP surgery and hospital pharmacy team are not available.

Participants generally demonstrated a preference for rational thinking and a tendency to organise, abstract and evaluate information. No statistically significant relationship was found between performance on any of the decision-making scales used and prescribing errors. An educational intervention on clinical decision making did not result in a reduction in prescribing errors.

Conclusions

It is likely that multifaceted interventions are needed to improve the quality of prescribing and reduce errors. These should be designed to target both the rational and experiential processing preferences of individuals. An educational approach which addresses the theory of clinical decision making, error-prone types of prescribing, and systems to support prescribing reduce errors, should be accompanied by on-going feedback on prescribing errors to facilitate learning. Clinical and educational tutors have a crucial role to play in reinforcing the importance of prescribing as a clinical task and strategies to minimise errors.

Declaration

Whilst registered as a candidate for the above degree, I have not been registered for any other research award. The results and conclusions embodied in this thesis are the work of the named candidate and have not be submitted for any other academic award.

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Abbreviations and Glossary

ADE	Adverse Drug Event
ADR	Adverse Drug Reaction
ASHP	American Society of Hospital Pharmacists (now American Society of Health-System Pharmacists)
BD	*bis in die*, twice daily
BMA	British Medical Association
BNF	British National Formulary
BPS	British Pharmacological Society
CAMHS	Child and Adolescent Mental Health Services
CEST	Cognitive-Experiential Self Theory
CPOE	Computerised physician order entry (i.e. electronic prescribing)
CRT	Cognitive Reflection Test
DHSC	Department of Health and Social Care (formerly Department of Health)
EP	Electronic Prescribing
EPMA	Electronic Prescribing and Medicines Administration (i.e. closed loop system)
EPUT	Essex Partnership University NHS Foundation Trust
EWTD	European Working Time Directive
fMRI	Function Magnetic Resonance Imaging
Foundation trainee	Doctor in their first or second year after medical school
GMC	General Medical Council
GP	General Practitioner
GPhC	General Pharmaceutical Council
IRAS	Integrated Research Application System
Leave	Period during which the patient is away from hospital but still classified as an in-patient. Usually a short visit home, for example over a weekend, to assess how the patient will cope following discharge
Medication order	The order for supply and/or administration of a single medicine
MHA	Mental Health Act
MHAU	Mental Health Assessment Unit
NCC MERP	National Coordinating Council for Medication Error Reporting and Prevention
NCS	Need for Cognition Scale (also abbreviated to NFC)

NFC	Need for Cognition Scale (also abbreviated to NCS)
NHS	National Health Service
NICE	National Institute for Clinical Excellence (1999 - 2005) National Institute for Health and Clinical Excellence (2005 - 2013) National Institute for Health and Care Excellence (2013 - present)
NIMC	National Inpatient Medication Chart (Australia)
NLRS	National Reporting and Learning System
NMC	Nursing and Midwifery Council
NMP	Non-Medical Prescribers
NPSA	National Patient Safety Agency (now part of NHS Improvement)
PICU	Psychiatric Intensive Care Unit
PID	Personal Identifiable Data
Prescription	May refer to a single medication order, but can also be used to describe all of the medication orders relating to an individual patient
PSA	Prescribing Safety Assessment
RCPsych	Royal College of Psychiatrists
REI	Rational Experiential Inventory
RGG	Research Governance Group (SEPT)
SAS doctor	Staff Grade, Associate Specialist and Specialty doctors
SEPT	South Essex Partnership University NHS Foundation Trust
SFEC	Science Faculty Ethics Committee (University of Portsmouth)
SCR	Summary Care Record
Specialty trainee	Doctor who has completed foundation training and is undertaking training in a specialised area of medicine. Sometimes referred to as a registrar or specialty registrar.
SSRI	Selective Serotonin Re-uptake Inhibitor (class of antidepressant)
TTA	‘to take away’, also known as TTO (‘to take out’); discharge medication
UK	United Kingdom
US	United States
USP	US Pharmacopeia
WHO	World Health Organisation

Acknowledgements and dedication

"It is a capital mistake to theorise before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."

Sherlock Holmes,
(Arthur Conan Doyle, 1891. *A Scandal in Bohemia*)

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Dissemination

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Scott H. Brown D, Herrera H. Prevalence and nature of prescribing errors in a mental health setting: initial analysis of a prospective study. Oral presentation at the Health Services Research & Pharmacy Practice Conference 2018.

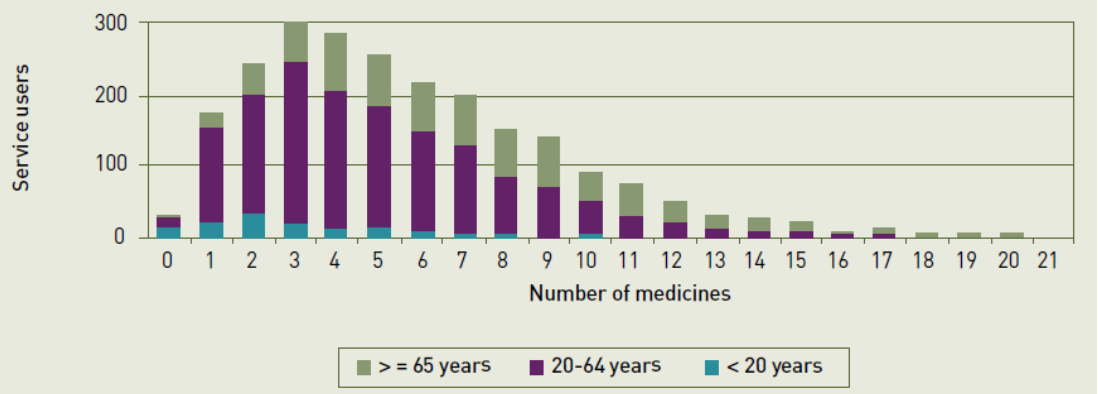
Scott H, Brown D, Herrera H. Prevalence and nature of prescribing errors in a mental health setting: initial analysis of a prospective study. Int J Pharm Pract. 2018; 26(Suppl 1):13.

Chapter 1. Introduction

1.1 Background and context

Medicines play a significant part in the care of patients with mental health problems. The vast majority (around 85%) of patients with a mental health problem will be prescribed medication for their condition.[1,2] Almost half of mental health patients will have been prescribed a new medication during the previous twelve month period.[2] Patients with the most complex mental health needs are more likely to require time in hospital; use of medicines in this group of patients is higher at approximately 99%, with more than 90% of patients taking two or more medicines.[1]

Figure 1.1, which shows the results of a ward-level audit of medication use, demonstrates that whilst the modal number of medicines taken by patients was three, a large number of patients were taking many more than this; older people represented a greater proportion of those taking high numbers of medicines.



Source: 2005/2006 medicines management review audit of clinical pharmacy services[1]

Figure 1.1: Number of medicines taken by service users admitted to mental health wards

Globally, medication errors are estimated to cost US$ 42 billion each year.[3] In 2017 the World Health Organisation (WHO) launched its third Global Patient Safety Challenge which addresses medication safety and aims to reduce the global level of severe, avoidable harm due to medication by 50% over the next 5 years. The WHO highlights that errors occur when weak medication systems and/or human factors affect the various stages of the medication pathway, including prescribing, and that such errors can result in severe harm, disability, and death.[4,5] To support the WHO campaign the Department of Health and Social Care (DHSC) commissioned a rapid review of the evidence base on medication errors in England,[6] and established a short life working group.[7] The rapid literature review estimated that in England, 237 million

medication errors occur at some point in the medication use process each year, of which 21.3% are prescribing errors, and 20% occur in secondary care.[6]

1.1.1 Prescribing errors

Six to ten per cent of acute hospital admissions are thought to be drug-related,[8–10] and between 2005 and 2010 over 526,000 reports of medication errors were made to the National Reporting and Learning System (NLRS).[11] Studies looking at the incidence of medication errors have found that adverse incidents due to drugs most commonly occur during the prescribing stage, involving the wrong dose, wrong drug choice, prescribing when a known allergy is present, wrong frequency and drug-drug interactions.[12–16] It has been estimated that more than four million prescribing errors occur in secondary care in England each year.[6] A significant proportion are preventable, with the likelihood of an incident having been preventable being greater for more serious incidents.[12]

Nearly one-fifth of the errors reported to the NLRS related to the prescribing of medicines.[11] A systematic review of the literature on the prevalence, incidence and nature of prescribing errors in hospital inpatients identified that errors occurred in a median of 7% of medication orders, affecting 2% of patient days and 50% of hospital admissions, although a lack of standardisation between the definitions and data collection methods used in different studies made it difficult to combine data confidently.[17] Data collected in 20 acute hospital trusts, as part of the EQUIP study commissioned by the General Medical Council (GMC), identified a mean error rate of 8.8% across all grades/types of prescribers, with the highest error rates observed in Foundation Year 2 (FY2) doctors.[18,19] Other studies have also identified that most prescribing errors are made by junior medical staff, however, this may also reflect the fact that they are responsible for the majority of prescribing.[14,20]

Prescribing errors are therefore a common problem with the potential to affect patient safety. However, understanding the epidemiology of such errors is problematic due to poorly defined numerators and denominators, and a range of designs, methods and error definitions.[21,22] Aronson and Ferner proposed definitions and a classification system for medication errors based on psychological principles with three broad types: knowledge-based and rule-based errors (‘mistakes’), action-based (‘slips’) and memory-based errors (‘lapses’). These fit with the model of human error types described by Reason.[23] Aronson also distinguished between faults which occur during the decision-making process involved in deciding what to prescribe and naming it, involving irrational, inappropriate or ineffective prescribing, over-prescribing and

under-prescribing; and those that are made during the act of writing a prescription, describing these as 'prescribing faults' and 'prescription errors' respectively.[24] Dean *et al* used a two-stage Delphi technique to arrive at a practitioner-led definition of a prescribing error which was tested against a number of clinical scenarios.[25]

Issues identified as contributing to prescribing errors include factors relating to organisation and management, working environment, team, task, patient, individual, defences built into systems[13,18,19,26,27] calculations, use of units, nomenclature, and characteristics relating to the declining patient[16] as well as themes relating to learning curves and use of knowledge, taking instruction and patient safety.[28]

Research into the prevalence, incidence, and nature of adverse drug events and drug-related hospitalisation has been taking place since the 1960s.[29] In 1962 in the US, Barker and McConnell published what was arguably the first study which demonstrated that medication errors occurred more frequently than anticipated.[30] Whilst literature at that stage mainly focused on errors involving the administration of medicines, in 1975 a UK study of hospital inpatient prescription charts demonstrated that 36% of prescriptions contained at least one prescribing error of either drug use or prescription writing.[31] A decade later Betz and Levy proposed an interdisciplinary method for classifying medication errors by type and practitioner group, to allow monitoring and performance improvement by prescribers and pharmacists.[32]

However, it is only in the last two decades that the role of negligence and errors in relation to medication-related patient safety has received much attention. During the 1990s a series of studies were published which raised interest in the issue of patient safety. The Harvard Medical Practice Study, a study of medical injury and malpractice litigation published in 1991, demonstrated that adverse events and injuries caused by medical care occurred in 3.7% of admissions and that 27.6% of the adverse events were due to negligence,[33] with drug complications the most common type of adverse event (19%), with 8.9% due to errors, and 52.8% judged to be negligent.[34] Results on a similar scale were found in further studies published during the 1990s for hospital patients in New South Wales and South Australia,[35] Utah and Colorado,[36] and London.[37,38]

During the same period, a number of researchers including Bates,[12,39–41] Classen[42,43] and Lesar[16,20,44,45] in the US started to investigate the incidence of adverse drug events, potential adverse drug events, medication errors and prescribing errors, followed towards the end of the decade by Dean and Barber in the UK.[46]

As the 1990s progressed professional interest in patient safety increased. Whereas at the beginning of the decade the editor of the *British Medical Journal* had been criticised for suggesting the need for a study of the incidence of adverse events,[47] in 2000 the journal published an entire themed issue on patient safety,[48] including a key article about human error and the systems approach to accident causation by James Reason.[49]

In 1999 the US Institute of Medicine report *To Err is Human* increased public, professional and political awareness of patient safety.[50] In the UK, the Chief Medical Officer published *An Organisation with a Memory*, the report of an expert group on learning from adverse events in the NHS, which stressed the need to understand the underlying causes of adverse events and learn from them, and drew parallels with other high risk industries which had improved safety records.[51]

This report was followed in 2001, with two implementation documents setting out the Government's plans for promoting patient safety. The first, *Building a Safer NHS for Patients*, set out the blueprint for a new national system for learning from adverse events and near misses (the NRLS), created the National Patient Safety Agency (NPSA) and provided clarity on investigations into major service failures, serious public concerns, and complaints by patients. The report also targeted a number of areas for specific action, including a reduction of 40% in the number of serious errors in the use of prescribed drugs by the end of 2005.[52] In 2004, the Chief Pharmaceutical Officer published a supporting report exploring the causes and frequency of medication errors. highlighting drugs and clinical settings that pose a particular risk, and identified models of good practice to reduce risks.[53]

It is against this backdrop that work to improve patient safety related to the use of medicines, and specifically prescribing errors has continued to develop since the beginning of this century.

1.1.2 Clinical decision making

Clinical decision making, or clinical reasoning, has been extensively studied by health professionals, education specialists, cognitive psychologists, and sociologists over the last 40 years. It is an essential aspect of professional practice, encompassing the evaluation and management of a patient's medical problem, and a major determining factor in clinical competence.[54] However, as noted by Maskrey *et al*, whilst healthcare professionals seek to become excellent decision makers, neither undergraduates nor postgraduates are exposed to the evidence about how humans make decisions.[55]

Although a small number of studies have looked at clinical decision making in the context of prescribing decisions,[56–61] the majority of work in the healthcare field has concentrated on diagnostic decision making rather than therapeutic management.

A series of papers on human judgement published in the 1960s and 1970s by Tversky and Kahneman extend beyond academic psychology across a range of disciplines including medicine. Inspired by biased real-world judgements, they challenged the previously held view that rational choice was based on an assessment of the probability and utility of all possible outcomes.[62] At a similar time, Simon was challenging the view that such full rationality was an unrealistic expectation given the processing limitations of the human mind, describing what became known as "bounded rationality".[63] Tversky and Kahneman proposed that judgement was subject to mental "short-cuts" or "rules of thumb", termed heuristics, that may produce systematic biases[64] and which are associated with intuitive judgement.[62] However, researchers disagree about the reliability of intuition and the degree to which heuristics lead to errors.[54,64,65] On one side of the debate, work by Croskerry, Graber and others has shown that use of cognitive heuristics may contribute to errors[66–69] On the other, work by Eva and Norman has suggested that heuristics can lead to a decrease in diagnostics errors and that they should not necessarily be considered a bad thing.[70–73] As both sides provide examples in which heuristics have led to more or less errors, it has been suggested that the research agenda needs to move forward beyond this debate to identify factors that improve accuracy.[65]

1.2 Thesis outline

This thesis consists of seven chapters. Following the introduction, chapter one provides a review of the literature and theory relating to prescribing errors and clinical decision making, including the historical context, definitions, terminology and epidemiology of prescribing errors, human error theory and causes of prescribing errors. Chapter two describes the methods used in all four sections of this study, whilst the results and implications of each section of the study are presented in chapters three to six. Chapter seven summarises the key findings, discusses what the research adds, along with its strengths and limitations, and makes recommendations for future work.

1.3 Definitions and terminology

Studies have reported widely varying rates of medication errors.[17] Although these differences may be partially explained by the setting of the study, nature of the

population, specialty, or health system studied, differences in the definitions and terminology used as well as methods of data collection have a significant impact on the reported prevalence of medication errors.[74] As well as many individual interpretations of the same terms, multiple terms are also used for the same situation. For example the terms “near miss”, “potential adverse drug event” and “potential error” appear to be used interchangeably; whilst the term “near miss” can be used to refer both to an error that was intercepted before it reached the patient and one that reached the patient but did not cause patient harm.[75]

In 2005, Yu *et al* explored the differences in functional meaning of medication safety terms defined on the websites of 33 organisations involved in medication safety.[75] Little uniformity was seen between organisations’ definitions of the same or related terms. The greatest diversity was seen with the group of terms representing ‘near miss’, with 12 definitions remaining even after similarly worded definitions were combined. The authors applied these 12 different definitions to four clinical scenarios involving a penicillin hypersensitivity reaction in order to determine the functional meaning of each definition. The same two scenarios were considered to fit within ten of the definitions. Only one scenario was considered to fall within each of the remaining two definitions, but in each case the included scenario was different. Therefore, three functional meanings were identified from the scenario assignments. This demonstrates the practical difficulties for clinicians and researchers in deciding whether or not an incident involving medication meets a particular definition, which has operational implications for incident reporting systems and highlights the importance of arriving at a universal language when communicating issues of medication safety.

Five years later, Lisby *et al* published a systematic review of studies in hospital settings relating to medication errors or adverse drug events (ADEs).[74] The researchers identified 203 potentially eligible studies relating to medication errors and ADEs; only 45 of which contained a generic definition of medication error, although a further 34 contained stage-specific error definitions relating to the tasks of prescribing, dispensing or administration. Surprisingly, the vast majority of studies (124/203; 61%) gave no definition. Of the 45 definitions, 26 differed in wording and/or content. In 15 the word ‘error’ occurred in the definition; yet one of the essential attributes of a definition is that it avoids circularity. A further 10 used the words ‘failure’ or ‘deviation’ whilst 17 studies used the definition developed by the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP).[76]

In 2012, Pintor-Marmol *et al* published a further systematic review of original studies and review articles which contained terms used in medication-related patient safety.[77] Sixty terms with 189 different definitions were identified referring to the process of medication use (23 terms), clinical outcomes of medication use (31 terms) or a combination of process and outcome (13 terms). The term most commonly used was medication error (22.7%), and the most frequently used definition of medication error was that proposed by the NCC MERP.[76]

1.3.1 Definition of a medication error

In 1993, as part of guidelines on preventing medication errors, the American Society of Hospital Pharmacists (ASHP) defined medication errors as:

> "*episodes in drug misadventuring that should be preventable through effective systems controls involving, physicians and other prescribers, nurses, risk management personnel, legal counsel, administrators, patients and others in the organizational setting, as well as regulatory agencies and the pharmaceutical industry*."[78]

The guidelines identified a short list of medication error types, but the definition, whilst listing elements of the system which may have a role in the progeny of an error, failed clearly to describe the role of individual practitioner's actions, or the nature and consequences of an error.

Other authors have defined medication errors in terms of a difference between what was ordered and what was administered.[46,79–82] However, these fail to acknowledge that errors may occur in the process of prescribing and dispensing, as well as administration. In addition, were the person administering the drug to correct an error made by the prescriber, for example, to administer 250 micrograms of digoxin when the prescriber incorrectly ordered 250 mg, this would be considered an error with these definitions.

The National Coordinating Council for Medication Error Reporting and Prevention defines a medication error as:

> "*A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication;*

> *product labeling* [sic]*, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use*."[76]

This definition is comprehensive, taking into account all aspects of the processes involved in the use of medicines. The Council recommends that their definition is used by medication errors researchers, software developers, and institutions to identify errors. A systematic literature review of the definitions used in studies relating to medicines errors in hospitals, conducted by Lisby *et al*, found that the majority of the studies which contained a definition (17/45; 38%) used the NCC MERP definition, suggesting that it has been widely adopted, at least by researchers.[74] The NCC MERP definition has now been adopted by the ASHP.[83]

Ferner and Aronson have critiqued many of the existing definitions of medication error,[83,84] including providing a detailed analysis of the essential attributes of a definition, and the methods by which a definition may be derived.[24] They proposed a definition of medication error which is both stipulative and intentional, and has the advantage of being brief:

> "*a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient*."[83]

The treatment process involves the use of any medicinal product for treatment, investigation or prevention of disease or physiological change. Medication errors can occur in any stage of the process involved in choosing a medicine, writing the prescription, manufacturing the formulation to be used, dispensing the product, administering or taking the medicine and monitoring therapy.[85]

However, two systematic reviews which investigated the terminology used in relation to medication errors have found little evidence that the Ferner and Aronson definition is widely used.[74,77] Indeed the only study cited by Pintor-Marmol *et al*[77] as quoting their definition was one of their own articles.[83]

Following their earlier systematic review of medication error definitions used in the literature,[74] Lisby *et al* used a modified electronic Delphi technique to arrive at a consensus definition of medication error.[86] Using five definitions derived from the 45 generic definitions found in the systematic review, and including the Aronson and Ferner[83] and NCC MERP[76] definitions, a panel of experts drawn from 13 Danish healthcare organisation or chosen by the project group, reached consensus on the following definition:

> "*An error in the stages of the medication process - ordering, dispensing, and administering and monitoring the effect - causing harm or implying a risk of harming the patient*"

The expert panel also assessed the relevance as medication errors of 76 contextual or behavioural scenarios taken from the 282 different error type expressions identified during the literature review.[74] Consensus was achieved with the majority of these, resulting in an index of 60 error types. The researchers applied the definition and error type index to the results of a previous study they had undertaken investigating the frequency, type and clinical consequences of medication errors in a Danish hospital.[87] Their original study identified 655 errors in 1,942 opportunities for error (34%). These were classified using a 4-point scale as potentially non-significant, potentially significant, potentially serious, or potentially fatal. As the newly agreed definition required harm or potential harm to have occurred for an incident to be considered a medication error, those incidents which had been categorised as potentially non-significant and potentially significant were excluded. This resulted in a substantial reduction in the error rate to 7% (144/1,942). The authors suggest that the reduction seen in the reported error rate when using this definition and index of error types is of benefit allowing concentration on those errors which have the potential to cause harm.

1.3.2 Other related terms

Various authors have looked at the relationship between adverse events, adverse drug events/reactions and medication errors.[24,40,83,88–91]

Adverse events

An adverse event is an adverse outcome for the patient which, whilst it may occur while a patient is taking a drug, may or may not be attributable to it. Aronson and Ferner proposed the following definition:[88]

> *"An adverse event is any abnormal sign, symptom, laboratory test, syndromic combination of such abnormalities, untoward or unplanned occurrence (e.g. an accident or unplanned pregnancy), or any unexpected deterioration in a concurrent illness."*

Adverse drug reactions (ADRs)

An adverse drug reaction, also sometimes referred to as an adverse drug event (ADE), is an adverse outcome which can be attributed to an action of a drug, with reasonable certainty. All adverse drug events are adverse effects, but not all adverse events are adverse drug events.

Although the WHO definition[92] of an adverse drug reaction is widely accepted, it has been highlighted by some authors as having defects. The inclusion of the word 'noxious' effectively excludes minor adverse effects which may be inconvenient but not harmful, and other definitions have been suggested.[93,94] Aronson and Ferner highlight that the WHO definition and others exclude error as a source of adverse effect, and suggest the following definition:[88]

> *"An appreciably harmful or unpleasant reaction, resulting from an intervention related to the use of a medicinal product; adverse effects usually predict hazard from future administration and warrant prevention, or specific treatment, or alteration of the dosage regimen, or withdrawal of the product".*

Medication error

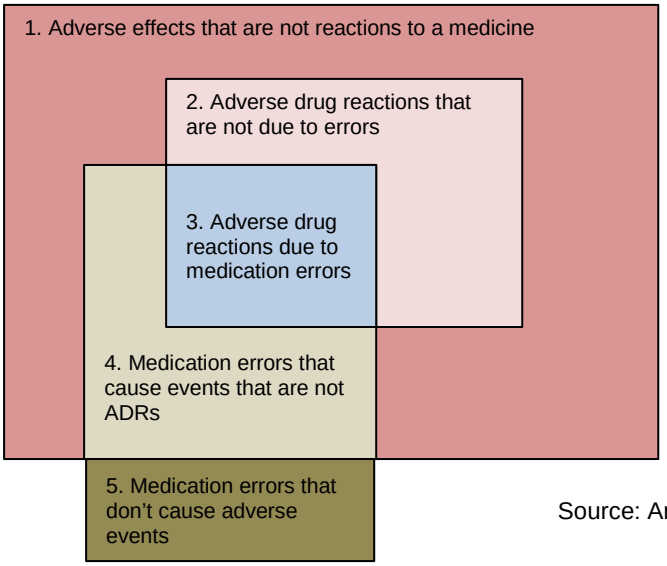
Although multiple definitions have been suggested, the most concise was proposed by Ferner and Aronson:[83]

> *"A medication error is a failure in the treatment process that leads to, or has the potential to lead to, harm to the patient."*

This suggests that the treatment process has fallen below some attainable standard. The treatment process is intended to start from the point of the decision to treat and includes the processes of prescribing, transcribing (where relevant), manufacturing and compounding, dispensing and administration of a drug, and the monitoring of its effect.[24,83]

Medication errors are considered to be preventable, and most do not result in harm to the patient. Errors may be intercepted before they reach the patient, may reach the patient unnoticed, and often go unreported even if they do reach the patient or are considered insignificant.[53] In non-healthcare settings, it has been estimated that there is a ratio of one major injury and 29 minor injuries to 300 no-harm incidents.[95]

The relationship between adverse events, adverse drug reactions, and medication errors is shown in Figure 1.2. Prescribing errors represent a subset of medication errors.



2 + 3 = all adverse drug reactions

3 + 4 + 5 = all medication errors

3 = adverse drug reactions due to medication errors

Source: Aronson & Ferner[24,83,88]

Figure 1.2: The relationship between adverse events, adverse drug reactions, and medication errors

1.3.3 Definition of a prescribing error

In order to be able to compare published evidence concerning the prevalence, incidence, and nature of prescribing errors consistent terminology is necessary. In a systematic review of literature from 1985 to 2007, Lewis *et al* identified 63 publications, detailing 65 unique studies, which reported on the detection and rate of prescribing errors in adults and/or child hospital inpatients.[17] Nearly a quarter of these (15/65; 23%) provided no definition of prescribing error, whilst nearly half (27/65; 42%) developed their own definition or modified definitions used in other studies. The most commonly used definition was that developed by Dean *et al*,[25] which was used in 11 of the studies (17%).

Dean *et al* used a two-stage Delphi technique[96,97] to arrive at a practitioner-led definition of a prescribing error which was tested against a number of clinical scenarios. A panel of physicians (9), surgeons (3), pharmacists (12), nurses (7), clinical pharmacologists (2) and an anaesthetist was purposively selected to include a wide range of healthcare professionals of different grade and clinical specialty. Individuals were also included based on their expertise in risk management or involvement in the study of prescribing errors. Use of the Delphi technique maximised the opportunity to identify consensus using a structured but flexible approach, without the problems which can be associated with group decision making where the views of one or two participants dominate.[98] The views of each panel member have equal weighting and each participant is anonymous to the rest of the panel.

Each panel member was asked to rate, using a numerical scale, a preliminary definition of prescribing error developed by the researchers and to suggest improvements. The median score (7.0) and interquartile range (6.5 - 8.0) suggested acceptance of the researchers' preliminary definition. Panel members' comments could be divided into three categories: whether prescribing decision-making errors should be included or considered part of the broader concept of clinical decision making; use of the word "significant" and differentiation between clinically meaningful errors and optimisation of treatment; and the need for a comparator when considering the risk of harm.

Having taken the panel's comments into account their finally adopted definition of a prescribing error was:

> "*A clinical meaningful prescribing error occurs when, as a result of a prescribing decision or prescription writing process, there is an unintentional, significant (1) reduction in the probability of treatment being timely and effective or (2) increase in the risk of harm when compared with generally accepted practice*".

Panel members were also asked to indicate agreement on whether or not 42 general scenarios represented a prescribing error. These were based on incidents from previous prescribing error studies and included a range with incident types that had been included in some studies but excluded from others and some with potential ambiguity. Panel members were asked to justify or qualify the scores they assigned with text. This first stage of the Delphi process resulted in consensus for 11 of the scenarios.

In the second stage, panel members were asked to re-score those scenarios where no consensus had been reached. They were provided with the comments made by other panel members, and the median score and interquartile range for each scenario. This second stage resulted in consensus for a further 25 scenarios and partial agreement for the remaining six. The 27 situations that should be included as prescribing errors, seven which may be prescribing errors depending on the individual clinical situation, and eight that should not, are shown in Table 1.1, Table 1.2 and Table 1.3 respectively. Those situations which were considered to be prescribing errors involved prescribers not taking into account the patient's clinical status or pharmaceutical issues, failing to communicate essential information, or making transcription errors.

Table 1.1: Situations that should be considered prescribing errors

Scenario	
Errors in decision making	**Prescription inappropriate for the patient**
	Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, that drug is contraindicated
	Prescription of a drug to which the patient has a documented clinically significant allergy
	Not taking into account a potentially significant drug interaction
	Prescribing a drug in a dose that, according to the British National Formulary or data sheet recommendations, is inappropriate for the patient's renal function
	Prescribing a drug with a narrow therapeutic index, in a dose predicted to give serum levels significantly above the desired therapeutic range
	Writing a prescription for a drug with a narrow therapeutic range in a dose predicted to give serum levels significantly below the desired therapeutic range
	Not altering the dose following steady-state serum levels significantly outside the therapeutic range
	Continuing a drug in the event of a clinically significant adverse drug reaction
	Prescribing two drugs for the same indication when only one of the drugs is necessary
	Prescribing a drug for which there is no indication for that patient
	Pharmaceutical issues
	Prescribing a drug to be given by intravenous infusion in a diluent that is incompatible with the drug prescribed
	Prescribing a drug to be infused via an intravenous peripheral line, in a concentration greater than that recommended for peripheral administration
Errors in prescription writing	**Failure to communicate essential information**
	Prescribing a drug, dose or route that is not that intended
	Writing illegibly
	Writing a drug's name using abbreviations or other non-standard nomenclature
	Writing an ambiguous medication order
	Prescribing "one tablet" of a drug that is available in more than one strength of tablet
	Omission of the route of administration for a drug that can be given by more than one route
	Prescribing a drug to be given by intermittent intravenous infusion, without specifying the duration over which it is to be infused
	Omission of the prescriber's signature
	Transcription errors
	On admission to hospital, unintentionally not prescribing a drug that the patient was taking prior to their admission
	Continuing a GP's prescribing error when writing a patient's drug chart on admission to hospital
	Transcribing a medication order incorrectly when rewriting a patient's drug chart
	Prescribing "milligrams" when "micrograms" was intended
	Writing a prescription for discharge medication that unintentionally deviates from the medication prescribed on the inpatient drug chart
	On admission to hospital, writing a medication order than unintentionally deviates from the patient's pre-admission prescription

Source: Dean *et al*[25]

The panel members identified a number of situations where the individual patient's clinical situation was a deciding factor in whether a prescribing error had occurred or not. The role of conscious decision making and a reasoned rationale in arriving at the medication order was of particular importance, along with its potential consequences.

Table 1.2: Situations that may be considered prescribing errors, depending on the individual clinical situation

Scenario
Prescribing a drug in a dose above the maximum dose recommended in the British National Formulary or datasheet
Misspelling a drug name
Prescribing a dose that cannot readily be administered using the dosage forms available
Prescribing a dose regime (dose/frequency) that is not that recommended for the formulation prescribed
Continuing a prescription for a longer duration than necessary
Prescribing a drug that should be given at specific times in relation to meals without specifying this information on the prescription
Unintentionally not prescribing a drug for a clinical condition for which medication is indicated

Source: Dean *et al*[25]

For example, the panel suggested that major misspelling of a drug, where there was a risk of ambiguity, should be a prescribing error, whereas minor misspelling should not. Other researchers have quantified this by considering misspelling to be a prescribing error if two or more letters are incorrect.[99–101]Non-adherence to local or national guidelines or the drug's product licence were not considered prescribing errors.

Table 1.3: Situations that should be excluded as prescribing errors

Scenario
Prescribing by brand name (as opposed to generic name)
Prescribing a drug without informing the patient of its uses and potential side effects
Prescribing a drug for which there is no evidence of efficacy because the patient wishes it
Prescribing for a child a drug that has no product license for use in children
Prescribing a drug that is not in the hospital formulary
Prescribing contrary to hospital treatment guidelines
Prescribing contrary to national treatment guidelines
Prescribing for an indication that is not in a drug product's license

Source: Dean *et al*[25]

Ferner and Aronson[24,83,102] were critical of the use of the Delphi technique to arrive at a definition, highlighting that it was designed to predict events rather than decide facts, is a "form of committee" and "allows consensus … by attrition". However as Avery *et al* pointed out, validity is provided to the definition by its development involving the consensus of professionals, and it does not lack the credibility of some definitions, such as that of Betz and Levy[32] which includes as a prescribing error "prescribing a medication without sufficient education of the patient" which would not be recognised by most practitioners. Ferner and Aronson also suggested that by including "clinically meaningful" in their definition, Dean *et al* were excluding errors which occurred during the decision-making or prescription writing process but do not result in harm, highlighting that it is desirable to detect all errors so that they can be examined for

potential systems weaknesses, which on another occasion may lead to a clinically relevant outcome. However, inclusion in their definition of the terms “reduction in the probability…” and “increase in the risk…” suggest that Dean *et al* intended it to include no-harm errors, and this is reflected in the list of situations which are, or may be, considered prescribing errors.

Ferner and Aronson questioned the appropriateness of comparing against “generally accepted practice” as this may be poor, preferring instead an “attainable standard”.[83] However unless this is defined there is no baseline against which to compare practice. Finally, Ferner suggested that the hope that the definition would be taken up by others had not been realised,[102] basing his claim on a survey of ADE reporting in US intensive care units.[103] However, adverse drug events and prescribing errors are not the same and the requirements of incident reporting and research differ.[104] The 2009 systematic review of research investigating the prevalence, incidence, and nature of prescribing errors in hospital inpatients,[17] identified that the Dean *et al* definition was the most commonly used; albeit in only 17% of studies, and their original paper continues to be regularly cited in more recent articles. In a systematic review of the literature on prescribing errors made by junior doctors, Ross *et al* described this definition as a “strong contender for the ‘ideal’ definition”[21].

1.4 The epidemiology of prescribing errors

1.4.1 The prevalence and incidence of prescribing errors

As part of a programme of research commissioned by the GMC (the EQUIP study[18]) into the rates of prescribing errors in hospitals and what might cause them, Lewis *et al* undertook a systematic review exploring the prevalence, incidence, and nature of prescribing errors in hospital inpatients.[17] The authors searched a number of electronic databases for the period from 1985 to October 2007 for studies that reported the rate of prescribing errors in handwritten prescriptions written for adults and/or children. They restricted studies to those published in English but included systematic reviews, comparative and observational studies and abstracts which contained sufficient data to calculate prescribing error rates.

They identified 65 studies, most of which were conducted in the US (25/65; 38%) or the UK (22/65; 34%). Despite performing a literature search covering more than 20 years, more than two thirds of the studies (44/63; 70%) were published during the last seven years of the search period, demonstrating that interest in understanding the nature and scale of prescribing errors increased significantly after the publication of key documents[50–53] on the subject of patient safety; this can be seen graphically in

Figure 1.3 which shows the chronological incidence of the studies found. A more recent systematic review of literature published since 2007 identified a further 12 studies investigating prescribing errors in secondary care.[6]

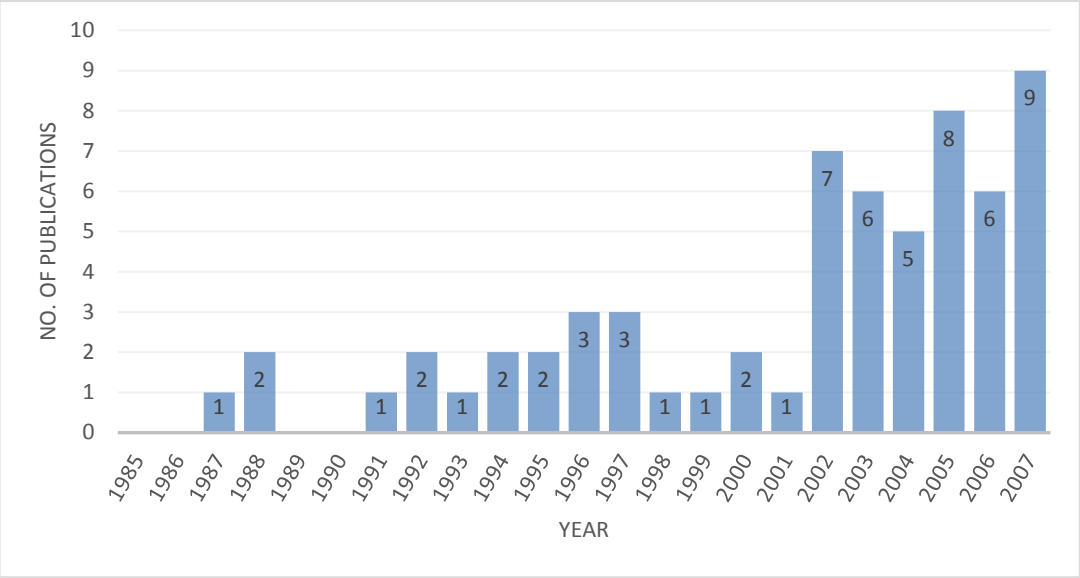


Figure 1.3: Chronological incidence of prescribing error studies cited by Lewis *et al*

Although the studies identified were extremely varied, the authors grouped them by the type of denominator in order to calculate median error rate and interquartile range. Most studies were prospective (58/65; 89%) rather than retrospective (7/65; 11%); and process-based (54/65; 83%), whereby data were collected by healthcare professionals reviewing prescriptions as part of their normal work. Only two studies were wholly outcome-based measuring actual patient harm (2/65; 3%). A proportion included process and outcome-based elements (9/65; 14%).

Most of the studies analysed (33/65; 51%) reported the percentage of erroneous medication orders, with a median of 7% and an interquartile range of 2 - 14%. Just under one third (19/65; 29%) used errors per admission to describe the error rate, with a median of 52 and interquartile range of 8 - 227. The authors highlight that this wide range can be partially explained by the different means used for error detection, with very low rates identified by incident reporting and the highest rate as a result of combining three methods of error detection. Eleven studies (11/65; 17%) reported the incidence of errors in terms of patient days, with a median of 24 errors per 1000 patient days and an interquartile range of 6 - 212. Again, low incidence rates were detected by studies using incident reporting as the collection method.

The study by Lewis *et al* was the first systematic review of the prevalence, incidence, and nature of prescribing errors in hospital inpatients, and demonstrated that errors

occurred in a median of 7% of medication orders, affecting 2% of patient days and 50% of hospital admissions. However, Franklin *et al*[105] expressed concern that the summary error rates produced in the review may be misleading due to the inclusion and exclusion criteria adopted, and the mixing of different methodologies when calculating the three grouped error rates. Franklin *et al* argued that conference abstracts and letters, which are unlikely to contain adequate information, along with studies based on incident reporting, which is known to result in very low error rates that significantly under-represent the problem,[106,107] should be excluded. They also expressed surprise at the exclusion of studies which used an estimated denominator[14,100,108,109] (including their own[14,108]), and the grouping of studies looking at different types of medication orders, as error rates may differ depending on the nature of the prescribing. Finally, they questioned the decision to conflate five different methods of identifying errors and ascertaining denominators and provide their own recalculation of the data on error rates with different inclusions and exclusions and grouping similar studies together (Table 1.4).

Table 1.4: Incidence of erroneous handwritten medication errors for hospital inpatients

Denominator	Numerator	No of studies in this category	Median error rate % (range)
All medication orders entered into computer system by pharmacy staff (in a system where all medication orders have to be sent to pharmacy prior to administration)	Errors identified in these medication orders by screening pharmacists	11	2.7% (0.3 - 20.3)
New medication orders screened for the first time by ward-based pharmacists (does not include medication orders that are not seen by ward pharmacists)	Errors identified in these medication orders by ward-based pharmacists	4*	9.9% (7.7 - 14.6)
Medication orders (both new and existing) screened by ward-based pharmacists on the day(s) of the data collection. Each medication order may be counted more than once	Errors identified in these medication orders by ward-based pharmacists	4	4.6% (2.2 - 27.0)
All medication orders written during the study period that were retrospectively reviewed by researchers	Errors retrospectively identified by researchers in the medication orders reviewed	2	8.0% (7.4 - 8.6)
All medication orders written during the study period regardless of whether or not they were seen by ward pharmacists	Errors identified by ward pharmacists	2	2.7% (1.5 - 3.8)
Figures in this table include studies excluded by Lewis *et al* on the basis of using an estimated denominator but exclude studies in which the methods used are unclear, those focussing only on discharge medication, those where it is not clear whether or not each medication order can be associated with more than one error, and those published only as abstracts or letters to the editor. *One reference included two separate studies			

Source: Franklin *et al* reworking of data from studies identified in Lewis *et al* systematic review[17,105]

However, the authors were agreed on the fact that “prescribing error research is an emerging research area”, and that there is “enormous methodological variation in the research being conducted to date”.[110]

Further studies have looked particularly at the prevalence and causes of errors made by junior doctors, as in the acute hospital setting they account for a significant proportion of all prescriptions written.[21,28,111–114]

1.4.2 Prescribing errors in mental health

Compared with the extensive literature on the epidemiology and causes of prescribing errors in general acute, specialist acute, and to a lesser degree, primary care, very little research has been undertaken into medication errors in a psychiatric setting, and still less into prescribing errors.

Six published literature reviews have attempted to summarise the evidence.[115–120] Grasso *et al* searched MEDLINE from 1966 to 2002 for articles relating to medication errors, ADRs and ADEs in psychiatry, as well as undertaking a hand search of bibliographies. Although unable to find any reports on medication error rates amongst psychiatric inpatients other than their own study published the same year,[121] the authors noted that some of the key studies of ADEs in general acute medical/surgical settings identified instances associated with psychotropic medicines.[39,42,44,122] In 2006, Grasso published a further review, commissioned by the US Institute of Medicine, to “review the results of studies in peer-reviewed journals over the last 10 years” relating to the incidence, severity, and costs of medication errors.[116] Despite searching six citation databases, the author only identified two studies reporting medication errors; the earlier one led by himself and one by Senst *et al* from 2001.[121,123]

Maidment *et al* undertook two systematic reviews, each searching the same five electronic databases for studies written between 1966 and the mid-2000s.[117,118] The earlier review sought studies which investigated the incidence or cause of medication errors occurring as part of the medication management process in community or hospital-based mental healthcare services.[117] The authors identified nine studies,[99–101,121,124–128] all of which were process-based, with significant differences in the rate of reported errors depending on the methods used to collect data. They found that most studies reported errors relating to the clerical aspects of prescribing, rather than those related to errors of clinical judgement or decision making. Of the nine studies identified, one investigated administration, dispensing, prescribing and transcription errors,[121] and another only administration errors,[126] two investigated administration,

dispensing and prescribing errors,[124,125] and five investigated prescribing errors alone,[99–101,127,128] one of which looked only at psychotropic prescribing.[127] The authors noted that they found no studies which systematically examined the cause of medication errors in a mental health setting.[117]

In their second review, Maidment *et al* concentrated on studies which investigated medication errors in older people with mental health problems.[118] Eight studies were identified,[99,101,124–127,129,130] of which six had also been included in the earlier review.[99,101,124–127] Two studies related exclusively to administration errors,[126,129] whilst prescribing errors, either alone or in combination with other error types were considered in the remaining six.[99,101,124,125,127,130] The authors concluded that the use of very different definitions, denominators and methods made it impossible to produce overall error rates, although they did note that most of the data related to clerical prescribing errors, and administration errors of limited clinical significance.

A more recent review, published in 2010 by Procyshyn *et al*,[119] used four electronic databases to look at studies from 1999 onwards, using a variation on Cochrane's Highly Sensitive Search Strategy[131] in an attempt to retrieve a greater proportion of high-quality peer-reviewed publications. This review identified a further four studies[132–135] which were not retrieved in the Grasso or Maidment reviews, only one of which related to prescribing errors.[133]

The most recent review, published in 2017 by Alshehri *et al*[120] searched 10 electronic databases for studies published between 1999 and October 2016, identifying 14 studies reporting data on prescribing errors. The review identified a further six studies,[136–141] although two of these were abstracts from conference proceedings.[137,141]

Primary studies

Twenty-three publications report research into prescribing errors in mental health,[99,100,134,136,137,139,140,142–146,101,147–149,121,124,125,127,128,130,133] whilst two others have looked specifically at discrepancies in the information held on medicines between primary and secondary care,[150,151] and one publication considered discrepancies at the time of discharge.[152] One study was published as both a conference abstract[139] and a journal article; only the article has been considered in detail.[148]

Details of the 22 papers relating to prescribing errors are provided in Appendix 1 and described briefly below. Two papers reported on the same Japanese study,[125,134]

appearing to investigate errors in prescribing, dispensing and administration; however, all the reported data related to administration errors. Another Japanese study concentrated mainly on adverse drug events but measured medication errors as a secondary outcome; this provided only an overall rate of medication errors with the proportion due to prescribing.[142] Of the remaining 19 studies, four were conducted in the USA,[121,130,133,145] two in India,[140,146] and one in each of Denmark,[149] Pakistan,[136] Thailand,[137] and Japan.[144] Apart from differences in healthcare systems which may make it inappropriate to apply their findings to the UK, in the US in particular systems for prescribing differ from those in the UK. US prescribers write a medication order within the patient's healthcare record, which is then transcribed by a nurse or aide to the medication administration record (MAR) before the supply is requested from the pharmacy.[46,115,116] Therefore, the opportunities for errors are different to those in the UK. The remaining nine studies[99–101,124,127,128,143,147,148] were conducted in the UK, with three[99,100,143] undertaken within an exclusively private hospital setting.

Three studies collected no denominator data so did not report an error rate.[99,128,146] Jhanjee *et al* reviewed 648 outpatient prescriptions in Delhi, using the WHO guidelines for prescription writing[153] as a standard, and calculated the number that demonstrated each of 13 error types. However, no information was provided about the overall number of prescriptions containing at least one error, nor the overlap in errors seen.[146] In 2002, Paton *et al* prospectively collected details of prescribing errors identified by psychiatric pharmacists within 12 NHS mental health trusts during the period of one month.[128] Of the 557 errors detected, 58% were considered to be clinical (decision-making) errors, whilst 27% were clerical (prescription writing) in nature. Approximately twice as many errors involved psychotropic drugs as non-psychotropic drugs and 11% of all errors were considered to be potentially serious. A similar study was undertaken by Stubbs *et al* the following year and attributed 23%, a much lower proportion of errors, to decision making. They found an almost equivalent number of errors relating to psychotropic and non-psychotropic medication.[99]

Another study, undertaken during 2002 at the same UK private hospital, identified only 13% of errors due to decision making, with 60% of errors relating to non-psychotropic drugs. In that study, Haw *et al* used the total medication order numbers checked by pharmacists on four sample days to identify a denominator and calculated that errors were detected in 2.2% of prescribed items.[100]

Nirodi *et al*[127] in the UK, Rothschild *et al*[130] in the US and Sahithi *et al*[140] in India used patient episode and number of admissions to express prescribing errors. Nirodi *et al*

undertook a retrospective review of a sample of 112 patient records from two psychiatric units for the elderly and identified that only 18% of patient records were legible and error free.[127] Rothschild *et al* prospectively collected data over a six-month period and found a prescribing error rate of 7.2 errors per 1000 patient days and 7.4 errors per 100 admissions. They found a similar balance between errors involving psychotropic (70%) and non-psychotropic drugs (30%) to Paton *et al.*[128] Sahithi *et al* prospectively collected data over a six-month period on medication errors in inpatients and outpatients who were receiving at least one psychotropic drug, and identified 72 prescribing errors affecting 59 patients, from a total study population of 166 patients giving an error rate of 0.4 prescribing errors per patient.[140]

Shawahna and Rahman explored prescribing errors in psychiatry in a small sample of 15 inpatient cases.[154] They identified 33 errors in the 84 medications prescribed for these patients, giving an error rate of 39.3%. However, the most common categories of errors that they found related to "order to break a delivery system that shouldn't be broken" (9/33; 27.3%), and polypharmacy (7/33; 21.2%), factors that are unlikely to have been included in other studies of prescribing errors.

A further study by Stubbs *et al*, involving eight NHS mental health trusts and one private hospital is one of only two multi-centre studies to provide a prescribing error rate.[101] Pharmacists prospectively recorded prescribing errors detected as part of their routine work over 5 working days, as well as the total number of medication orders checked. The overall error rate found was 2.4%, with prescription writing errors accounting for 77% of errors and decision making for 23%. Almost equivalent proportions of psychotropic drugs (55%) and non-psychotropics (40.5%) were involved in errors, similar to at least one of the earlier studies.[99]

The two most recent studies, by Keers *et al*, involved three NHS mental health trusts.[147,148] In the first, data were prospectively collected on prescribing errors and omitted items in newly written prescriptions by pharmacists as part of their routine work over 10 data collection days.[147] An overall error rate of 6.3% was found, with medicines omitted on admission to hospital the most common type of errors (12.5%). The authors analysed frequency of errors by prescriber grade and prescribing stage, identifying that specialty trainees had the highest prescribing error rate (6.8%), but were also responsible for the majority of newly written items; whilst junior doctors had error rates lower than their senior colleagues (FY1 5.1%; FY2 4.9%). Medication orders written on admission to hospital were associated with higher error rates (10.7%) than those written at other stages during the patient stay, including discharge.

In their second study, Keers *et al* identified prescribing errors, clerical errors, and communication issues occurring in discharge prescriptions screened during a six week period.[148] They found that 81% of discharges were affected by at least one error, with 5.1% of individual medication orders containing an error, more than half of which (52.9%) were considered to be clinically relevant, and 5.4% to be potentially serious.

The two remaining UK studies,[124,143] one Japanese study,[144] and one US study[145] analysed medication events reported via the organisations' incident reporting schemes. All reported very small numbers of prescribing errors which, on the basis of studies that compared errors detected by active methods with spontaneous reporting schemes,[121,155] are likely to be very significant under-estimates.

The results of the key UK studies are summarised in Table 1.5.

Table 1.5: Prescribing errors identified in studies within UK mental health facilities

	Overall error rate (%)	Decision-making errors (%)	Prescription writing errors (%)	Errors involving psycho-tropics (%)	Errors involving non-psycho-tropics (%)
Haw *et al*, 2003[100]	2.2%	12.5%	87.5%	39.8%	60.1%
Paton *et al*, 2003[128]	-	-	-	67.7%	32.3%
Stubbs *et al*, 2004[99]	-	23.7%	76.3%	52.6%	47.4%
Stubbs *et al*, 2006[101]	2.4%	22.6%	77.4%	55.3%	40.5%
Keers *et al*, 2014[147]	6.3%	-	-	-	-
Keers et al, 2015[148] (discharge prescriptions only)	5.1%	-	-	-	-

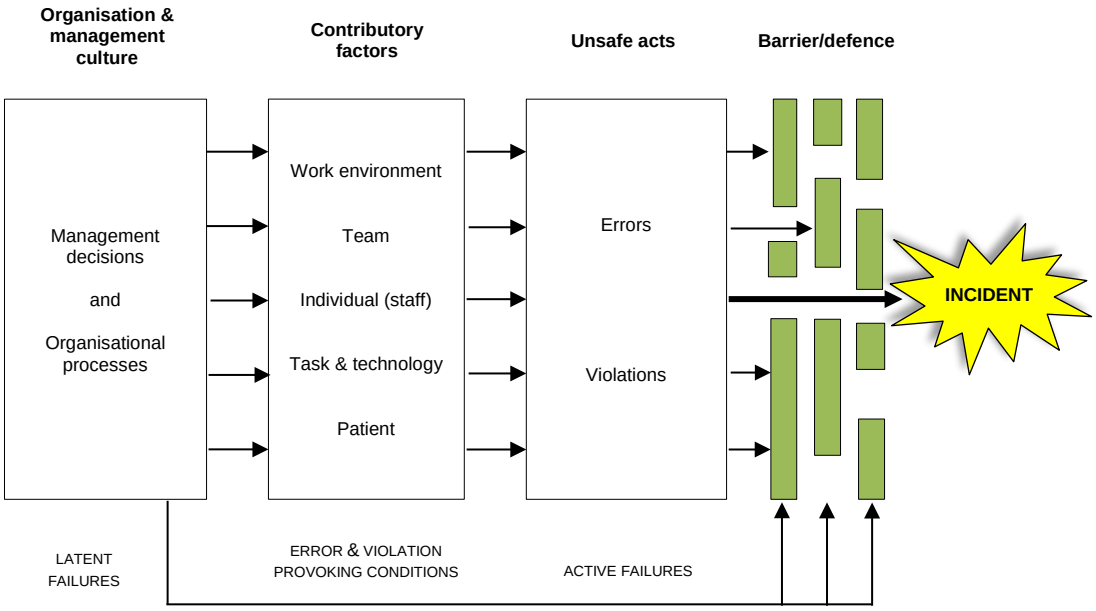
1.5 Human error theory

Human error can be defined as the *failure of planned actions to achieve their desired ends - without the intervention of some unforeseeable event.*[23] It is routinely cited as the main cause or a contributing factor in accidents in a diverse range of industries, with the person or people most obviously linked to the incident blamed. However, this oversimplifies the real situation; detailed analysis of an incident usually reveals a number of events and deviations from safe practice, each influenced by the working environment and wider organisational context.[156]

Reason's model of organisational accident causation[23,157] was originally developed for use in complex industrial systems and is one of the most influential and frequently cited models of systems safety.[158] It has been successfully adapted[156,159,160] and expanded[161,162] to take into account the unique characteristics of healthcare systems. The aetiology of organisational accidents is described in terms of four contributory concepts[23,47,49,157,163] (see Figure 1.4):

- Active failures
- Latent failures
- Error-producing conditions
- Defences/barriers

Accidents in healthcare, other industries, and our personal lives do not happen in isolation and need to be viewed from a comprehensive systems perspective if they are to be understood. Whilst the actions and failures of an individual person or group of people may play a fundamental part, their thinking and behaviour are influenced by their immediate work setting and wider organisational policies and procedures.



Sources: Reason, Vincent, Taylor-Adams[47,160,164]

Figure 1.4: Organisational accident causation model

1.5.1 Active failures

In his analysis of error types, Reason divided active failures into those which result from unintended actions and those which result from intended actions. These are represented graphically in Figure 1.5. Effectively, intended actions (mistakes and violations) are the result of a conscious decision, whether or not that decision was

based on incorrect or incomplete information, or motivated by specific circumstances. Unintended actions (slips and lapses) tend to occur during the largely automatic performance of a routine task, usually in familiar surroundings.[47]

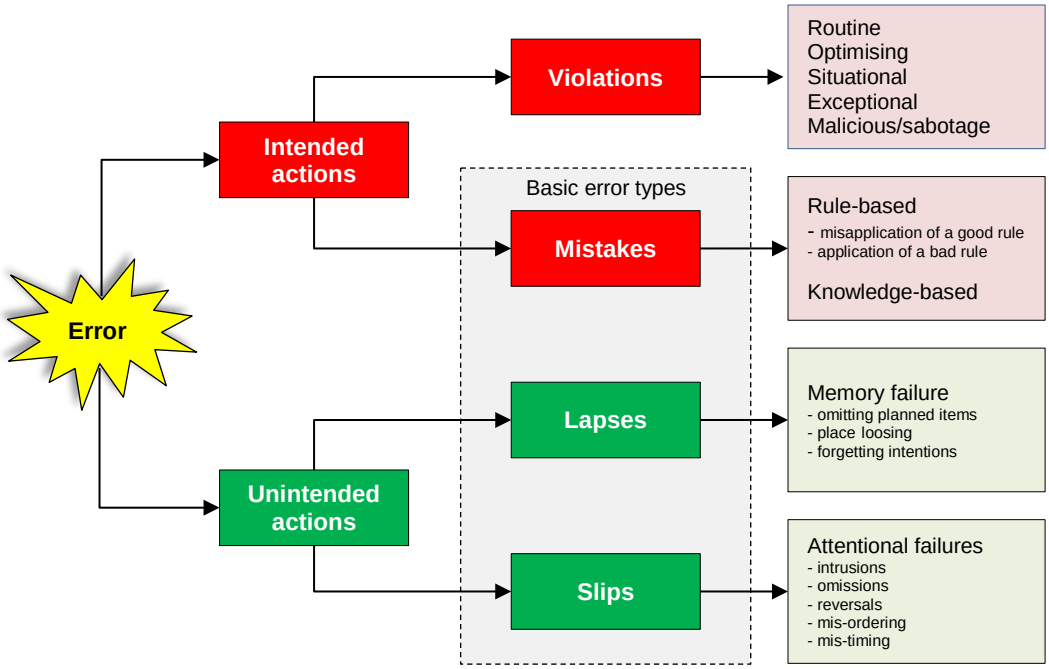


Figure 1.5: Error types

Slips and lapses

Slips are errors of observable action; where there is an error in executing a perfectly good plan, resulting in an action that was not what was intended (such as 'slip of the tongue' or 'slip of the pen'). Everyone is prone to slips of this kind in everyday life, such as putting the cereal box in the fridge instead of the cupboard, and usually realise the slip very quickly. They are associated with attentional failure, arising either from the surroundings, or the individual's internal preoccupations with something else. Medication-related examples of slips and lapses are given in Table 1.6

Errors of this type caused by distractions and interruptions are generally difficult to eliminate completely but can be controlled. For example, many hospitals now provide the nurse undertaking the drug administration round with a coloured tabard to remind others not to disturb them during this important task.[165]

Technical errors are a failure of skill, and as such are errors in executing a plan, e.g. inserting a cannula or making up an infusion. Therefore, they are a subset of slips. Lapses are covert slips, involving errors of internal action, and are associated with failures of memory. They may only be apparent to the person who makes the lapse.

Table 1.6: Error types with medication-related examples

Type of error	Examples
Mistakes	
Knowledge-based	- Giving penicillin, without having established whether the patient is allergic - Knowing that the patient is allergic to penicillin but not knowing that co-fluampicil contains a penicillin - Being unaware of the value of sodium bicarbonate in amitriptyline poisoning - Continuing to give amiodarone at the loading dose after 2 weeks - Initiating pregabalin at 75 mg daily when severe renal impairment required a dose reduction to 25 mg daily
Rule-based	
mistakenly applying a good rule	- Injecting diclofenac into the lateral thigh (the usually preferred site for intramuscular injections) rather than the buttock (which is preferred for diclofenac) - Following a treatment regimen for a 10 to 15-year-old child for a child who is just 10 and very small for age resulting in an effective overdose which causes an adverse effect - Prescribing oral treatment for a patient with dysphagia - Prescribing trimethoprim in a patient whose mid-stream urine sample suggested resistance to the drug - Prescribing ciprofloxacin for a urinary tract infection without considering the interaction with duloxetine which is already prescribed - Prescribing tramadol in a brain injury patient with seizures without considering the seizure lowering potential
applying a bad rule or failing to apply a good rule	- Using excessive doses of captopril (as was done during early use of the drug) - Prescribing amoxicillin for sore throat - Prolonging antibacterial treatment unnecessarily - Duplicating the prescription for co-amoxiclav - Prescribing medication based on a patient's previous admission, so the prescription was invalid
Skill-based errors	
Action-based (slips)	- Intending to write 'chlorpromazine' but instead writing the more familiar chlorpropamide - scrawling 'chlorpromazine' which is misread as 'chlorpropamide' - picking a pack containing chlorpromazine from the pharmacy shelf when intending to take one containing chlorpropamide - A prescriber who habitually uses pethidine 100 mg for postoperative analgesia automatically writing morphine 100 mg - 150 tablets selected instead of 150 mg during computerised drug selection - selecting ceftriaxone instead of cefuroxime
technical errors	- Putting the wrong amount of acetylcysteine in an infusion
Memory-based (lapses)	- Giving penicillin, knowing the patient to be allergic, but forgetting - A nurse, having already added potassium chloride 20 mmol/l to an infusion bag, forgetting having done so and adding more potassium chloride - Omitting a date on which to stop treatment - Intending to stop doxycycline but unintentionally continuing it.

Sources: Ferner, Aronson, NPSA[24,83,166,167]

Mistakes

Whilst slips and lapses are errors in executing a correctly planned action, mistakes are errors in planning the action in the first place. Here the plan is inadequate to achieve its intended outcome, and the failure lies at a higher level: the mental processes involved in assessing the available information, planning, formulating intentions and judging the likely consequences.[23,47]

Mistakes can be subdivided into those that result from ignorance (knowledge-based errors), and those that are the result of a failure to apply a rule, guideline or procedure (rule-based errors). Mistakes are therefore more subtle, more complex, less well understood, harder to detect, and generally constitute a greater danger.[47] Medication-related examples of mistakes are given in Table 1.6.

Knowledge-based errors usually occur in novel situations, where the solution to the problem is not already stored in memory or has lapsed due to lack of use and has to be worked out from first principles.

Violations

As Vincent states, errors are, by definition, "unintended in the sense that we do not want to make errors".[47] By contrast, violations are deliberate deviations from safe operating practice, procedures or standards. In relation to human error theory Reason defines violations as "deliberate, but not necessarily reprehensible, deviations from those practices deemed necessary to maintain the safe operation of a potentially hazardous system".[23,157]

Violations fall into three main categories[157,164]:

- Routine - taking short-cuts in skill-based performance whenever the opportunity arises, such that over time the violation tacitly becomes accepted practice
- Optimising - taking actions to further personal rather than task-related goals (violating for the thrill of it)
- Situational - flouting the rules when it is seen as the only way of getting the job done because the rules or procedures seem inappropriate for the present situation. They may occur in exceptional situations, may involve situations where the opportunity for harm is foreseeable and ignored, and may become accepted practice over time.

In contrast to errors, which are related to attentional and informational problems, violations tend to be associated with motivational issues such as low morale, poor role models and inadequate management.[156]

Malicious violations are not errors, but occur where the intention is to cause harm, such as deliberate sabotage. These are uncommon but the outcome can be devastating, e.g. the actions of Harold Shipman,[168] Beverley Allitt,[169] and Victorino Chua.[170]

1.5.2 Latent failures

Latent failures are the organisational processes that create an environment where active failures and error producing conditions are more likely to result in errors; they influence staff performance and may precipitate errors.[156] Examples include poor design, gaps in supervision, undetected maintenance failures, unworkable procedures, clumsy automation, training shortfalls, inadequate equipment, and organisational processes (i.e. decisions relating to planning, scheduling, forecasting, designing, policy making, communicating, or regulating).[164]

Reason compares them to resident pathogens within the human body as these latent failures "may be present for many years before they combine with local circumstances to penetrate the systems many layers of defences."[23,157] He acknowledges that management and organisational decisions are shaped by economic, political and operational constraints and that the healthcare system involves many interdependent organisations including government agencies, professional and patient organisations which have an influence on the operation of an individual organisation.[164]

1.5.3 Error-producing conditions

Latent failures created by organisational processes and management decisions impact on operations within the workplace to create the conditions necessary to promote the occurrence of errors and violations - for example, understaffing, high workload or poor communication.[164]

Vincent *et al* extended Reason's model and adapted it for use in a healthcare environment,[156,159,160] classifying error-producing conditions and organisational factors (latent failures) into a single broad framework of factors affecting clinical practice which they refer to as the "seven levels of safety" (see Table 1.7).

Table 1.7: Contributory factors that influence clinical practice

Factor type	Contributory influencing factor
Patient factors	Condition (complexity and seriousness) Language and communication Personality and social factors
Task and technology factors	Task design and clarity of structure Availability of protocols Availability and accuracy of test results Decision-making aids
Individual (staff) factors	Knowledge and skills Competence Physical and mental health

Table 1.7: Contributory factors that influence clinical practice (continued)

Factor type	Contributory influencing factor
Team factors	Verbal communication Written communication Supervision and seeking help Team leadership
Work environment factors	Staffing levels and skill mix Workload and shift patterns Design, availability, and maintenance of equipment Administrative and managerial support Physical environment
Organisational and management factors	Financial resources and constraints Organisational structure Policy, standards, and goals Safety culture and priorities
Institutional context factors	Economic and regulatory context National Health Service Executive* Links with external organisations

Source: Vincent *et al* [47,156]

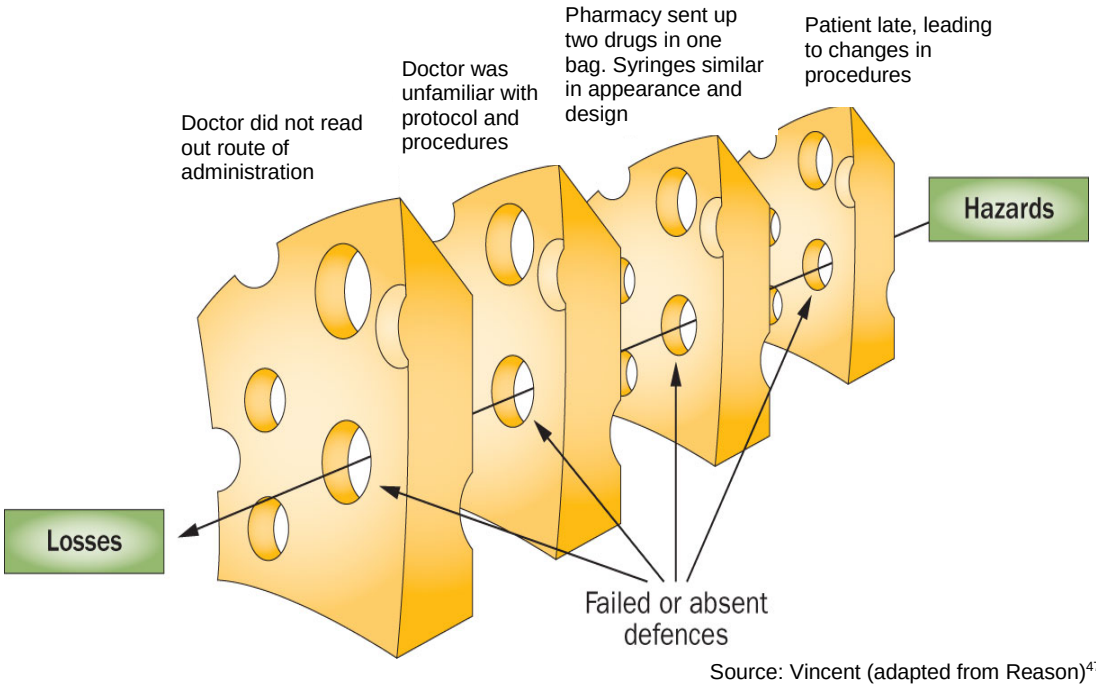
1.5.4 Defences/barriers

Defences are the ways in which systems ensure safety. These are usually particular administrative, physical or other barriers that protect or guard against deviations from normal practice. For example, the checking of medicines by a second nurse before administration or the checking of prescriptions by a ward pharmacist to intercept prescribing errors.

In an ideal world, all layers of defence would be intact, preventing penetration by possible accident trajectories (see Figure 1.4). However, each layer of defence may contain gaps or weaknesses, which are in constant flux. Particular defences may be removed deliberately during maintenance or testing, or due to errors or violations.[157] These 'holes' in the system provide an opportunity for incidents to occur without being prevented by the defensive system.

This "Swiss Cheese" metaphor is commonly used to describe defensive systems.[47,49,157] Like slices of Swiss cheese, each defensive layer has many holes, although these are constantly opening, closing and shifting position. The holes in one "slice" do not usually result in an incident as the presence of intact defences in other "slices" prevent it. However, when the holes in many layers of defence temporarily align to permit a "trajectory of accident opportunity" an incident can occur[49] (see Figure 1.6).

* Relevant at the time of publication but would now be Department of Health and Social Care and/or NHS England



Source: Vincent (adapted from Reason)[47]

Figure 1.6: 'Swiss Cheese' model

Vincent used this analogy[47] to describe the circumstances, in 2001, which led to the death of a patient as a result of the correct administration by the intrathecal route of the chemotherapy drug cytosine, being erroneously followed by injection of a second chemotherapy drug, vincristine, which must only be given intravenously.[47,171] Defences and barriers existed; cytosine and vincristine were usually administered on separate days, the drugs were stored separately in pharmacy and sent separately to the ward from the pharmacy, with two doctors checking labels and doses prior to administration. However, on this occasion, a series of defences and barriers were all breached at one time with disastrous consequences.

1.6 Causes of prescribing errors

Although considerable quantitative research has been undertaken looking at the prevalence of prescribing errors, relatively little has explored the reasons that underlie errors. As part of a programme of research commissioned by the GMC (the EQUIP study)[18] into the rates of prescribing errors in hospitals and what might cause them, Tully *et al* undertook a systematic review exploring the causes of and factors associated with prescribing errors in hospital inpatients.[172] The authors searched a number of electronic databases for the period from 1985 to July 2008 for studies that reported on the causes of and/or factors associated with prescribing errors in handwritten prescriptions. They restricted studies to those published in English and excluded studies where causality or associated factors were surmised, restricting those included to studies which containing empirical data. They identified 17 publications, detailing the findings of 16 studies, most of which were conducted in the

US (7/16; 43%) or the UK (3/16; 19%). Despite performing a literature search covering more than 20 years from 1985, more than two-thirds of the studies (11/16; 69%) were published since 2000. Seven studies reported on the causes of prescribing errors[15,26,27,173–176] and nine on factors associated with them.[16,44,174,177–184] Other studies investigating the causes of prescribing errors and factors contributing to them in a hospital setting have been published since the Tully *et al* review.[28,113,114,185–190]

1.6.1 Contributory factors

Whilst the opinion of researchers or a general cross-section of healthcare professionals has been used in some studies to categorise an assumed cause for errors,[13,28,111] those that have interviewed the prescriber him/herself about a specific prescribing error are likely to have gained the greatest insight into the causes of error. For example, only the person who made the error will know whether they were distracted resulting in a slip in attention or lacked the knowledge which led to a mistake.

Studies which have conducted an in-depth analysis of the causes of a particular error, through qualitative interview with the prescriber or by direct observation, have identified that for each error there are often multiple causes.[18,26,27,113,175,188,189] These can be categorised using the 'seven levels of safety' model developed by Vincent *et al* (see Table 1.8), based on Reason's model of accident causation.[23,157]

Prescribers have reported lack of knowledge about the patient,[15,18,26,104,190] their condition,[26,27,113,185,189,190] and medication[15,28,104,113,174,185,187–190] as contributory factors to making errors. Much of the research has been undertaken with junior doctors,[18,19,26,28,113,185,187,189] and this has been reported to be particularly the case when they move to a new training rotation or are on call.[18,27,187,188] Individual factors such as hunger and thirst,[18,26,27] tiredness,[18,27,185,187–190] and excessive workload[18,26–28,104,113,185,187–190] have all been reported in connection with errors.

There is far less literature available on the causes of error than on their epidemiology. What has been published may not be fully representative of the situation in a mental health setting. Much of the work has been undertaken with junior doctors who represent a much smaller proportion of the medical workforce in a mental health setting than in acute care. Existing studies have been undertaken within acute hospital settings[12,18,26–28,113,185,187–189] or primary care[190] environments which may contain different contributory factors. No study has investigated the causes of and factors contributing to prescribing errors in a mental health setting.

Table 1.8: Contributory factors identified in qualitative prescribing error studies

Factor type	Contributory influencing factor
Patient factors	'Difficult' patients[27,190] Clinically complex cases/polypharmacy[26,27,104,113,185,189,190] Language/communication problems[26,27,189] Unfamiliar patients[15,18,26,104,190] Pressure from patient/relatives[18,28] Poor/wrong information provided by patient[18,113]
Task and technology factors	Unavailability of protocols/guidelines/reference sources[27,185,188,189] Task outside normal routine[27,185] Another person's error/violation ('following orders')[18,26,28,113,185,187] Inadequate patient information (e.g. weight, pre-admission drugs, test results)[113,185,189] Fragmentation of tasks/poor completion by the previous person[113]
Individual (staff) factors	Physical health • Tired[18,27,185,187–190] or hungry/thirsty[18,26,27] • Unwell[27] Mental well being[27] • Feeling flustered/confusion[18,185] • Boredom, lack of concentration[18] • Stress/anxiety[18,104,188–190] • Low morale/poor motivation[26,185,189] Personal issues[188] Skills and knowledge[15,28,104,113,174,185,187–190] • Lack of training[15,26,27,185] • Lack of experience/expertise[18,26,27,187] • Calculations[27] • Familiarity with brand names[27] • Not double checking/"thought they knew"[18,187] • Unaware of role of pharmacy services[18,187] Multitasking[18,26,113,187,188] Ignoring ePrescribing alerts[18] Rule violations[15,18,104,174,185]
Team factors	Poor communication[15,104,113,190] • Poor handwriting[27] • Not documenting/wrong allergy information [18,27] • Inept crossing off of prescriptions[27] • Absence of documentation in the patient's notes[27,113] • Wrong documentation in the patient's notes[18] • Missing drug charts[27] Inadequate supervision/senior support[18,26–28,187,188] Poorly defined responsibilities[18,27,28,104,190] Pressure from nurses/other staff[18,104,113,188]
Work environment factors	Staffing issues • Inadequate staffing levels[18,27,189] • New or locum staff[27,189] • Dealing with another doctor's patient/on-call[18,27,187,188] Heavy workload/working longer than rostered/time pressures[18,26–28,104,113,185,187–190] Physical environment (cramped, hectic, noisy, distractions, interruptions)[26–28,104,185,188–190] Design of ePrescribing system[18,104,175,190]/drug chart[18,26,28] Unfamiliar setting/new post[18,28]
Organisational and management factors	Lack of importance placed on the task of prescribing[18,27] Transcription (re-writing charts) not seen as prescribing[27,113] Culture of not questioning decisions/instructions of senior doctors[26,27,187] Culture of not asking for clarification if unsure[26,27,187]
Institutional context factors	Communication between healthcare settings[104]

1.7 Clinical decision making

Work in the field of cognitive psychology over the last 15-20 years has led to the development of a number of models for clinical reasoning and decision making known collectively as 'dual process theories'.[54] Various research groups have identified the existence of dual processing models of reasoning, although some researchers have argued for a three-stage model.[191,192] Although the terminology varies between the proposed models, all have a strong resemblance to each other and all propose two cognitive modes, types or systems of information processing underlying reasoning.[192–198]

1.7.1 Dual process theory

Whether referred to as 'experiential' and 'rational',[199,200] 'associative' and 'rule-based',[193] 'heuristic' and 'analytical',[195] 'Type 1' and 'Type 2',[201] or 'System 1' and 'System 2',[202–205] the characteristics of the two processes are similar (see Table 1.9), although Sloman warns that it may not be easy to decide which system is responsible for a given answer.[193]

Table 1.9: Characteristics of System 1 and System 2 decision-making processes

	System 1	System 2
Cognitive style	Heuristic, intuitive, associative, concrete	Analytical, normative, deductive, abstract
Processing	Parallel, multiple	Serial, linear
Responsiveness	Passive	Active
Cognitive awareness/control	Low	High
Action	Reflexive, skilled	Deliberate, rule-based
Rate	Fast	Slow
Effort	Minimal	Considerable
Automaticity	High	Low
Vulnerability to bias	Yes	Less so

Sources: Croskerry,[202–204] Evans[205]

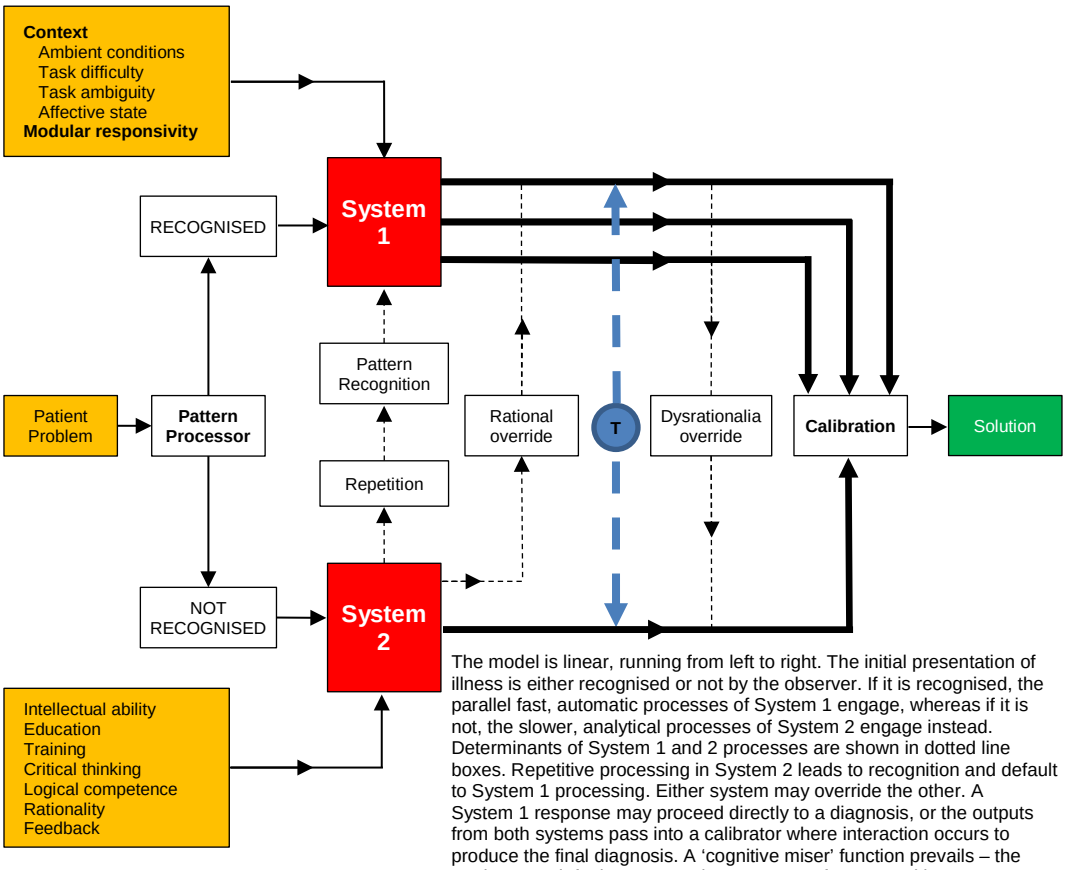
Dual process theory-based models distinguish between two cognitive systems – the fast, intuitive and automatic thinking of 'System 1' and the careful, rational and analytical thinking of 'System 2'.[204,206] System 1 and System 2 approaches are used in all areas of clinical decision making from diagnosis to decisions about clinical management, including drug therapy. Simplistically, routine problems, where there is a higher level of certainty, will more often be dealt with by the intuitive System 1, especially if time is short. The analytical System 2 will be engaged when the situation

is complex, time is available, the decision maker faces ambiguity or a non-routine situation, there are high-stakes outcomes, or in a context of uncertainty.[54]

Functional magnetic resonance imaging (fMRI) has shown that System 1 and System 2 thinking are associated with different areas of the brain, and patients with certain neurological disorders associated with damage to specific areas of the brain show difficulty with intuitive thinking. Neurophysiological studies in monkeys have shown similar functional distinctions.[72,204] Hruska *et al* observed differences in the neural areas activated in novices and experts during clinical decision making when diagnosing hard, but not easy, clinical cases. Novices demonstrated activation of neural regions associated with factual rule-based knowledge, whereas experts demonstrated activation of neural regions associated with experiential knowledge. They also observed that novices demonstrated increased activation of the neural regions associated with working memory compared with experts.[207,208] Melo *et al* using fMRI found similarities between the responses during diagnosing disease, prescribing, and naming animals and objects based on written stimuli, suggesting involvement of similar pathways.[209]

Affect is also intrinsically linked to the ability to process information and make decisions - stress, fatigue, personal problems, and other factors have all been demonstrated to impact decision making,[18] as can organisational processes and error-provoking conditions.[23,26] Croskerry notes that affect is inseparable from thinking and that there are numerous affective 'biases' that influence decision making, including overconfidence, self-deception, disillusionment, complacency and lack of motivation (see Appendix 2).[54,204,210] Masicampo and Baumeister demonstrated that the two thinking modes are not simply a psychological theory but has a physiological basis, showing that the ingestion of sugar can reduce reliance on intuitive, heuristic-based decision making and result in more analytical processing.[211]

Croskerry has written extensively about the role of cognition[66,67,210,212,213] and dual process theory in diagnosis,[202–204,214] describing the principal *modus operandi* of the dual process theory model as pattern recognition[204] (see Figure 1.7). He postulates that repeated presentations of the same problem to System 2 will eventually lead to the decision being relegated to System 1 - the development of automaticity through familiarity and practice. System 2 can exert an executive function and override the impulsive output of System 1; however, System 1 can also override System 2 leading to decisions against one's better judgement ("*dysrationalia"*).[214] He states that most errors in decision making occur when System 1 processing takes place.



Source: Croskerry,[202–204]

Figure 1.7: Model for reasoning based on dual process theory

However, researchers do not agree about the culpability of intuitive System 1 in relation to errors. Norman *et al* challenge the view that analytical reasoning is 'good' and intuitive reasoning is 'bad' which they state is dominant in diagnostic error literature, citing studies which have shown that analytical approaches can be inferior to System 1 methods and that both can be prone to errors. They caution against encouraging clinicians to avoid any form of System 1 or heuristic thinking, stating that System 1 thinking is both efficient and effective and that analytical thinking, because of its cognitive load, may lead to inferior solutions.[71,72,215] Groves *et al* reported that expert general practitioners (GPs) made more errors in data gathering and interpretation than novices, but were more accurate overall because they generated a better hypothesis. He postulated that this was because these clinicians reasoned intuitively using relatively few clinical data, whilst the less experienced appeared to adopt a more thorough, but less efficient and intuitive, approach to the clinical reasoning process.[216] Norman *et al* suggest that a critical component of expert and novice diagnostic reasoning is a similarity to previously encountered examples.

However, they acknowledge that reasoning cannot be non-analytic all the time, and that use of both non-analytical reasoning, and analytical knowledge can lead to improved accuracy over either used alone.[217] They have also suggested that the challenge for clinicians is to determine when they should trust their intuition and when to slow down and think deliberatively.[218]

Similar views have been expressed by Evans,[205] who has also highlighted the link between System 2 and working memory capacity which varies between individuals, and is linked to general intelligence and cognitive ability, increases with age during childhood and declines in old age.[194] He suggests that "whereas the heuristic system supplies hypothesis, it is the task of the analytic system to evaluate them, and if need be, modify or replace them" highlighting that a key issue is whether systems are parallel, sequential or interactive,[195] and whether there are actually multiple kinds of type 1 processes.[205]

Choosing the correct therapy for a patient is an essential component of the medical activities that lead to an effective, safe and suitable treatment. Bissessur *et al* describe therapeutic reasoning as the step in clinical reasoning that pertains to the choice of therapy and highlighted that it has received little attention,[219] whilst various researchers have highlighted deficiencies in the teaching of therapeutic reasoning, or the abilities of newly qualified doctors to demonstrate it.[59,220–224] In less experienced prescribers, such as medical students or newly qualified doctors, slow and relatively time-consuming analytical reasoning is carried out consciously and systematically, often with reference to the evidence base. As experience grows with repeated exposure to situations, pattern recognition leads to the development of rapid and subconscious non-analytical reasoning. However, even an experienced practitioner will need to revert to analytical reasoning when faced with a complex or novel case.[59]

The interactions between System 1 and System 2 are referred to as 'calibration', with the opportunity for System 2 to override the automatic responses of System 1. As Fagan in the musical *Oliver!* demonstrates when finding impulsive System 1 ideas appealing but rejecting them by "reviewing the situation".[214] Various strategies have been suggested to improve clinical reasoning, including improving knowledge about cognitive processes, metacognition (the ability to stand back from one's own thinking, observe it, and recognise opportunities to use interventional thinking strategies, or to literally stop, think and mentally challenge the first impression formed before finally committing to a decision), and cognitive forcing strategies.[212,225]

1.7.2 Validated scales

Notwithstanding the exact construct of dual process theory, or whether it is correct, an individual's tendency towards rational *vs*. experiential (intuitive) type thinking can be measured using personality tests.[200,226] In the early 1990s Epstein and fellow researchers developed a theory of personality termed the *Cognitive-Experiential Self-Theory* (CEST) which proposed that information is processed by two parallel, interacting systems: one rational and the other experiential.[199] Although both systems are used by people when making a decision, which system individuals use predominantly differs.[227] The tools used in this study are described below.

1.7.2.1 Cognitive Reflection Test

The 'Cognitive Reflection Test' (CRT)[226] is designed to test participants' ability to suppress the intuitive, spontaneous answer which springs 'impulsively' to mind, in favour of a more reflective or rational response. Although it has been criticised as being influenced by numerical ability,[228] it has been found to be a better predictor of rational thinking that either intelligence measures or measures of executive functioning.[229]

The original version of the CRT presented three problems found to frequently yield 'intuitive' wrong answers:

- A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball costs? _____ cents
- If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets? _____ minutes
- In a lake, there is a patch of lily pads. Every day, the patch doubles in size. It takes 48 days for the patch to cover the entire lake, how long would it take the patch to cover half of the lake? _____ days

These three items have become increasingly well known – especially the bat-and-ball problem, which has been used in many classroom situations and appeared in many books and journals.

1.7.2.2 Rational Experiential Inventory

The 'Rational Experiential Inventory' (REI-40)[200] is a 40-item instrument designed to measure an individual's propensity for rational and experiential decision making, which link to the two types of thinking postulated in dual process theory. It has been used in various populations of healthcare professionals including cardiologists,[230] physicians,[231–234] paramedics and student paramedics,[235] student pharmacists,[236,237] and doctors, nurses and managers.[238]

The instrument contains subscales for ability and engagement with rationality and experientiality, each measured by 10 questions:

- *Rational ability* refers to how well people believe they use logical and analytical thinking (e.g. “I have a logical mind.”)
- *Rational engagement* refers to perceived reliance on and enjoyment of using local and analytical thinking (e.g. “I enjoy intellectual challenges.”)
- *Experiential ability* refers to how well people believe they use their intuitive impressions and feelings (e.g. “I believe in trusting my hunches.”)
- *Experiential engagement* refers to perceived reliance on and enjoyment of using feelings and intuitions (e.g. “I tend to use my heart as a guide for my actions.”)

Ability subscales assess how well people believed they use each disposition, while engagement subscales assess reliance on and enjoyment of the disposition. Each item is measured on a 5-point Likert scale ranging from “strongly disagree” (1) to “strongly agree” (5) with a balanced number of positively and negatively worded items on each scale, and some items requiring reversed scoring. Scores are averaged to provide a composite score for each scale and subscale, with a higher score reflecting a greater tendency to endorse the thinking style.

1.7.2.3 Need for Cognition Scale

The ‘Need for Cognition Scale’ (NCS) contains items that focus on engagement in, and enjoyment of, cognitive activity, and is a measure of information processing, thinking, and judgement. Thus the scale relates to individual differences in rational processing and is considered to be predictive of the way in which people deal with tasks and social information. [239] The short, 18-item, form of the scale was used.[240]

Each item is measured on a 9-point Likert scale ranging from “very strongly disagree” (-4) through “neither disagree nor agree” (0) to “very strongly agree” (+4) with half of the items reverse scored. Scores from the 18 items are aggregated to give a single score. High scores indicate an individual’s tendency to organise, abstract and evaluate information.[239]

1.8 Research overview

1.8.1 Gaps in the research literature

The incidence and causes of medication errors have been extensively studied in hospitals,[8,12–15,21,26,27,38,108,113,172,187,241–245] and to a lesser extent in primary care.[190,246–248]

Few studies have investigated medication errors occurring within mental health settings. Nineteen studies have investigated prescribing errors in mental health settings.[99,100,137,140,143–149,101,121,124,127,128,130,133,136] Of these, 10 were conducted overseas[121,130,133,136,137,140,144–146,149] where differences in healthcare systems may make their findings less applicable to the UK. Three UK studies were undertaken within an entirely private hospital setting,[99,100,143] which may also mean that their results are less generalisable as systems may be different. Three studies collected no denominator information, only reporting the number of errors identified,[99,128,146] whilst three others used patient cases and admission numbers as denominators.[127,130,140] Four studies[124,143–145] analysed medication events reported via incident reporting schemes; all reported very small numbers of errors, and are likely to significantly underestimate the actual number of errors.

Only three studies have calculated the proportion of prescriptions affected by errors,[100,101,147] and one of these used a proxy for the total number of medication order numbers checked by pharmacists.[100] Therefore, there is a paucity of published data currently available on the prescribing error rate in a mental health setting.

In his review of publications, Maidment *et al* noted that there had been no systematic study of causes of medication errors in mental healthcare associated with deficits in knowledge or decision making.[117]

Studies have demonstrated some success with interventions to encourage dual processing and improve decision making, although they have largely related to the decision making involved in diagnosis.[67,249,250] Research specifically around initiatives to reduce prescribing errors has tended to look at academic detailing, decision support and addressing human factors.[251]

Although findings from acute hospital-based studies may be transferable, the most frequently used drugs in a mental health setting are very different with more than 90% of drugs (by cost) being for the treatment of conditions affecting the central nervous system.[252] Not surprisingly, the familiarity, knowledge, and experience of mental

health prescribers with drugs used for the treatment of physical healthcare conditions will also contrast due to different levels of exposure.

Therefore, the aims and objectives of this research contribute to gaps in the existing research literature.

1.8.2 Importance and contribution of the proposed research

This research adds to the limited information available about the epidemiology and pathophysiology of prescribing errors in mental health inpatient settings and contributes to the overall body of knowledge about prescribing errors. It also provides data on whether there is a link between prescribers' cognitive preferences and their tendency to make prescribing errors, and whether this can be influenced by raising awareness of the principles underpinning clinical decision making.

While there are robust definitions and methods for assessing the prevalence and nature of prescribing errors in a range of healthcare settings, this chapter has highlighted that in a mental health setting little research of this kind has been undertaken, and that the methods in use may not be universally fit for purpose. In addition, to the author's knowledge, there has been no research undertaken exploring the causes of prescribing errors in a mental health setting, or whether there are any links between prescribing errors and the thinking styles of individual prescribers. These areas are therefore the subject of the author's research.

1.8.3 Aims of the research

The purpose of this research was to investigate prescribing errors, their causes, and whether the two types of cognitive process (those executed quickly with little conscious deliberation and those that are slower and more reflective) have any impact on the occurrence of prescribing errors in a mental health setting.

1.8.4 Research objectives

- To investigate the prevalence and nature of prescribing errors in inpatients.
- To explore the causes of prescribing errors in hospital inpatients.
- To determine the decision-making characteristics of prescribers and whether there is a correlation between cognitive style and making prescribing errors.
- To investigate whether exposing prescribers to evidence about how humans make decisions affects the prevalence or nature of prescribing errors made.

Chapter 2. Methods

2.1 Literature review

The literature was searched for studies that reported on the occurrence of prescribing errors, causes of prescribing errors, dual process theory, and cognitive psychology. Searches were undertaken in February 2014 using the following databases: EMBASE, MEDLINE, CINAHL, and PsycINFO. Search terms, combined using Boolean operators, included the following: 'medication'; 'prescribing'; 'error(s)'; 'mental health'; 'psychiatr*'; 'thinking'; 'psychology'; 'dual process'; 'health'; 'cognitive psychology' (see Appendix 3). Search outputs were filtered for duplicates, and citation titles and/or abstracts reviewed for relevance. Full papers were obtained for potentially relevant articles, reviewed and annotated, and a short summary prepared for each. Electronic (PDF) copies of all papers were stored using Mendeley© version 1.19.1 (Mendeley Ltd, London), with additional physical copies filed and indexed.

Reference lists of reviewed studies were hand searched for additional relevant publications. Citation alerts were set up for articles considered to be of importance, and subscriptions set up to receive the electronic table of contents of relevant journals and/or email alerts for articles published online. These were regularly checked, and appropriate articles added to the list of references held in Mendeley©. More than 1100 publications were reviewed, of which approximately 200 were considered to be important texts, with a further 250 of minor interest, reviewed for background information.

2.1.1 Development of methodology

To facilitate decisions about the methods to be used in this study, an options appraisal was undertaken for each aspect of the research design. This was based on a detailed analysis of the methods used in existing studies of a similar nature, and the strengths and limitations of each (see Appendix 4). The selected methods are summarised in Table 2.1.

Table 2.1: Development of methods

Required decision	Detail	Chosen option
Prevalence and nature of prescribing errors		
Study population	Wards	All
Data items	Medication orders containing errors (Numerator)	Newly prescribed items (not previously screened by a pharmacist)
	Definition	Dean *et al* practitioner-led definition[25]
	Denominator	Number/proportion of new medication orders in which a prescribing error found
	Errors per order	Multiple prescribing errors per order allowed
	Sample size	Adequate to allow 95% confidence with 1% - 5% margin of error
	Method	Drug chart review
	Data collector	Ward/dispensary pharmacist
Data analysis	Classification of error type	Based on type of discrepancy
	Classification of error origin (decision making *vs.* prescription writing)	By researcher
	Severity scale	Dean & Barber tool (established reliability for prescribing errors)[253]
	Severity assessment	By data collector with sample assessed by panel of 'experts'
Causes of prescribing errors		
Study population	Prescribers	Sample of prescribers who have made non-serious and serious errors
Data collection	Format	Semi-structured interview
	Time limit on contacting prescribers	96 hours
	Type of interview	Face to face
	Sample	Until saturation
Data analysis	Classification	Reason's model of accident causation
Decision-making characteristics		
Data collection	Method	Electronic/paper survey
	Participants	All prescribers

2.2 Setting

2.2.1 Study organisation

The study was undertaken within South Essex Partnership University NHS Foundation Trust (SEPT) which provided mental health, learning disabilities, social care and community health services within Essex and Bedfordshire.

Table 2.2: Data collection sites

Ward	Service type	Location
Alpine	Adult - Forensic (Medium Secure)	Brockfield House, Wickford
Assessment Unit	Adult - Assessment	Mental Health Unit, Basildon Hospital
Aurora	Adult - Forensic (Medium Secure)	Brockfield House, Wickford
Beech	Older People - Assessment	Rochford Hospital
Byron Court	Learning Disability	Billericay
Causeway	Adult - Forensic (Low Secure)	Brockfield House, Wickford
Cedar	Adult - Acute	Rochford Hospital
Clifton Lodge	Older People - Continuing Care	Westcliff-on-Sea
Dune	Adult - Forensic (Low Secure)	Brockfield House, Wickford
Forest	Adult - Forensic (Medium Secure)	Brockfield House, Wickford
Fuji	Adult - Forensic (Medium Secure)	Brockfield House, Wickford
Gloucester	Older People - Assessment	Mental Health Unit, Basildon Hospital
Grangewaters	Adult - Acute	Mental Health Unit, Basildon Hospital
Hadleigh Unit	Adult - Psychiatric Intensive Care	Mental Health Unit, Basildon Hospital
Lagoon	Adult - Forensic (Medium Secure)	Brockfield House, Wickford
Maple	Older People - Assessment	Rochford Hospital
Mayfield	Older People - Continuing Care	Thurrock Hospital
Meadowview	Older People - Assessment	Thurrock Hospital
Mountnessing Court	Older People - Continuing Care	Billericay
Poplar	Child & Adolescent - Assessment	Rochford Hospital
Rawreth Court	Older People - Continuing Care	Rayleigh
Thorpe (was Westley)	Adult - Acute	Mental Health Unit, Basildon Hospital
CRHT[†] Team (East)	Adult – Acute (virtual ward)	Rochford Hospital
CRHT Team (West)	Adult – Acute (virtual ward)	Mental Health Unit, Basildon Hospital
Section 136 Suite	Adult - Assessment	Rochford Hospital

The study sites for this project were the Essex mental health and learning disability wards within the mental health division of the organisation as detailed in Table 2.2. On 1st April 2017 SEPT merged with the neighbouring mental health trust, North Essex Partnership University NHS Foundation Trust, to form a new legal entity -

[†] CRHT – Crisis Resolution and Home Treatment

Essex Partnership University NHS Foundation Trust (EPUT). Any aspects of the study completed after that date were undertaken only within the boundaries of the former SEPT.

2.2.2 Prescribing arrangements

Prescribers within these services were predominantly medical staff, but also included a small number of nurse and pharmacist prescribers. Details of prescriber types are shown in Table 2.3.

Table 2.3: Types of prescribers in hospital services

Prescriber type	Description
Foundation year 1 (FY1)	Newly qualified doctors in their first year of post-graduate training who have provisional registration with the GMC
Foundation year 2 (FY2)	Doctors in their second year of post-graduate training who have full registration with the GMC
Core trainee (CT1-3)	Doctors who have completed two years of foundation training and are now undertaking three years of basic specialty training in psychiatry
GP trainee (GPST1-3)	Doctors who have completed two years of foundation training and are now undertaking a 6-month psychiatry placement as part of a 3-year training programme to become a general practitioner.
Higher specialty trainee (ST4-6)	Doctors working as part of a higher training programme which leads to independent practice in a psychiatric specialty (general adult psychiatry, child & adolescent psychiatry, old age psychiatry, forensic psychiatry, medical psychotherapy, psychiatry of intellectual disability). This usually takes 3 years.
Staff grade	Doctors appointed to a permanent position as a senior doctor without completing their consultant training, but with at least two years of post-foundation training. Includes Staff Grade, Associate Specialist, and Specialty Doctors (SAS doctors)
Consultant	Doctors who hold a Certificate of Completion of Training which is the highest level in a specialty (usually after at least 8 years)
Pharmacist prescriber	Pharmacists registered with the General Pharmaceutical Council (GPhC) as a supplementary or independent prescriber
Nurse prescriber	Nurses registered with the Nursing and Midwifery Council (NMC) as a supplementary or independent prescriber
Others	Sometimes elements of the care of some patients are provided by visiting general practitioners, or consultants from another hospital trust, for example, geriatricians.

Sources: BMA, RCPsych[254,255]

The process used within the trust for prescribing medicines follows normal UK practice. Medication orders are handwritten onto a six-page, tri-fold, paper prescription and administration chart; ordinarily referred to as the “drug chart”. An example of the drug chart in use at the time of data collection can be found in

Appendix 5. The front page contains mainly patient information, including name, NHS number, date of birth, and allergy status.

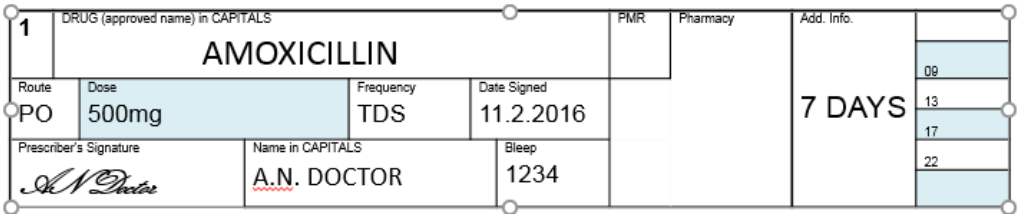


Figure 2.1: Extract from trust drug chart

Each individual medication order is written into a template which prompts for details of drug name, route, dose, frequency and administration times, then signed and dated by the prescriber (see Figure 2.1). Brief instructions on prescribing are contained on the front sheet.

Nurses use the same form to identify when medication doses are due to be administered and to document their administration. One page is designed for prescriptions for home leave. Discharge medications are prescribed on a separate paper prescription form, which doubles as the immediate notification form supplied to the patient's GP at discharge.

2.2.3 Pharmacy services

Wards receive a typical UK hospital pharmacy service; each ward has an allocated pharmacist who visits the ward on a regular basis to assess the patients' drug charts. The frequency of visits is determined by the nature of the ward and the likely length of stay of patients. For example, the Assessment Unit, which has a high turnover of patients, is visited daily, whilst wards with a longer average length of stay will be visited less frequently. The pharmacist screens each patient's drug chart to ensure that all medication orders are clear, legal, and clinically appropriate, resolve any problems identified, and initiates supply of medicines which are not held as stock on the ward or are intended for the patient to take home for leave or on discharge.

As part of their routine duties, ward pharmacists identify any prescribing ambiguities and errors. If a medication order is ambiguous or has information missing, but the pharmacist can determine the intended medication, the drug chart is annotated to clarify the intention; for example, by adding the approved name where the medication had been ordered using the brand name or clarifying the formulation such as where tablets had been prescribed but the product was only available as capsules. If the pharmacist is not certain of the prescriber's intention, or the medication order contains

more significant errors, the prescriber is contacted to clarify and/or discuss what the medication order should contain. Such clinical pharmacy interventions are routinely recorded for in-house analysis, however, only about half of pharmacy interventions tend to involve prescribing errors.[241,256]

2.3 Prevalence and nature of prescribing errors

This prospective quantitative part of the study investigated the prevalence and nature of prescribing errors in inpatients in a mental health setting.

2.3.1 Definition

The practitioner-led definition of prescribing error developed by Dean *et al*[25] which was used in this study (see Section 1.3.3) has been used by the Department of Health[53] and extensively in other similar research studies.[13,14,17–19,99–101,104,257–259]

As this definition was developed for use in an acute hospital setting, the list of situations that should be included or excluded as prescribing errors was extended, based on other studies,[99–101] to include scenarios relevant to mental health. These included compliance with the 'Consent to Treatment' requirements of the Mental Health Act (MHA) and appropriate monitoring for high-risk psychotropic drugs such as lithium and clozapine.

2.3.2 Data collection

Fourteen ward pharmacists, none of whom had prescribing responsibilities for inpatients, were involved in the collection of prescribing error data as part of their routine prescription monitoring duties. To ensure consistency and optimise accurate data collection, all participating pharmacists underwent one-to-one or small group training, delivered by the researcher, in advance of their first episode of data collection. This covered the background, objectives, and data collection methods of the study, including full details of the prescribing error definition being used, advice on what should and should not be included as prescribing errors, and step-by-step instructions on how to complete the data collection forms.

Pharmacists were advised to include all prescribing errors that met the definition, regardless of their severity, including 'minor' errors that they corrected by endorsing the chart, and those that were not changed by the prescriber following an intervention, as they would be reviewed by the researcher.

Each pharmacist was provided with an explanatory handbook, written by the researcher, for reference during the study (see Appendix 6). This covered the items

discussed during the training session, and included examples of completed data collection forms, These were based on instructions provided to data collectors in previous studies.[260,261]

Because the data routinely collected within the trust on pharmacy interventions were not designed for research purposes, during the study period ward pharmacists were asked to collect additional information about the prescribing errors that they identified. Data collection for the study did not replace the need to report errors through the trust's incident reporting system as normal. In order that it was clear that the procedures involved were outside their routine ward activities, and their participation was voluntary, pharmacists were asked to complete a consent form which advised that they had the right not to take part in data collection for the research project if they preferred (see Appendix 7).

2.3.3 Sampling and data collection

Pharmacists prospectively checked prescription charts for newly prescribed or rewritten items, or items omitted. Prescriptions written on admission, during the inpatient stay, and for leave or discharge, including once-only and when required medicines were included. Data were collected between 09.00 and 17.30, Monday to Friday and 09:30 to 12.30 Saturday, but included medication orders written outside those hours. Data were collected every fourth week between August 2015 and June 2016, and again between October 2016 and August 2017.

Where omitted items were identified during medicines reconciliation following admission, or by comparison with previous drug charts (leave, discharge or re-written prescriptions) the pharmacist determined whether the items were intentionally omitted before recording them as a prescribing error.

Data on the number of newly prescribed or omitted items and the resultant number of errors identified were captured using two standard forms, which were piloted within one service type (forensic wards – see Table 2.2) during December 2014. For each newly prescribed/omitted item the pharmacist recorded the prescriber type (see Table 2.3), stage of patient stay, whether the item was a psychotropic or non-psychotropic drug, and for regular or when required use (see Appendix 8). These data provided the denominator for calculating prescribing error rates.

For each prescribing error, the pharmacist recorded prescriber details along with the nature of the prescribing error, whether any doses had been administered/omitted before the error was detected, whether harm was experienced by the patient, and

potential clinical significance (see Appendix 9). These data provided the numerator for calculating prescribing error rates. Each medication order could be associated with more than one prescribing error.

2.3.4 Classification of errors

Pharmacists classified errors using the categories shown in Table 2.4, which were based on error types identified by Lisby *et al* during a systematic literature review of 203 studies into the definition and characteristics of medication errors.[74,86] All completed data collection forms were checked by the researcher to verify that errors met the study's definition and that they were correctly classified, with exclusion or re-classification as necessary. Medicines involved in errors were also categorised according to the relevant chapter and section of the legacy British National Formulary (BNF).[262]

Table 2.4: Error categories

Allergy information missing	Omission of route of administration
Allergy to prescribed drug	Omission of signature
Ambiguous drug name	Omission of strength/unit
Calculation error	Omission of treatment time
Decimal place error	PRN without maximum dose limit
Drug-disease interaction	PRN without minimum dose interval
Drug-drug interaction	Wrong concentration
Drug-lab test interaction	Wrong dose
Duplication of drug(s)	Wrong dosing interval
Illegible handwriting	Wrong drug
Omission of date	Wrong formulation
Omission of dose	Wrong duration of treatment
Omission of dosing interval	Wrong route of administration
Omission of drug	Wrong strength/unit
Omission of formulation	Wrong transcription
Omission of indication for PRN	Other

2.3.5 Assessment of clinical significance

Ward pharmacists were asked to assess the potential clinical significance of each error, using a validated method originally developed for assessing the severity of medication errors,[253] which had previously been adapted for use with prescribing errors.[263,264]

This involved a visual analogue 0 to 10 scale with anchors of ‘no potential effect’ and ‘death’ (Figure 2.2). Errors with a score of less than 3 were considered to be minor, those with a score between 3 and 7 (inclusive) considered to be moderate, and errors with a score above 7 to be severe.

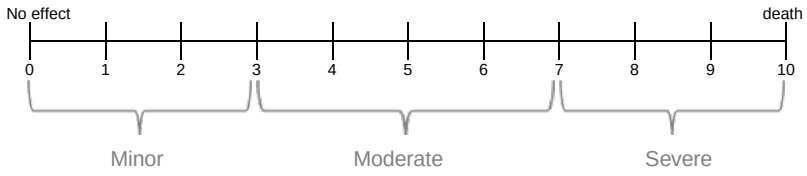


Figure 2.2: Clinical significance scale

Pharmacists needed to use their professional judgement, taking into account the specific circumstances of the patient, their drug regimen, their condition and co-existing morbidities. Examples from previous studies [16,20,44,180,261] were provided in the explanatory handbook (Appendix 6) to help pharmacists assess clinical significance, and this was discussed during the training.

2.3.6 Validation

The assessments of severity given by the ward pharmacists were verified by a multi-professional panel of four experienced health care professionals. The panel consisted of two mental health clinical pharmacists (who were from other organisations, and therefore not involved in data collection), one consultant psychiatrist, and one senior nurse (who was also qualified as an independent non-medical prescriber). Between them, the panel members had more than 80 years of relevant professional experience.

A brief description of each error was produced describing the drug, dose, and strength and presented to the panel alongside a copy of the visual analogue scale (see Appendix 10). Legal issues were assumed to have no clinical significance and were excluded from this process. Where the same or very similar errors had been identified more than once, only one occurrence was assessed to minimise workload for the panel, and the resulting score applied to all errors of that type.

For each error description, the mean score across the four members of the panel was calculated and used as the index of clinical significance.

2.3.7 Data analysis

Descriptive statistics were applied to analyse the frequency of error by prescriber type and the nature of prescribing errors identified (e.g. stage, route, severity, drug class).

Analysis was undertaken using the software program SPSS® version 22 (IBM Corporation, Armonk, NY, USA).

The denominator for calculating prescribing error rates was the number of newly prescribed medication orders screened by pharmacists and omitted items. The numerator was the number of such medication orders which contained one or more prescribing error. All confidence intervals (CIs) were calculated at 95%.

2.3.8 Sample size calculation

Sample size calculations were undertaken by Select Statistics‡ (personal communication; 15 May 2015) to determine the number of medication orders needed:

- to estimate the overall prescribing error rate, with 95% confidence, to within a margin of error of ±1% to ±5%
- to estimate the prescribing error rate for each prescribing stage, with 95% confidence, to within a margin of error of ±1% to ±5%
- to estimate the prescribing error rate for each prescriber type (grade) with 95% confidence, to within a margin of error of ±1% to ±5%

Sample sizes based on estimates for the expected proportions of medication orders with an error, taken from previously published studies by Haw & Stubbs,[100] Stubbs *et al*,[101] and Keers *et al,*[147] are shown in Table 2.5.

Table 2.5: Sample size estimate for overall prescribing error rate

Reference	Expected error rate (%)	Estimated Sample Size	
		1% margin of error	5% margin of error
Haw & Stubbs, 2003[100]	2.2%	827	34*
Stubbs *et al*, 2006[101]	2.4%	900	36*
Keers *et al*, 2014[147]	6.3%	2,268	91

* np <5 so sample size should be treated with caution as may be insufficient to achieve the required precision.

For example, it was calculated that a sample size of 2,268 medication orders was required to estimate the overall prescribing error rate with 95% confidence and to within a margin of error of ±1%, based on an expected rate of 6.3%, whilst smaller sample sizes would be adequate if the prescribing error rate was actually lower.

‡ Select Statistics, Exeter, UK. www.select-statistics.co.uk

In order to allow sub-analysis based on various parameters, similar sample size calculations were undertaken for prescribing stage and prescriber type, based on the results found by Keers *et al.*[147] These are shown in Table 2.6.

Table 2.6: Sample size estimate for sub-analysis prescribing error rates

	Expected error rate	Estimated Sample Size	
		1% margin of error	5% margin of error
Prescribing Stage			
On admission	10.7%	3,671	147
During stay	6.5%	2,335	94
Re-write	3.6%	1,334	54*
Leave	4.5%	1,651	67*
Discharge	6.5%	2,335	94
Prescriber Grade			
Foundation year 1	5.1%	1,860	75*
Foundation year 2	4.9%	1,791	72*
Specialty trainee	6.8%	2,435	98
Staff grade	6.5%	2,335	94
Consultant	5.8%	2,099	84*

* np <5 so sample size should be treated with caution as may be insufficient to achieve the required precision.

For example, it was calculated that a sample size of 3,671 medication orders written on admission was required to estimate the prescribing error rate for that type of medication order, with 95% confidence and to within a margin of error of ±1%, whilst a sample size of 2,435 medication orders written by specialty trainees was required to estimate the prescribing error rate for that group of prescribers with the same level of confidence and precision.

Based on the relative proportions of overall medication orders falling into each category within the Keers *et al* study[147] it was estimated that a total sample size of approximately 11,000 medication orders was required to allow sub-analysis with a ±1% margin of error; a lower sample size would achieve a margin of error between ±1 and ±5%. The sample size was reviewed during data collection to achieve a balance between scientific rigour in relation to the margin of error and workload for the data collectors.

2.4 Causes of prescribing errors

This qualitative, interview-based part of the study explored the causes of prescribing errors in hospital inpatients in a mental health setting.

2.4.1 Sampling and data collection

A purposive sample of prescribers was identified. During each third data collection week between August 2015 and August 2016, all prescribers who made a prescribing error were given a letter by the ward pharmacist inviting them to participate in a semi-structured qualitative interview about the error made (see Appendix 11) and asking them to contact the researcher. The letter was accompanied by a participant information sheet (Appendix 12) and consent form (Appendix 13). Potential participants were assured that all information collected during the interview would remain private and that any verbatim quotes used would not be attributed to named individuals. Details of the prescriber and prescribing error were provided to the researcher by the ward pharmacist, omitting any information about the patient for whom the item(s) had been prescribed. Written consent was obtained from each interview participant.

2.4.2 Interview design

Where possible, semi-structured interviews were conducted within 96 hours of the error to aid recall. Interviews were guided by an interview schedule (see Appendix 14) which included mainly open-ended questions about the prescriber, the prescribing error, circumstances in which the error occurred, and perceived contributing factors to the error. Interviews were up to 60 minutes duration, conducted face-to-face by the researcher, and in a place convenient to participants to ensure privacy.

2.4.3 Transcription and thematic analysis

All interviews were audio-recorded with the participant's consent (see Appendix 13) and participants were assured that they would not be named in any resulting reports or publications. In case of device failure, interviews were recorded using two digital recorders, wherever possible in venues intended to ensure appropriate sound quality, for example, the participant's office, or seminar/meeting rooms. The audio-recordings were transcribed by the researcher as a 'clean verbatim' transcription, excluding non-verbal utterances (e.g. uhm, uh, stutters, laughter and false starts) or confirmatory interruptions by the interviewer or interviewee (e.g. "I see", "yes", "uh-huh"). External sounds such as "sound of door opening" were excluded from the transcription, as were names of patients or staff members mentioned during the interview. All transcripts were proofread for accuracy before analysis. A sample of 20% of audio recordings and transcripts were checked by a third party for accuracy and completeness. Transcriptions were de-identified.

Transcripts were analysed using the six-step process of inductive thematic analysis described by Braun and Clark[265] with the aid of NVivo© qualitative data analysis software (v11; QSR International Pty Ltd, Melbourne, Australia) to organise the data. Once the accuracy of transcripts had been confirmed, initial codes were generated on a line by line basis. Words, phrases, and sections of text that could be considered to have a specific meaning were assigned to codes within each transcript. Coding was reviewed across transcripts to ensure that they had been consistently applied, with each transcript being reviewed three times. Codes were grouped, and themes were identified from them, again being reviewed for consistency across the dataset. Themes were then grouped into categories. Codes, themes, and categories were based on the words and phrases used by the interviewees. Anonymised quotations are used to illustrate themes in the results section (see Chapter 4).

2.5 Decision-making characteristics of prescribers

This part of the study sought to determine the decision-making characteristics of prescribers and whether there was a correlation between cognitive style and making prescribing errors.

2.5.1 Sampling and data collection

Between October 2015 and November 2016, trust staff with the potential to prescribe within the study sites identified in Table 2.2 were invited by email to participate in this part of the study. A web-based survey tool (SurveyMonkey Inc. Palo Alto, California, USA) was used to communicate with most participants, although some completed a paper-based version. The opening page of the web-based survey contained a participant information sheet and consent form, with participants asked to select “I agree” to participate, or “I do not agree” to leave the survey.

The survey included questions about demographics (i.e. age, gender, number of years in practice, level of training, sub-specialty), as well as three validated scales in which individual differences in thinking style can be demonstrated (see Appendix 15). Non-responders received up to four follow-up requests by email.

2.5.2 Scales and measures used

The three scales used were the Cognitive Reflection Test (CRT),[226] Rational Experiential Inventory (REI-40),[200] and Need for Cognition Scale (NCS).[239] Separately and collectively these tools are designed to identify the preference of prescribers for rational or experiential (intuitive) thinking and are described in more detail in Section 1.7.2.

Cognitive Reflection Test

An 8-item version was used in this study containing five additional problems kindly supplied by Professor Frederick (personal communication; 05 May 2014); two of which have subsequently been validated as part of an expanded 7-item CRT.[266] Scores were calculated on the number of correct items. In order to ascertain that respondents who answered incorrectly were lured by the 'intuitive' incorrect answers, a second coding system split responses into correct, 'intuitive' incorrect, and other incorrect answers.

Rational Experiential Inventory

The 40-item version of the 'Rational Experiential Inventory' (REI-40)[200] was used, which contained subscales for ability and engagement with rationality and experientiality. Each item was measured on a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5) with a balanced number of positively and negatively worded items on each scale, and some items reverse-scored. Scores were averaged to provide a composite score for each scale and subscale, with a higher score reflecting a greater tendency to endorse the thinking style.

Need for Cognition scale

The short, 18-item, form of the 'Need for Cognition Scale' (NCS) was used as a measure of information processing, thinking and judgement.[239,240] Each item was measured on a 9-point Likert scale ranging from "very strongly disagree" (-4) to "very strongly agree" (+4) with half of the items reverse-scored. Example questions include "I would prefer complex to simple problems" and "I only think as hard as I have to". Scores from the 18 items were aggregated to give a single score, with the possible range of scores from 72 to -72. High scores indicate an individual's tendency to organize, abstract and evaluate information.[239]

2.5.3 Data analysis

Two datasets were produced from the survey responses. The first provided an evaluation of the decision-making characteristics of prescribers working in a mental health setting. For the second, data on decision-making characteristics were correlated with information collected in an earlier stage of the study on prescribing errors.

Data were analysed using SPSS® version 22 (IBM Corporation, Armonk, NY, USA). Descriptive statistics were produced for the first dataset. For the second dataset,

descriptive and inferential statistics were produced. The following hypotheses were tested:

> ***H_0*** *– there is no statistically significant difference in the prevalence of prescribing errors made by prescribers with a preference for the two cognitive styles (those who execute tasks quickly and with little conscious deliberation, and those who take a slower and more reflective approach).*
>
> ***H_1*** *– there is a statistically significant difference in the prevalence of prescribing errors made by prescribers with a preference for the two cognitive styles (those who execute tasks quickly and with little conscious deliberation, and those who take a slower and more reflective approach).*
>
> and
>
> ***H_0*** *– there is no statistically significant difference in the nature of prescribing errors made by prescribers with a preference for the two cognitive styles.*
>
> ***H_1*** *– there is a statistically significant difference in the nature of prescribing errors made by prescribers with a preference for the two cognitive styles (those who execute tasks quickly and with little conscious deliberation, and those who take a slower and more reflective approach).*

Analysis was undertaken using the software program SPSS® version 22 (IBM Corporation, Armonk, NY, USA).

2.5.4 Sample size calculation

Sample size calculations were undertaken by Select Statistics (personal communication; 15 May 2015) to determine the number of medication orders needed:

- to carry out a test for a difference in the prescribing error rates by thinking style (rational *vs.* experiential), with 95% confidence and 80% to 90% power
- to carry out a multiple logistic regression analysis, including each relevant explanatory variable used in the study (excluding type of error)

As no research has been conducted regarding the association between thinking style and prescribing error rates, sample size calculations were based on “small”, “medium” and “large” effect sizes,[267] and a Chi-squared test for association. For example, it was calculated that a total sample size of 1,051 medication orders was required to test for a difference in the prescribing error rate by thinking style, with 95% confidence and

90% power, based on a "small" expected effect size (see Table 2.7). The smaller the expected difference between the two groups, the larger the number of medication orders were needed to ensure statistical rigour.

A generally accepted rule-of-thumb for multiple logistical regression is that 10 'events' (i.e. prescribing errors) are needed per coefficient.[268] In order to include each explanatory variable collected in the study (see Appendix 8 and Appendix 9), and assuming an error rate of approximately 6% required a sample size of at least 3,000 medication orders.

Table 2.7: Sample size estimate for testing a difference in prescribing error rates by thinking style

Effect size[267]	Estimated Sample Size	
	80% power	90% power
"Large" (w = 0.5)	32	43
"Medium" (w = 0.3)	88	117
"Small" (w = 0.1)	785	1,051

2.6 Educational intervention

This quantitative part of the study sought to investigate whether exposing prescribers to evidence about how humans make decisions affected the prevalence or type of prescribing errors made.

2.6.1 Participants

A convenience sample of participants was recruited to attend a 3-hour educational session on clinical decision making. This was provided as part of the normal weekly postgraduate education programme to which all medical staff are invited, and which doctors in training posts are expected to attend. Participation was voluntary.

2.6.2 Delivery

The session was delivered over one half-day in October 2016 by a recognised expert in this field - Professor Neal Maskrey, Professor of Evidence-informed Decision Making at Keele University and former Director of Evidence-based Therapeutics at the National Prescribing Centre, where he was involved in producing a video for prescribers on making better decisions.[269]

2.6.3 Content

The session started with a short introduction and preliminary findings from the first phase of the quantitative data collected on prescribing errors within the trust. This was followed by the main theories involved in information mastery and decision making, including practical demonstrations of heuristics and biases, an introduction to the dual process theory of decision making, including bounded rationality, and the impact of affect on decision making. Learning was then reinforced through the application of decision-making theory in small group discussion of participant-generated examples of real-life errors.

The session continued with a discussion of some of the techniques available to improve performance in clinical decision making, including metacognition and cognitive forcing strategies, and how these processes of calibration fit with dual process theory. Finally, some elements of the Cognitive Reflection Test were used to highlight personal thinking styles.

2.6.4 Sampling and data collection

A short questionnaire was developed to evaluate the session. Participants were asked to rate 11 statements about the theory, applied theory and practice of decision making before the session started and again at the end.[270] These measured participants understanding of decision-making processes, using a 5-point Likert scale, as well as collecting demographic and role-based information, and providing the opportunity to comment on the session generally (see Appendix 16). Pre- and post-session scores were compared using a paired samples *t*-test.

2.6.5 Data analysis

Although ideally, paired analysis would be used comparing the before and after prescribing error rate of the same prescribers, prescriber turnover made this unviable. Sample size was based on unpaired analysis to assess whether there was a statistically significant difference. Statistical analysis was used to test the following hypotheses:

> ***H_0*** *– there is no statistically significant difference in the prevalence of prescribing errors made before and after exposing prescribers to an educational intervention.*
>
> ***H_1*** *– there is a statistically significant difference in the prevalence of prescribing errors made before and after exposing prescribers to an educational intervention*.

and

***H*$_0$** *– there is no statistically significant difference in the nature of prescribing errors made before and after exposing prescribers to an educational intervention.*

***H*$_1$** *– there is a statistically significant difference in the nature of prescribing errors made before and after exposing prescribers to an educational intervention.*

2.6.6 Sample size calculations

Sample size calculations were undertaken by Select Statistics (personal communication; 15 May 2015) to determine the number of medication orders needed to carry out a test for a difference in the prescribing error rates pre- *vs.* post- an educational intervention, with 95% confidence and 80% to 90% power.

As it was recognised that dropout rates might be relatively high due to prescriber turnover and that a full set of paired observations was unlikely, the sample size calculations were based on unpaired observations, using the Chi-squared test to assess whether a statistically significant difference in prescribing error rate was present post-intervention. Estimates were calculated based on a reduction in the prescribing error rate from 6% pre-intervention to between 1% and 5% post-intervention (see Table 2.8).

Table 2.8: Sample size estimates for testing a difference in prescribing error rates following an educational intervention

Effect	Estimated Sample Size	
	80% power	90% power
Reduction from 6% to 1%	425	568
Reduction from 6% to 2%	754	1,009
Reduction from 6% to 3%	1,500	2,007
Reduction from 6% to 4%	3,729	4,992
Reduction from 6% to 5%	16,318	21,845

For example, it was calculated that a total sample size (pre- and post-intervention) of 2,007 medication orders was required to test, with 95% confidence and 90% power, for a reduction of 50% from a pre-intervention prescribing error rate of 6% (i.e. a post-intervention error rate of 3%). The smaller the difference in error rate seen as a result

of the educational intervention the greater the sample size required for statistical rigour.

2.7 Ethical issues

2.7.1 Confidentiality

Patients' personally identifiable data (PID) were not collected by the researcher. Details of potential errors were provided to the prescriber by the ward pharmacist who detected it as part of their normal daily duties in a form which did not identify the patient involved.

Interview participants were asked to avoid naming patients during the semi-structured qualitative interviews. Any personally identifiable data mentioned during the interview were removed at the transcription stage. Only anonymised audio-recordings and transcripts were validated by any third party.

No interview participants were named in the report or during any dissemination of findings. Any verbatim quotes were not attributed to named individuals.

Audio recordings and transcripts were anonymised and given file names which did not identify the interviewee, and the key to coding was kept in a separate, password protected document.

2.7.2 Risks to participants

The qualitative semi-structured interviews addressed the subject of making errors, and as such presented the potential to cause psychological distress or anxiety to participants. However, the participants were assumed to be confident, articulate healthcare professionals making this unlikely. The interviews were conducted sensitively, and participants were assured that no blame was being attributed to them.

If the error being discussed had resulted in significant patient harm or was potentially the result of a serious breach of practice, the researcher asked whether the error had been reported via the trust's incident reporting scheme and encouraged the interviewee to do so if it had not. However, any error with the potential to cause patient harm was likely to have already been reported by the member of staff who first discovered it, which might be the original prescriber, another prescriber, administering nurse or pharmacist.

In order that the decision to participate in the study was not influenced by the researcher, the risk of coercion was minimised by sending details about the study through ward pharmacists.

2.7.3 Ethical approval

Guidance on the conduct of research within the NHS indicated that NHS Research Ethics Committee review was not required as the research involved only NHS staff.[271]

The research protocol, including copies of all material to be used during the study (e.g. consent forms, letters, participant information leaflets), was submitted to the University of Portsmouth Science Faculty Ethics Committee (SFEC) in March 2015. The first ethical review led to a request for more information. Re-submission in April 2015 resulted in a favourable ethical opinion with one condition - to use a standard template consent form with the pharmacists who collected data, which was met (Reference: SFEC 2015-015 SCOTT). This can be found in Appendix 17.

In parallel to the SFEC submission, an application was made to the SEPT Research Governance Group (RGG) for permission to undertake the research within the organisation. This involved submission of the online Integrated Research Application System (IRAS) dataset and research protocol. Research Governance approval was provided on 27th March 2015, subject to amendments discussed at the RGG meeting to the IRAS research and development form. These related to sections 54 - 62 and covered the primary and secondary outcome measures, sample size and statistical analysis. An amended version of the IRAS form containing the required amendments was provided to the research manager in May 2015.

Chapter 3. Prevalence and nature of prescribing errors: results and discussion

3.1 Introduction

Between August 2015 and August 2017, 13,684 newly written medication orders were assessed by pharmacists for errors or omissions for this study. A total of 690 errors were recorded; 60 of which were excluded for not meeting the prescribing error definition being used[25] or because insufficient information was provided. Although four reported errors were excluded because insufficient information had been provided by the ward pharmacist to categorise the error, the majority (45/60; 75%) were errors that related to the entire prescription chart rather than to one medication order, with most (42/60; 70%) as a result of the patient's allergy status being omitted from the drug chart. Other whole-chart issues included the prescribers name not being printed (in addition to the signature), not prescribing in line with the format specified in trust policy, and the wrong ward, NHS number, or date of birth entered on the drug chart. Errors affecting the whole chart were also detected in large numbers in a previous multi-centre psychiatric study where 324/880 detected errors were whole chart errors and excluded from analysis; 78% (252/324) of those related to a failure to record the patient's allergy status.[101]

National Institute of Health and Clinical Excellence (NICE) guidance on the diagnosis and management of drug allergy recommends that people's drug allergy status should be documented in the medical records using standard nomenclature and recording details of any drug allergies documented. Patient safety incidents reported to the NRLS between 2005 and 2013 identified over 18,000 incidents involving drug allergy, the majority of which involved a patient with a previously known allergy to the drug or class of drug, and more than a quarter of which caused harm.[272]

The definition of a prescribing error used in this study[25] was developed many years prior to this guidance being issued and it is possible that if the same Delphi exercise was repeated now, the absence of documented allergy status would be considered as a prescribing error. Omission of the general allergy information for a patient, as opposed to errors involving prescribing of a drug to which the patient has a specific allergy, has been included in studies of prescribing error incidence by several researchers.[18,121,187,257,273,274]

Therefore, 630 newly prescribed items were affected by one or more prescribing error or omission, giving an overall error rate of 4.6% (95% CI 4.3 - 4.9%). Fifty-nine medication orders were affected by two errors, and 19 orders by three errors, resulting in a total of 727 errors. The inclusion of the 42 allergy errors excluded in the analysis of this study would have increased the overall prescribing error rate to 4.9% (95% CI 4.6 - 5.2%).

The overall prescribing error rate of 4.6% identified in this study was lower than that found in a similar study involving three mental health trusts in the North West[147] but was higher than found in earlier studies conducted in three private psychiatric hospitals,[100] and in a sample of eight NHS and one private psychiatric hospitals respectively.[101] It was also lower than the median rate of 7% reported in a systematic review of prescribing errors in general hospitals.[17]

Keers *et al* conducted the first study to prospectively identify the prevalence, nature, and predictors of inpatient prescribing errors for newly written or omitted prescriptions in a mental health setting. They found 6.3% (288/4,427) of medication orders to be affected by one or more error compared with the error rate of 4.6% (630/13,684) found in this study. The overall prescribing error rate in both the current study and found by Keers *et al*[147] were higher than previously found by Haw and Stubbs in 2003[100] (2.2%) and Stubbs, Haw and Taylor in 2006[101] (2.4%) in UK psychiatric studies. However, there were methodological differences which are likely to have contributed to the lower error rates found. Haw and Stubbs calculated a denominator from a sample of four days rather than collected denominator data throughout the study's duration. In addition, errors were scrutinised independently by a three-person panel and only included in the study if two or more panel members agreed an error had occurred.[100]

3.1.1 Denominator

Some studies[16,20,189,274] have used all medication orders written during the study period as the denominator from which to calculate prescribing error rates. However, in the US all medicines are individually dispensed for each patient and the pharmacy computer system can be used to easily identify the total number of medication orders written.[16,20] Due to the routine use in the UK of ward stock medicines rather than individually dispensed items this is not possible. Similarly, where electronic prescribing is in place data can more easily be extracted on the total number of medication orders processed.[274] An alternative approach used has been to estimate the number of medication orders written during the study period from a sample of healthcare records,[14] but this is resource intensive and provides only an estimate.

However, most studies restrict data collection to newly prescribed items which have not previously been screened by a pharmacist.[13,101,147,245,259,275] This has the advantage of ensuring that errors cannot be double counted, reduces the amount of extra work required by ward pharmacists, and does not require reference to other data sources.[241] In a study which compared four methods of detecting prescribing errors in the same patient cohort, the authors concluded that only prospective data collection by ward pharmacists and retrospective healthcare record review were usable for research purposes.[155] A comparison of pharmacy, medical and nursing students found that pharmacy students showed a significantly higher prescribing error-identification rate, which the authors suggested may have been due to the greater time spent studying pharmacology and pharmacotherapeutics.[276] This supported the use of pharmacists to identify prescribing errors.

3.1.2 Using ward pharmacists for data collection

The main disadvantage of collecting data during routine clinical practice, rather than as a specific review with the primary aim of collecting research data, was that the number of errors that pharmacists miss, and the number that they identify but fail to record, was unknown.[241] A recent Australian study, involving two teaching hospitals, found that of more than 12,000 prescribing errors identified during retrospective record review, there was evidence that only 10.2% (1,282/12,567) had been detected by hospital staff or patients. A correction or annotation made by the doctor, nurse or pharmacist to the drug chart, a note made in the healthcare records, or existence of a pharmacist's intervention report were considered to be evidence of detection. A greater proportion of those prescribing errors considered to be clinically important were detected by staff (118/539; 21.9%). Very few errors were reported to the hospitals' incident reporting systems - 1.3% of clinically important prescribing errors and 0.12% of all prescribing errors.[107] A Dutch study of prescribing errors added to the medication of test patients also showed that not all errors were detected, with 57% correctly identified by hospital pharmacist and pharmacy technicians.[277] However, the specialist knowledge and training of pharmacists in pharmacology, pharmacotherapeutics and pharmacokinetics makes them ideally placed to identify errors in both practice and research scenarios.[276]

In a study involving one UK teaching hospital, Tully and Buchan identified that the likelihood of senior pharmacists identifying errors was greater than junior pharmacists, and that errors were least likely to be identified on the busiest days, with 40% fewer errors identified on days when the number of drug charts to be clinically checked was

in the upper quartile. They also identified a 'Friday effect' affecting some, but not all, specialties with 16% fewer errors identified on Friday compared with other days of the week, regardless of workload or pharmacist seniority.[275]

Meanwhile, Lesar *et al* commented that the errors detected in their study of prescribing errors in a US teaching hospital over a 9-year period were likely to be "a minimum estimate" because of the lack of adequate patient-specific information to the centralised (dispensary-based) pharmacists who collected data.[44] This supports the view that, even with the potential problems highlighted above, collection of data by ward pharmacists is likely to be more accurate than collection of data by dispensary-based pharmacists, where more errors will go undetected as staff do not have access to the patient or to their clinical information.[241]

Ward-based pharmacists had access to full data on indications and concurrent medical conditions (via patients' paper-based healthcare record and/or the electronic unified record) and were more likely to know both the patient and the prescriber. This method also resulted in larger quantities of data than could have been collected by a single researcher. Donyai *et al* identified that 52% of pharmacist interventions relate to prescribing errors.[256] Data collection by staff who were routinely present on the ward was also less likely to confound the study by what some have called the 'Hawthorne effect', and likely to improve the identification of prescribers.[278]

Two studies which took a similar approach of using ward pharmacists to collect data during their routine ward activities quantified the additional time required for data collection. One found that an average of nine minutes per ward per day was required to collect the data,[245] whilst the other reported that the completion of data collection forms for research purposes was found to be insignificant.[147] Whilst this suggests that the results found in this study may still be an underestimate of the true prescribing error levels, the fact that the ward pharmacists were aware that data were being collected for a specific purpose meant that during data collection weeks, their incentive to accurately record all errors found was high.

3.1.3 Number of prescribers making errors

Medication orders were written by 212 individual prescribers; nearly two-thirds of prescribers (135/212; 63.7%) made at least one prescribing error during the study period. The number of prescribers in each staffing category and the number who made at least one prescribing error is shown in Figure 3.1. Amongst medical

prescribers, 57% of higher specialty trainees made at least one error, whilst 88% of GP trainees did so.

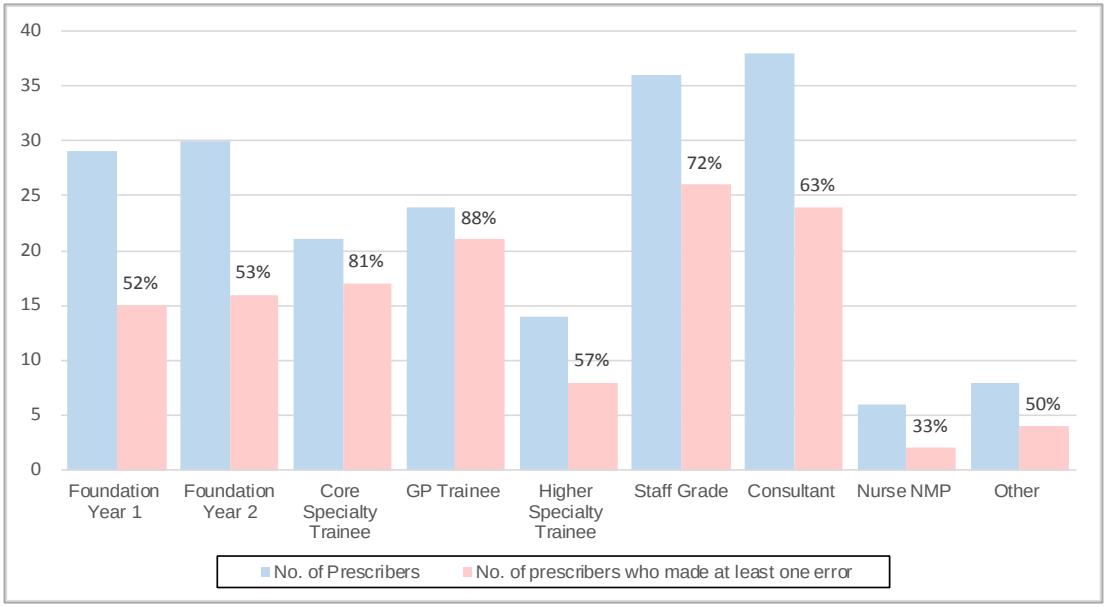


Figure 3.1: Proportion of prescribers who made at least one error

3.1.4 Doses given or omitted before detection

During data collection, pharmacists recorded the number of doses given or omitted before the error was identified for 573 of the 727 errors (78.8%). In nearly two-thirds of cases (61.1%; 350/573) the error was corrected before any doses were administered, with a further 10.6% (61/573) intercepted after one dose had been administered.

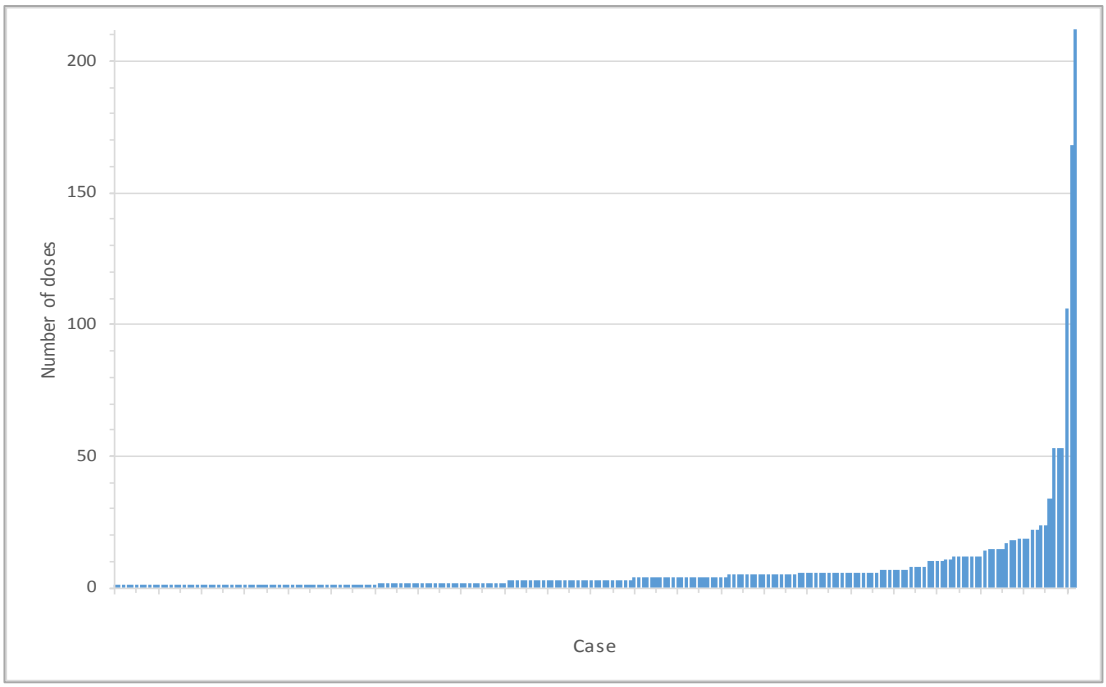


Figure 3.2: Number of doses administered/omitted before detection

In those cases where at least one dose was administered or omitted before the error was identified and corrected (223/573; 38.9%), the mode of doses administered/ omitted was 1.0 and the median 3.0. However, data were skewed by a small number of cases (11/573; 1.9%) where the number of doses administered/omitted before detection was very high (more than 20 doses) (see Figure 3.2). Seven of these errors, including the three with the greatest number of doses prescribed before the error was corrected, were prescription writing errors which involved omission of the formulation. None were considered to have any clinical significance.

3.2 Prescribing stage

Data were collected on the stage during the patient's journey at which a prescription was written. More than two-thirds of items (9,265/13,684; 67.7%) were prescribed either as an addition or change to therapy or because the prescription chart needed to be rewritten. Almost one-fifth of items were prescribed or omitted, at the time of admission, and 12.0% (1,644/13,684) at the time of discharge or when a patient was allowed home on short-term leave as part of their therapeutic management plan (see Table 3.1).

Table 3.1: Items prescribed by stage in the patient journey

	No. of new prescriptions	Proportion of overall new prescriptions
Admission	2,613	19.1%
During inpatient stay	4,552	33.3%
Rewritten prescription	4,713	34.4%
Leave	598	4.4%
Discharge	1,046	7.6%
Not known	162	1.2%
Total	**13,684**	**100.0%**

Although the overall error rate was 4.6%, differing error rates were seen for medication orders prescribed at different stages in the patient journey. Excluding the 162 items where the stage of prescribing could not be determined or was not recorded, items prescribed on discharge were associated with the highest error rate (7.7%; 81/1,046), although these accounted for a small proportion of the total prescription volume (7.6%; 1,046/13,684). In contrast, re-written drug charts were associated with the lowest error rate (2.1%; 100/4,713) and accounted for the largest proportion of prescriptions written (34.4%; 4,713/13,684). The respective prescribing

error rates associated with different stages of the patient journey are shown in Figure 3.3.

The differences between error rates for the stages in the patient journey were tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. This demonstrated a significant difference between the error rates for each of discharge prescriptions, prescriptions written on admission, and rewritten prescriptions, when compared with those written during all other prescribing stages in the patient journey (χ^2 (5) = 120.525, $p < 0.001$).

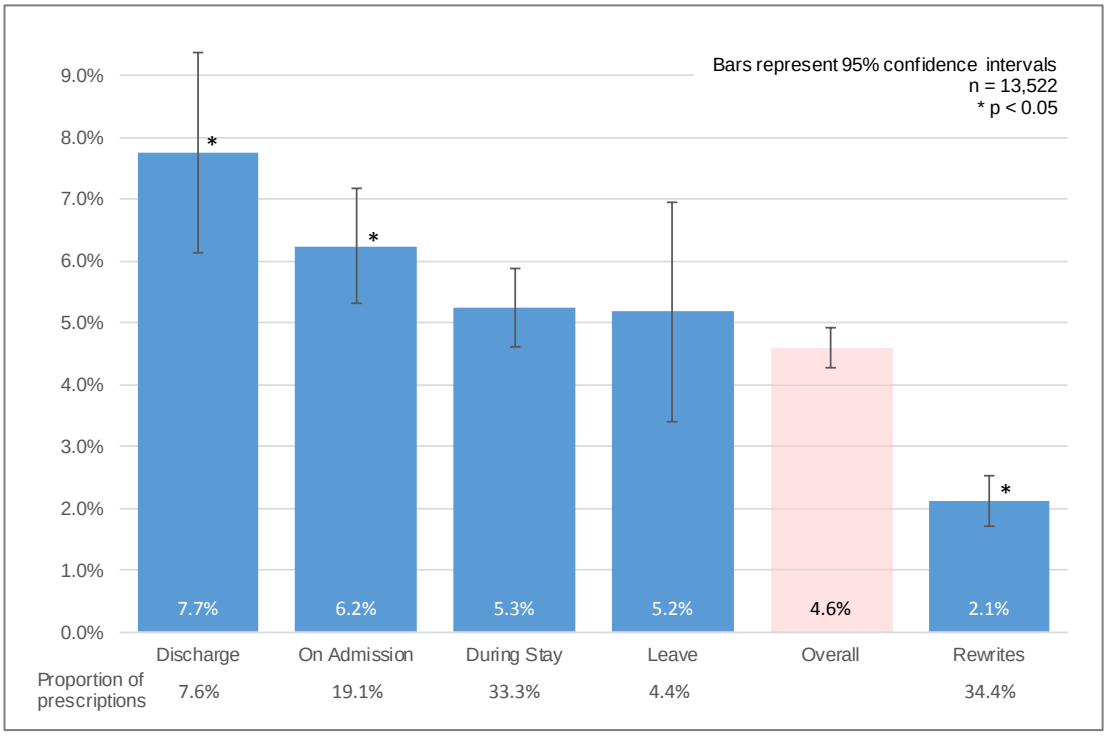


Figure 3.3: Prescribing error rate by prescribing stage

Significantly higher rates of prescribing errors were observed at those stages in the patient's journey involving transitions of care, with the error rate for medication orders written on admission 6.2% and on discharge 7.7%. It is well recognised that when patients move between care providers there is a substantial risk of miscommunication and unintended changes to medicines.[279] Significant levels of omission of drugs on admission and discharge prescriptions have been found in other studies of prescribing errors in general hospitals,[13,17–19,257,261] but had not been previously noted in UK psychiatric studies[99–101,128] until the publication of the Keers *et al* study in 2014.[147]

3.2.1 Prescribing errors on admission

The admission error rate observed in this study (6.2%) was lower than that reported by Keers *et al*[147] who found that 10.7% of medication orders written at that stage in

the patient's journey contained one or more error, with omissions being the main contributor. A 2002 study by Morcos *et al* identified that when patients were admitted to a psychiatric hospital, medication was omitted in 57% of the cases they reviewed.[150] The introduction of medicines reconciliation following guidance issued by NICE/NPSA in 2007[280] was intended to reduce such discrepancies, and a study by Brownlie *et al*[281] in 2013 identified that unintentional medication discrepancies, most involving omissions, were identified and resolved in 56.2% of mental health admissions because of medicines reconciliation. A mean discrepancy rate of 1.5 medicines per admission was found.

Within SEPT, almost all admissions are received into a single Mental Health Assessment Unit (MHAU), which allows the staffing resources associated with undertaking medicines reconciliation to be concentrated in a single place. This results in more than 95% of admissions being able to benefit from a pharmacy-led medicines reconciliation.[282] This model of service is not implemented in all trusts and may have an impact on the timeliness and effectiveness of medicines reconciliation at the point of admission. This may explain why the error rate found in the current study was lower than found by Keers *et al*.[147]

In a general hospital setting, Franklin *et al* identified a higher error rate for medical admission wards, which was associated largely with the omission of patient's usual medication following admission to hospital,[13] whilst Seden *et al* identified the most frequent error in a study of nine hospitals to be unintended medication omission following admission.[257] Although it has been identified that the majority of medicines omitted on admission will result in negligible patient impact, a small proportion will result in significant long-term impact, and more in significant short-term impact.[283]

In single hospital studies, Tully *et al* found that 14.5% of medication orders on admission contained an error, with the majority (46.8%) associated with the category 'need for drug' which included omissions,[275] while Dean *et al* found an error rate on admission of 1.3%.[14] However, that study used an estimated denominator and only associated one prescribing error with each medication order, so may have reported an underestimate of the actual error rate, as it was much lower than found in other studies. Ashcroft *et al* identified that prescribing errors were 70% more likely at the time of admission to hospital than during the inpatient stay, with an error rate on admission of 13.3%, compared with 7.5% during the hospital stay.[284] Further details of studies which have explored prescribing error rates at different stages of the patient's journey are shown in Table 3.2.

Table 3.2: Comparative prescribing error rates by prescribing stage

Study	Details	Prescribing error rate (%) (95% CI)					
		On admission	During stay	Rewrites	Leave	Discharge	Overall
General hospital setting							
Dean *et al*. 2002[14]	Prospective study over 4 weeks in one UK hospital. 36,168 (estimate) medication orders reviewed, and 538 errors identified.	1.3%	1.8%	1.0%	-	1.3%	1.5%
Tully *et al*, 2009[275]	Prospective study over 18 months in one UK hospital. 33,012 medication orders reviewed, and 3,455 prescribing errors identified for 2,324 patients.	14.5%	9.0%	7.4%	-	12.0%	10.5%
Seden *et al* 2013[257]	Prospective study of at least 400 prescriptions* per site in nine UK hospitals. 4,238 prescriptions reviewed, and 3,011 prescribing errors found in 1,857 prescriptions	56.7%	-	-	-	34.5%	43.8%
Ashcroft *et al*, 2015[19]	Prospective study over 7 data collection days in 20 UK hospitals. 124,260 medication orders reviewed, and 11,235 prescribing errors found in 10,986 orders	13.3% (12.8 – 0)	7.5% (7.1 – 7.9)	3.9% (3.5 – 4.4)	-	6.3% (5.9 – 6.7)	8.8% (8.6 – 9.1)
Mental health setting							
Keers *et al*, 2014[147]	Prospective study over 10 data collection days in three UK mental health trusts. 4,427 medication orders reviewed, and 288 prescribing errors found in 281 orders	10.7% (8.6 – 12.7)	6.5% (5.3 – 7.8)	3.6% (2.6 – 4.6)	4.5% (1.9 – 7.0)	6.5% (4.3 – 8.6)	6.3% (5.6 – 7.1)
Keers *et al*, 2015[148]	Prospective study over 6 data collection weeks in three UK mental health trusts. 1,456 medication orders reviewed, and 74 prescribing errors found.	-	-	-	-	5.1% (4.0 - 6.2)	5.1% (4.0 - 6.2)
This study	**Prospective study over 24 data collection weeks in one UK mental health trust. 13,684 medication orders reviewed, and 727 prescribing errors found in 630 orders**	**6.2% (5.3 – 7.2)**	**5.3% (4.6 – 5.9)**	**2.1% (1.7 – 2.5)**	**5.2% (3.4 – 7.0)**	**7.7% (6.1 – 9.4)**	**4.6% (4.3 – 4.9)**

* one prescription could contain one or more medication order.

3.2.2 Prescribing errors at discharge

At the opposite end of the patient's journey, the transition of care on discharge was also associated with a significant error rate. Discharge medicines demonstrated the highest error rate within the study, with 7.7% of medication orders containing one or more error or omission. This finding was slightly higher than found by Keers *et al* who reported a prescribing error rate on discharge of 6.5%.[147] In a further study specifically investigating the quality and safety of discharge prescriptions in a specialist mental health setting, Keers *et al* found that one in twenty (5.1%) of individual medication orders written on discharge contained at least one prescribing error, and one in five (20.8%) discharge prescriptions were affected.[148] Nelson *et al* had also previously identified 23.3% of discharges from a US psychiatric inpatient facility to have a medication discrepancy when the medication discharge plan was compared with the medication administration record for the last day of the hospital stay. However, they did not quantify an error rate in terms of medication orders.[152]

Although Lewis *et al* in their systematic review of the prevalence and nature of prescribing errors in hospital inpatients, undertaken as part of the EQUIP study commissioned by the GMC,[18,172] did not comment on prescribing errors by stage in the patient's journey, some individual studies have provided this analysis. Tully *et al* studied prescribing errors in a single hospital and found that 12.0% of medication orders written on discharge contained an error, with most (49.8%) categorised as 'need for drug' which would include errors relating to omitted medicines.[275] In another single hospital study, Dean *et al* found a prescribing error rate of 1.3% for discharge medication, although the use of an estimated denominator may have impacted the calculations.[14] Ashcroft *et al* undertook a study of prescribing errors in 20 UK hospitals and identified an error rate of 6.3% associated with discharge medication.[19]

Whilst most studies have explored errors rates for individual medication orders, Seden *et al* investigated complete prescriptions (i.e. all items on a single inpatient prescription chart or discharge prescription) citing this as a more realistic estimate of the number of patients potentially at risk of harm from prescribing errors. Their study identified that 34.5% of discharge prescriptions (containing one or more medication order) contained at least one prescribing error.[257]

Data by both prescribing stage and prescriber grade/type are shown in Table 3.3.

Table 3.3: Prescribing errors by prescriber grade/type and prescribing stage

Prescriber		Prescribing Stage						
		On admission	During stay	Rewritten	Leave	Discharge	Unknown	TOTAL
Foundation Year 1	Items written/omitted	37	249	129	22	88	8	**533**
	No. with errors	1	23	1	0	4	1	**30**
	Error rate (95% CI) (%)	2.7 (0.0-8.0)	9.2 (5.6-12.8)	0.8 (0.7-2.3)	0 (N/A)	4.5 (0.2-8.8)	12.5 (0.0 - 35.4)	**5.6 (3.7-7.6)**
Foundation Year 2	Items written/omitted	211	222	38	23	23	9	**526**
	No. with errors	34	7	3	1	0	1	**46**
	Error rate (95% CI) (%)	16.1 (11.1-21.1)	3.2 (0.9-5.5)	7.9 (0.0-16.5)	4.3 (0.0-12.6)	0 (N/A)	11.1 (0.0-31.6)	**8.7 (6.3-11.1)**
Specialty Trainee	Items written/omitted	787	1,522	1,218	215	266	57	**4.065**
	No. with errors	64	86	46	3	32	9	**240**
	Error rate (95% CI) (%)	8.1 (6.2-10.0)	5.7 (4.5-6.9)	3.8 (2.7-4.9)	1.4 (0.0-3.0)	12.0 (8.1-16.0)	15.8 (6.3-25.3)	**5.9 (5.2-6.6)**
Staff Grade	Items written/omitted	708	1,195	2,695	112	184	28	**4,922**
	No. with errors	27	58	45	9	12	1	**152**
	Error rate (95% CI) (%)	3.8 (2.4-5.2)	4.9 (3.6-6.0)	1.7 (1.2-2.2)	8.0 (3.0-13.0)	6.5 (2.9-10.0)	3.6 (0.0-10.5)	**3.1 (2.6-3.6)**
Consultant	Items written/omitted	329	1,020	439	210	289	59	**2,346**
	No. with errors	20	46	2	11	33	4	**116**
	Error rate (95% CI) (%)	6.1 (3.5-8.7)	4.5 (3.2-5.8)	0.5 (0.0-1.2)	5.2 (2.2-8.2)	11.4 (7.4-15.0)	6.8 (0.4-13.2)	**4.9 (4.0-5.8)**
Nurse Prescriber	Items written/omitted	0	14	14	6	2	0	**36**
	No. with errors	0	1	0	1	0	0	**2**
	Error rate (95% CI) (%)	-	7.1 (0.0-20.5)	0 (N/A)	16.7 (0.0-46.5)	0 (N/A)	-	**5.6 (0.0-13.0)**
Other	Items written/omitted	467	252	180	0	190	1	**1,090**
	No. with errors	15	12	3	0	0	0	**30**
	Error rate (95% CI) (%)	3.2 (1.7-4.9)	4.8 (2.2-7.5)	1.7 (0.0-3.6)	-	0 (N/A)	-	**2.8 (1.8-3.8)**
Unknown	Items written/omitted	74	78	0	10	4	0	**166**
	No. with errors	2	6	0	6	0	0	**14**
	Error rate (95% CI) (%)	2.7 (0.0-6.4)	7.7 (1.8-13.6)	-	60.0 (29.6-90.4)	0 (N/A)	-	**8.4 (4.2-12.7)**
TOTAL	**Items written/omitted**	**2,613**	**4,552**	**4,713**	**598**	**1,046**	**162**	**13,684**
	No. with errors	**163**	**239**	**100**	**31**	**81**	**16**	**630**
	Error rate (95% CI) (%)	**6.2 (5.3-7.2)**	**5.3 (4.6-5.9)**	**2.1 (1.7-2.5)**	**5.2 (3.4-7.0)**	**7.7 (6.1-9.4)**	**9.9 (5.3-14.5)**	**4.6 (4.3-4.9)**

3.3 Grade/type of prescriber

Most medication orders were written by middle-grade doctors (staff grade, associate specialists and specialty doctors), who were responsible for more than one-third of items (4,922/13,684; 36.0%). A further quarter of items (25.0%; 3,423/13,684) were prescribed by consultant psychiatrists, visiting consultants (mainly geriatricians) or general practitioners. Very few items were prescribed by newly qualified doctors during their foundation training years (7.7%; 1,059/13,684), with a larger proportion prescribed by junior doctors undergoing specialist psychiatric training or a psychiatry rotation as part of GP training (29.7%; 4,065/13,684). The distribution of prescribed items by staff grade is shown in Table 3.4.

Table 3.4: Items prescribed by prescriber grade

	No. of new prescriptions	Proportion of overall new prescriptions
Foundation Year 1	533	3.9%
Foundation Year 2	526	3.8%
Specialty Trainee	4,065	29.7%
Core Trainee (Psychiatry)	*1,904*	*13.9%*
GP Trainee	*818*	*6.0%*
Higher Specialty Trainee (Psychiatry)	*1,343*	*9.8%*
Staff Grade	4,922	36.0%
Consultant Psychiatrist	2,346	17.1%
Other (Visiting Consultants/GPs)	1,090	8.0%
Nurse Non-Medical Prescriber	36	0.3%
Not known	166	1.2%
Total	**13,684**	**100.0%**

3.3.1 Initial analysis by prescriber grade/type

Junior doctors in their second post-qualification year (FY2), and the first year after achieving GMC registration, had the highest error rate at 8.7% (46/526), followed by specialty trainees at 5.9% (240/4,065). Junior doctors in their first post-qualification year (FY1) (30/533), and nurse non-medical prescribers (NMPs) (2/36) both had an error rate of 5.6%, although the number of prescriptions written by nurse NMPs was very low and therefore the 95% confidence interval for the error rate was high (± 6.52%) by comparison to the other categories. Foundation year trainees prescribed less than one in twelve of all medication orders. The error rates for all prescribers by grade/type are shown in Figure 3.4.

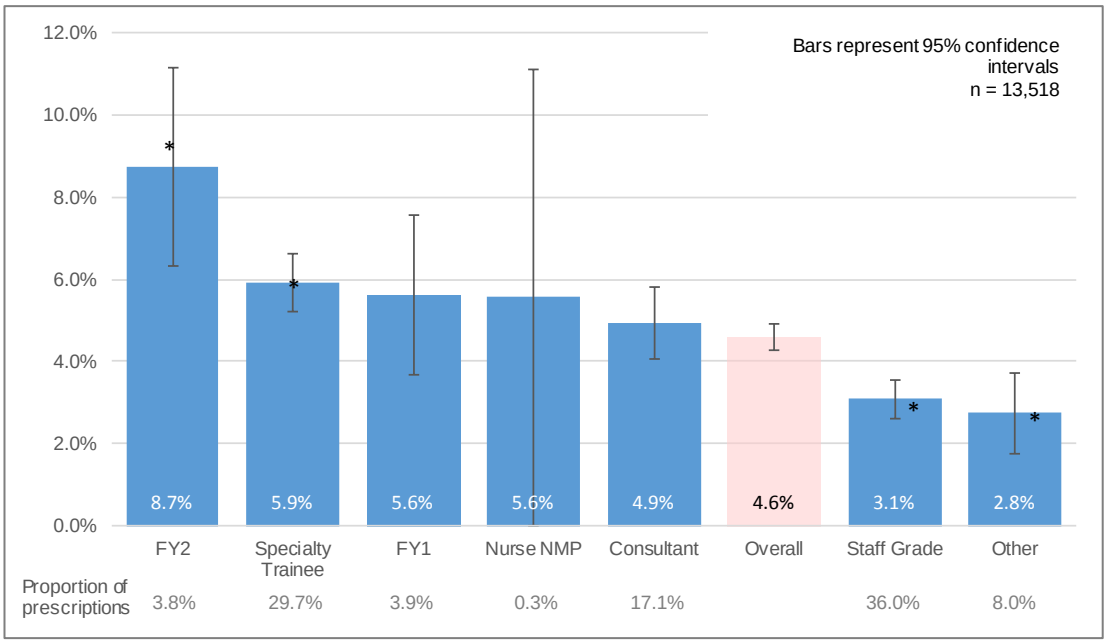


Figure 3.4: Prescribing error rate by prescriber grade/type

The error rate was also high for those prescribers whose identity and therefore grade could not be determined (8.4%; 14/166) however, the prescriptions written by such prescribers represented a very small proportion of the overall number of medication orders (1.2%; 166/13,684). These and medication orders where the prescriber was unknown have been excluded from further analysis and also from data shown in Figure 3.4, Figure 3.5 and Figure 3.6.

The differences between error rates for different prescriber grade/type were tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. This demonstrated that the error rate for foundation year two doctors, specialty trainees, staff grade doctors and 'other' prescribers (visiting consultants, mainly geriatricians, and general practitioners) each differed significantly from other prescriber grade/types, (χ^2 (7) = 77.954, $p < 0.001$). The error rate for nurse NMPs was not significantly different from any other prescriber grade/type due to the very low number of prescriptions (0.3%; 23/7,953) and large 95% confidence interval.

The results found showed some differences from those reported by Keers *et al*,[147] in the only other study in mental health to have investigated prescribing errors by prescriber grade. Their study of three mental health trusts in the UK found that specialty trainees had the highest prescribing error rate at 6.8%, a similar level to this study (5.9%). However, FY2 doctors in the Keers *et al* study were found to have the lowest error rate at 4.9% compared with the highest in this study, at 8.7%. Differences also existed in the patterns of prescribing responsibility between the two studies.

Within SEPT, staff grade doctors were found to make significantly fewer prescribing errors than their colleagues; they were also responsible for writing the greatest proportion of medication orders, accounting for 36.0% of the study sample. In the North West trusts studied by Keers *et al* staff grade doctors were responsible for one third the proportion of medication orders (10.5%) that their SEPT counterparts undertook. In contrast, specialty trainees in the North West undertook 52.8% of the prescribing, compared with SEPT specialty trainees who were responsible for slightly more than half the prescribing of their northern colleagues at 29.7%. Foundation year trainees in the North West also appeared to be responsible for a greater proportion of medication orders at 16.9% compared with 7.6% in South Essex.

Although few studies have reported prescribing error rates by prescriber grade, studies in general hospitals have also demonstrated a considerable difference in the proportion of prescribing undertaken by newly qualified, junior and senior doctors, from that seen in mental health within both this study and the Keers *et al* study.[147] Following suggestions that doctors in their first year of practice (FY1) were responsible for a significant proportion of prescribing errors, the GMC commissioned the EQUIP study,[18] which sought to compare the prevalence of prescribing errors made by FY1s with that of errors by senior doctors. This study of prescribing in 20 UK hospitals identified that more than two thirds of the 124,300 medication orders reviewed were written by foundation year trainees. By contrast consultants were responsible for writing 2.5% of the medication orders studied, and staff grade doctors 3.5%.[18,19] Similarly, a study in eight hospitals in Scotland identified that whilst foundation year trainees were responsible for 64.9% of errors, they were also responsible for 63.9% of prescribing, with consultants and staff grade doctors responsible for 2.6% and 13.3% of medication orders respectively.[189] A systematic review by Ross *et al* of 24 studies addressing prescribing errors by junior doctors identified considerable variation in reported error rates reported ranging from 0.2% - 5.1%; however the authors concluded that inconsistencies in methodology, reporting units and error definition made any meaningful conclusions difficult.[21]

The current study showed the majority of medication orders (36.0%) to be written by staff grade doctors, followed by specialty trainees (29.7%) with consultants responsible for 17.1%) and foundation trainees by comparison undertaking very little of the prescribing (FY1; 3.9%, FY2; 3.8%). Whilst closer to the pattern seen in North West England by Keers *et al*, this is very different from the pattern seen in studies of prescribing in general hospitals (see Table 3.5).

Table 3.5: Comparative prescribing error rates by prescribing grade

Study	Details	Prescribing error rate (%) (95% CI) Proportion of overall prescribing (%)					
		FY1	FY2	Specialty trainee	Staff grade	Consultants	Overall
General hospital setting							
Ashcroft *et al*, 2015[19]	Prospective study over 7 data collection days in 20 UK hospitals. 124,260 medication orders reviewed, and 11,235 prescribing errors found in 10,986 orders	8.6% (8.2 – 8.9) 40.2%	10.2% (9.7 – 10.7) 27.9%	8.1% (7.5 – 8.7) 13.5%	6.4% (5.2 – 7.6) 3.5%	4.8% (3.8 – 5.7) 2.5%	8.8% (8.6 – 9.1) -
Ryan *et al*, 2014[189]	Prospective study over 14 data collection weeks in eight Scottish hospitals. 44,726 medication orders reviews, and prescribing errors found in 3,364 orders	7.4% - 52.1%	8.6% - 11.9%	8.8% - 13.3%	4.1% - 16.1%	6.3% - 3.2%	7.5% - -
Mental health setting							
Keers *et al*, 2014[147]	Prospective study over 10 data collection days in three UK mental health trusts. 4,427 medication orders reviewed, and 288 prescribing errors found in 281 orders	5.1% (2.2 – 8.0) 4.8%	4.9% (3.0 – 6.7) 12.1%	6.8% (5.8 – 7.8) 52.8%	6.5% (4.2 – 8.7) 10.5%	5.8% (3.9 – 7.7) 13.2%	6.3% (5.6 – 7.1) -
This study	**Prospective study over 24 data collection weeks in one UK mental health trust. 13,684 medication orders reviewed, and 727 prescribing errors found in 630 orders**	**5.6%** **(3.7 – 7.6)** **3.8%**	**8.7%** **(6.3 – 11.1)** **3.9%**	**5.9%** **(5.2 – 6.6)** **29.7%**	**3.1%** **(2.6 – 3.6)** **36.0%**	**4.9%** **(4.0 – 5.8)** **17.1%**	**4.6%** **(4.3 – 4.9)** **-**

This may reflect a greater reluctance on the part of medical supervisors in South Essex to allow early career doctors to take on prescribing responsibilities but may also be as a result of prescribers in the North West being responsible for signing medication orders but not necessarily for making the clinical decisions about what to prescribe. In an observational study in a large acute hospital in Scotland, Ross *et al* demonstrated that in 62% of cases where a new medicine was prescribed, the decision maker was not the same person as the prescription writer, with the decision made by more senior doctors than wrote the prescription. They found that whilst doctors in foundation and specialty training grades wrote 97% of the prescriptions, they were only responsible for the prescribing decisions in 66% of cases.[112]

3.3.2 Detailed analysis by prescriber grade

Initial analysis aggregated data for all doctors in post-foundation training posts into a single category of 'specialty trainee'. However, this included three distinct categories of trainee:

- **Core specialty trainees** - in their first three years of basic specialty training in psychiatry, and likely to be 3 - 5 years' post-qualification
- **GP trainees** - in a six-month psychiatry rotation during three years of training to become a GP, and likely to be 3 - 5 years' post-qualification
- **Higher specialty trainees** - in years 4 - 6 of psychiatry training, and likely to be 6 - 9 years' post-qualification.

As the category of 'specialty trainee' shown in Figure 3.4 could include doctors between three and nine years post-qualification and with a wide range of experience, further analysis was undertaken to determine whether error rates varied between the three categories of trainee (see Figure 3.5).

GP trainees were found to have the highest error rate at 9.7% (79/818), whilst staff grade and 'other' prescribers had the lowest error rates at 3.1% (152/4,922) and 2.8% (30/1,090) respectively. GP trainees were responsible for writing a small proportion of prescriptions (6.0%) compared with either core specialty trainees (13.9%) or higher specialty trainees in psychiatry (9.8%) (see Table 3.4). Due to the small proportion of overall prescribing performed by these groups of prescribers the 95% confidence intervals for FY1, FY2 and GP trainees were also relatively large compared with other prescriber groups at ± 1.95%, ± 2.41%, and ± 2.02% respectively.

The differences between error rates for the different prescriber grade/types shown in Figure 3.5 were tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. This demonstrated a significant difference between the error rates for each of GP trainees, FY2 doctors, staff grade and 'other' doctors in comparison to all other prescriber grade/types (χ^2 (9) = 115.391, $p < 0.000$).

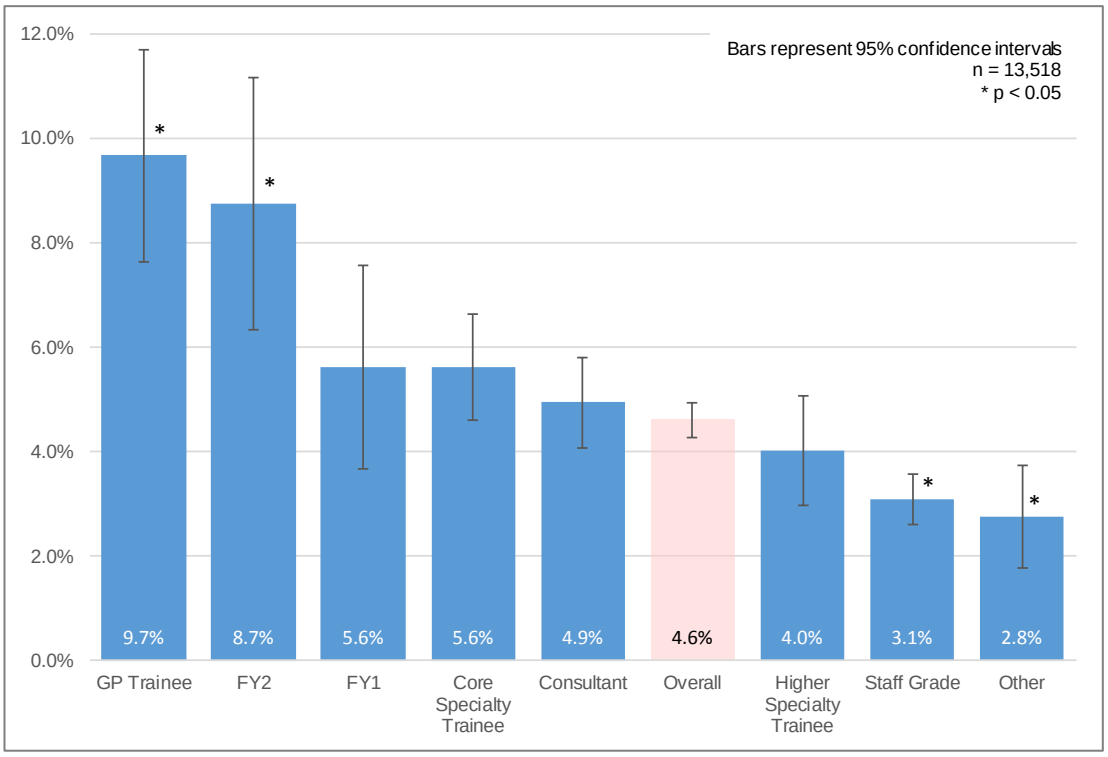


Figure 3.5: Prescribing error rate by prescriber grade/type (detailed)

In line with the approach taken by other similar studies of prescribing errors in general and mental health settings,[18,19,147,189,257] initial analysis aggregated data for all doctors in post-foundation training posts into the single category of specialty trainee, regardless of whether they were undertaking psychiatry or general practice training, and across the potential 6 years required for core and higher specialty psychiatric training. However, as this grouping could include doctors in a wide range of posts and stages of career development, further analysis was undertaken to look at GP trainees, core specialty trainees and higher specialty trainees separately. Although sample size calculations for the study (section 2.3.8) did not anticipate this level of granularity of the data, all grades of prescriber demonstrated a margin of error of less than ±5%.

This would appear to be the first UK study which has investigated prescribing error rates by specialty trainees at this level of detail and demonstrated that as well as FY2 doctors, GP trainees had a significantly higher prescribing error rate than other

doctors, whilst the prescribing error rate of core and higher specialty trainees was not significantly different.

In additional analysis of a study of prescribing errors in oncology patients in a Brazilian teaching hospital,[285] Ferracini *et al* considered the prevalence and severity of prescribing errors by medical residents in years two, three and four of residency training (MR2, MR3 and MR4 respectively).[286] They found that 57% of prescriptions and 61.1% of errors were written by MR2, 18.1% of prescriptions and 20.5% of errors by MR3, and 24.9% of prescriptions and 18.4% of errors by MR4 residents. They noted that there was no statistically significant association between error rate and year of residency training. However, the authors did not provide prescribing error rates in terms of errors per medication order, only commenting on the relative proportions of prescriptions (containing multiple medication orders) and errors, therefore no comparisons can be made with the data provided in this study.

In the US, Lesar *et al* identified prescribing error rates by physician 'class' as early as 1990, classifying prescribers as attending, fellow or postgraduate by year if resident house staff (first, second, third, fourth or greater). The authors reported that first-year residents (equivalent to British FY1s) had a significantly greater error rate than other physicians, with error rates declining progressively with postgraduate years of training, suggesting that experience and knowledge were important factors in performance. They also noted that, surprisingly, attending physicians (equivalent to British consultants) had the second highest error rate, and suggested that infrequent writing of medication orders (attendings wrote only 4.3% of medication orders) increased the risk of errors.[20] A few years earlier Folli *et al* in a study of prescribing errors in two paediatric hospitals, had noted that "the frequency of errant orders declined as physicians' training status increased".[180]

3.3.3 The role of experience

To explore whether there was any relationship between the time since medical qualification and prescribing error rates, further analysis was undertaken separating trainees by year within each training role. Whilst this should be considered an approximate measure as trainees may have transferred into either psychiatry or general practice training following a period working in another specialty, and staff grade doctors and consultants may have been working at this grade for many years, it was used as a proxy to reflect their level of experience (see Figure 3.6).

The differences between error rates for different prescriber grades were tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. This demonstrated a significant difference between the error rates for FY2 doctors and doctors in their first year and second years of core psychiatry or GP training, in comparison to all other prescriber grades. Additionally, there was a significant difference between the error rate for staff grade doctors and all other prescriber grades (χ^2 (10) = 129.591, $p < 0.000$).

The relationship between error rate and prescriber grade (used as a proxy to reflect the level of experience of the individual) was explored using the non-parametric Spearman's correlation coefficient (r_s). This demonstrated a correlation coefficient, r_s, of -0.049 (95% confidence interval -0.030 to -0.067) significant at p < 0.01, indicating a weak relationship between increased experience and decreased prescribing error rates.

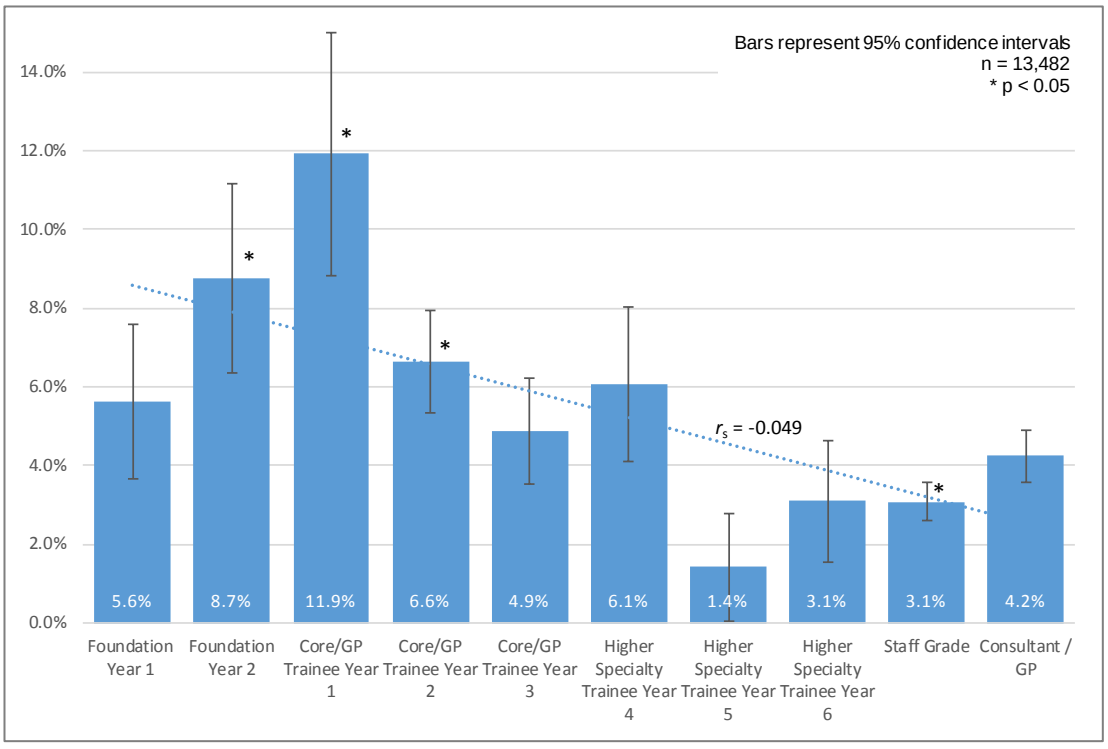


Figure 3.6: Prescribing error rate by prescriber grade (which reflect level of experience)

The current study indicated that early career doctors in the years immediately following registration demonstrated significantly higher error rates. Whilst this finding is similar to other studies which have found that junior doctors are more likely to make prescribing errors,[18–20] some have looked specifically at prescribing errors made by doctors during their foundation training, rather than in any detail at further periods in the career pathway of doctors.[189,287]

It is perhaps unsurprising that FY2 and new core/GP specialty trainee doctors had the highest rates of prescribing errors, as this is the point in their training when they start to work independently, providing out-of-hours cover and operating as the 'duty' doctor on-call. Despite having telephone access to more senior medical colleagues for advice, they are often the only doctor available on-site and are expected to take responsibility for the care of both newly admitted patients, and patients normally in the care of other doctors. For both groups this may also be their first experience of working within psychiatry.

Taking their lead from high-risk industries, Dearden *et al* developed a prototype taxonomy of non-technical skills required for safe prescribing by junior doctors. They highlighted that the application of a similar approach in aviation (termed crew resource management) has been used to reduce accidents and could show promise in medical fields. Their systematic review of studies analysing prescribing behaviours and errors by junior doctors identified a tendency to underestimate the risk to patients from an incorrect prescription, difficulty asking for help, and a belief that they make less errors than the literature suggests, which others will intercept. They also found that junior doctors do not necessarily have the opportunity to learn the skills that they require to become expert prescribers.[288]

Evaluation of the essential knowledge, skills and attitudes in clinical pharmacology and therapeutics has suggested that, across Europe and elsewhere, final-year medical students show an overall lack of essential prescribing competencies, with poor knowledge of drug interactions and contraindications, and the inability to choose appropriate therapies for common diseases.[223,289,290] More than two-thirds of European medical schools did not provide students with the opportunity to practice real-life prescribing prior to qualification.[291] The majority of UK medical students reported that they had filled in a hospital prescription chart less than three times prior to being required to prescribe for the first time as a junior doctor,[292] despite such experience being valued by medical students.[293]

Students lacked insight into their own strengths and weaknesses in prescribing,[114,221] and often did not feel prepared for prescribing.[292,294] Junior doctors have reported difficulties in applying knowledge gained at medical school to clinical practice,[295] and that approachable, available and up-to-date 'teachers' (pharmacists, nurses and more senior doctors) have a significant impact on practical learning about prescribing.[296] More positively, the vast majority of UK final-year medical students are able to pass the prescribing safety assessment (PSA) introduced in 2014.[297]

When faced by unfamiliar and complex situations, humans often rely on heuristics to make fast decisions, as rational and deliberative analysis is not always possible.[206] Most of the research about the cognitive processes used by medical staff has concentrated on diagnosis, but it is likely that there are transferable concepts to the development of treatment plans and prescribing. The concept of "scripts" for arriving at a diagnosis has been suggested - incoming information activates a previously acquired network of relevant knowledge and experience which directs the selection, interpretation and memorisation of new information.

Reasoning with an "illness script" can be seen as both hypothetico-deductive and unconscious, with the activation phase automatic, but the processing phase - the search for evidence to rule a hypothesis in or out, controlled and deliberate.[298] Schmidt *et al* put forward a stage theory for the development of clinical reasoning, based on the assumption that experienced physicians operate on the basis of illness scripts - knowledge structures which emerge from continuous exposure to patients and contain a wealth of clinically relevant information about a disease, its consequences and context. Their theory asserts that physicians use memories of previous patients while diagnosing (and presumably treating) new cases.[299] They describe four developmental stages that are characterised by the emergence of four different knowledge structures, which remain with them:

- **Stage 1**: *development of elaborated causal networks* - acquired knowledge is organised into cognitive models, which provide meaning and structure to otherwise chaotic information. These causal networks explain the causes and consequences of disease in terms of general underlying pathophysiological process and become increasingly elaborate and complex with increased learning.

- **Stage 2**: *compilation of elaborated networks into abridged ones* – through extensive and repeated application of acquired knowledge and exposure to patient problems, the elaborate knowledge base becomes compiled into simplified causal models which contain only the higher-level concepts from the original pathophysiological networks.

- **Stage 3**: *emergence of illness scripts* – the pathophysiological networks are gradually compiled into diagnostic labels or simplified mental models that sufficiently explain the phenomena observed. Problem solving in routine cases becomes a process of script search, selection and verification.

- **Stage 4**: *storing patient encounters as instance scripts* – physicians retain vivid "autobiographical memory" of cases seen earlier. An important component of expertise is the accumulation of countless prior examples and their rapid and effortless retrieval when confronted with a similar situation. The recollections of prior patients, indexed by the relevant illness script, are stored in episodic memory, making them easily accessible.

The authors contend that this is a reasonably accurate description of the development sequence, but also suggest that previously acquired knowledge structures remain available and that expert clinicians may move from one to another as the complexity of the problem demands. It is likely that this equates to the interaction between System 1 and System 2 thinking described as "rational override" and "calibration" in the model of reasoning based on pattern recognition and dual process theory described by Croskerry (see Figure 1.7).[202–204]

It has been suggested that the development of expertise requires intense practice extended for a minimum of 10 years,[300,301] a concept popularised as "the 10,000-hour rule" in Malcolm Gladwell's book *Outliers.*[302] The result seen in this study that there is an, albeit weak, inverse relationship between prescribing error rates and experience would appear to support this assertion. The likelihood of errors decreases with increasing expertise and knowledge[73] with more experienced individuals able to see the relevant information in a problem and analyse it in an explicit, logical manner, while the inexperienced individual does not recognise the critical information and performs worse.[303]

3.4 Steps in the drug use process

Errors most frequently occurred during the step of the prescribing process that related to providing instructions for the supply of the medicine (35.9%; 261/727) such as specifying the correct strength/unit, formulation or route of administration. However, this also included failure to comply with legal requirements such as signing (3.4%) or dating (8.3%) the prescription and complying with controlled drug legislation (0.4%). Overall, nearly one-quarter of errors related to selecting the dosage regimen (23.9%; 174/727), with 10.2% (74/727) of errors due to prescribing an incorrect dose. Further detail can be found in Table 3.6.

Table 3.6: Types of prescribing errors by step in the drug use process

Error type	No.	%
Need for drug	**117**	**16.1%**
Duplication of drug(s)	48	6.6%
Omission of drug on admission	29	4.0%
Omission of drug on leave/discharge prescription	24	3.3%
Wrong transcription	8	1.1%
Omission of drug on rewritten prescription	4	0.6%
Premature discontinuation	2	0.3%
Drug not indicated	2	0.3%
Select specific drug	**26**	**3.6%**
Wrong drug	18	2.5%
Ambiguous drug name	3	0.4%
Allergy to prescribed drug	2	0.3%
Non-compliance with MHA requirements	2	0.3%
Drug-lab test interaction	1	0.1%
Select dosage regimen	**174**	**23.9%**
Wrong dose	74	10.2%
PRN without minimum dose interval	45	6.2%
PRN without maximum dose limit	22	3.0%
Omission of duration/review date	14	1.9%
Wrong duration of treatment	11	1.5%
Omission of dose	8	1.1%
Provide administration instructions	**149**	**20.5%**
Wrong dosing interval	64	8.8%
Omission of dosing interval	37	5.1%
Omission of indication for PRN	20	2.8%
Omission of treatment time	16	2.2%
Wrong route of administration	7	1.0%
Omission of indication for an antimicrobial	5	0.7%
Provide instructions for supply of product	**261**	**35.9%**
Omission of formulation	104	14.3%
Omission of date	60	8.3%
Omission of signature	25	3.4%
Omission of strength/unit	25	3.4%
Wrong formulation	22	3.0%
Wrong strength/unit	12	1.7%
Omission of route of administration	7	1.0%
Illegible handwriting	3	0.4%
Non-compliance with controlled drug requirements	3	0.4%
	727	**100.0%**

A greater proportion of the errors made by core/GP trainees and consultants involved the process of determining the need for a drug. This step in the process accounted for 23.0% (47/204) and 21.3% (37/174) of the errors made by these types of prescribers respectively, compared with 19.1% (135/708) overall. Staff grade doctors made the most errors involving the process of selecting a specific drug with these accounting for 36.5% (65/178) of all errors made by them, compared with 21.2% (150/708) of errors overall. Errors associated with selecting a specific drug were also higher amongst FY1 doctors at 27.8% (10/36). More information on the step in the drug use process and prescriber grade can be found in Figure 3.7.

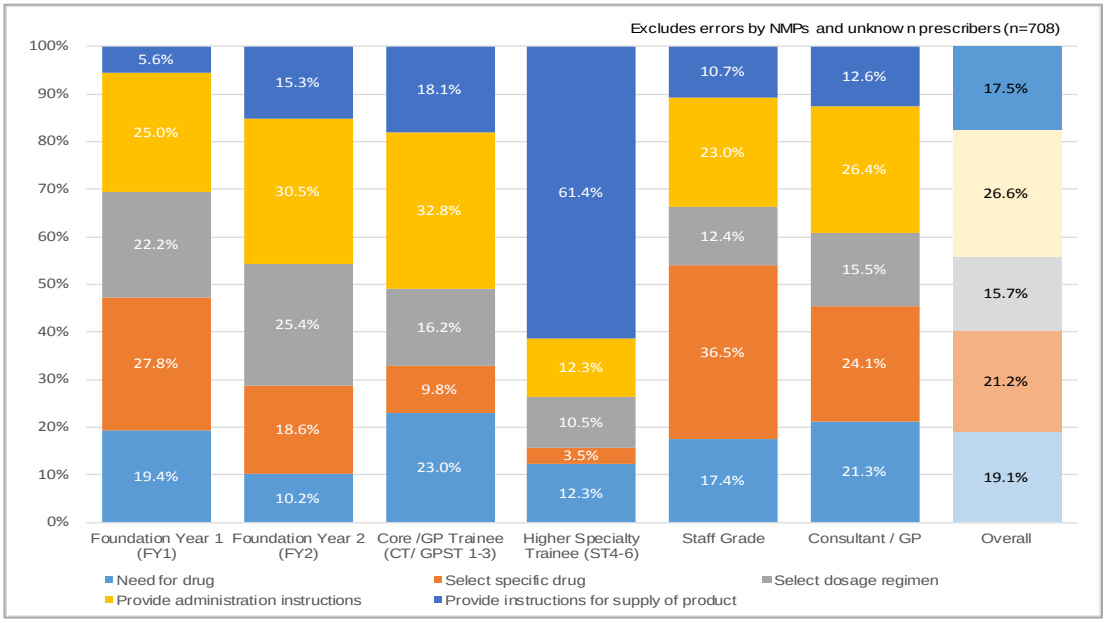


Figure 3.7: Proportion of errors by step in the drug-use process and prescriber grade

Classification based on the steps in the drug use process was originally used to capture clinical pharmacists' interventions,[304] but has since been used to categorise prescribing errors in a number of studies.[14,19,155,305] However, the proportion of overall errors occurring in each step in the drug use process and their respective rankings varied between studies. Prescribing errors relating to the selection of a drug where the least common category in all of these studies; a situation also seen in the current study. However, there were differences in the process step which was most commonly involved in errors.

Errors involving selection of the drug dose were most common in a study of errors in a UK teaching hospital which identified 538 prescribing errors. Of these 54% related to the process of selecting the drug dose, while 18% related to the need for drug therapy.[14] The process of selecting the drug dose was also the most common area for error in a study comparing prescribing errors before and after the introduction of

computerised physician order entry (CPOE) in a single general surgery ward. Pre-CPOE, dose selection was involved in 38%, with again the second most common step involved being the need for therapy (36%)[155], although the difference between the first and second ranked errors was relatively small compared with the earlier Dean *et al* study.[14] In studies by Tully *et al*[305] and Ashcroft *et al*[19] 'need for drug' was the step in the drug-use process which was most commonly associated with a prescribing error. However, although 'need for drug' was most common in both studies, the proportions of errors identified in this category were quite different. The earlier study, in which data were collected in 2003/04, identified 37% of errors which related to the need for a drug,[305] whilst the later study identified 48.7% of errors in this category.[19] The more recent study identified a greater proportion of errors due to the omission of a drug on admission (28.5% compared with 15.2%), which is likely to reflect the improved recognition of medication issues which occur at transfers of care, and the greater emphasis on medicines reconciliation on admission to hospital which has been in place since the NICE/NPSA guidance in 2007.[280]

In the current study prescribing errors most commonly occurred during the process of providing instructions for the supply of the product (261/727; 35.9%), which was ranked as third or fourth in the previous studies. However, a high number of errors were identified (104/727; 14.3%) which involved failure to specify the formulation or product which have contributed to this position. The second most common step of the process involved in errors was selecting the dosage regimen, which is more in line with the results from previous studies. The current study found a higher proportion of omissions occurring at discharge rather than admission compared with other studies, which may be accounted for by the high level of medicines reconciliation which occurs at admission within SEPT, or the practice in some trusts of pharmacists writing discharge medication orders which has been shown to have very low error rates.[306]

Only one study investigated the step in the drug-use process by stage in the patient's hospital stay.[275] Tully *et al* found that errors relating to the need for therapy occurred more commonly during admission and discharge, errors relating to drug doses during the inpatient stay, and to providing administration and supply instructions when drug charts were rewritten. The current study found some similarities and differences. Errors relating to the need for therapy (mainly omissions) were more commonly associated with discharge, those involving supply instructions when drug charts were rewritten, and those involving dosage regimens when drug charts were rewritten and during the inpatient stay (see Table 3.7).

Table 3.7: Prescribing errors identified at different stages of the patient's journey by step in the drug-use process

	Admission	During stay	Rewriting	Leave	Discharge	Not known	Total
Items written/omitted No. with errors Error rate (%)	2,613 163 6.2%	4,552 239 5.3%	4,713 100 2.1%	598 31 5.2%	1,046 81 7.7%	162 16 9.9%	13,684 630 4.6%
Stage of the prescribing process							
Need for drug	39 (20.3%)	36 (12.6%)	10 (9.5%)	4 (11.1%)	26 (28.9%)*	2 (11.1%)	117 (16.1%)
Select specific drug	3 (1.6%)	6 (2.1%)	2 (1.9%)	11 (30.6%)*	3 (3.3%)	1 (5.6%)	26 (3.6%)
Select dosage regimen	54 (28.1%)	91 (31.8%)*	10 (9.5%)*	3 (8.3%)	13 (14.4%)	3 (16.7%)	174 (23.9%)
Provide administration instructions	40 (20.8%)	64 (22.4%)	11 (10.5%)	4 (11.1%)	26 (28.9%)	4 (22.2%)	149 (20.5%)
Provide instructions for supply of product	56 (29.2%)	89 (31.1%)	72 (68.6%)*	14 (38.9%)	22 (24.4%)	8 (44.4%)	261 (35.9%)

* Errors of this type occur more commonly in this prescribing stage ($p < 0.05$)

3.5 Nature of errors

As well as arriving at a practitioner-led definition of a prescribing error, Dean *et al* asked panel members to indicate the extent to which 42 general scenarios represented a prescribing error. Consensus was reached on 27 scenarios which should be classed as prescribing errors, of which 13 errors were associated with the decision making of prescribing whilst 14 related to the process of prescription writing.[25] A similar approach was taken by Lisby *et al*, who assessed 40 prescribing error types identified in a systematic review[74] of 203 studies and reached consensus that 28 should be considered prescribing errors; 16 relating to decision making, and 12 to communication (prescription writing).[86] These scenarios/error types were used to guide the classification of prescribing errors found in the current study.

The two systems differed in how drug omissions and incorrect medication orders were treated; Lisby *et al* consider omission and incorrect orders (drug, formulation, dose, frequency, route, duration and strength/unit) to be decision-making errors, whilst Dean *et al* consider these to be a prescription-writing error. In the current study omitted drugs were classified as a prescription-writing error in line with Dean *et al*,[25] and incorrect medication orders as decision-making errors in line with Lisby *et al*.[86]

3.5.1 Prescribing error types

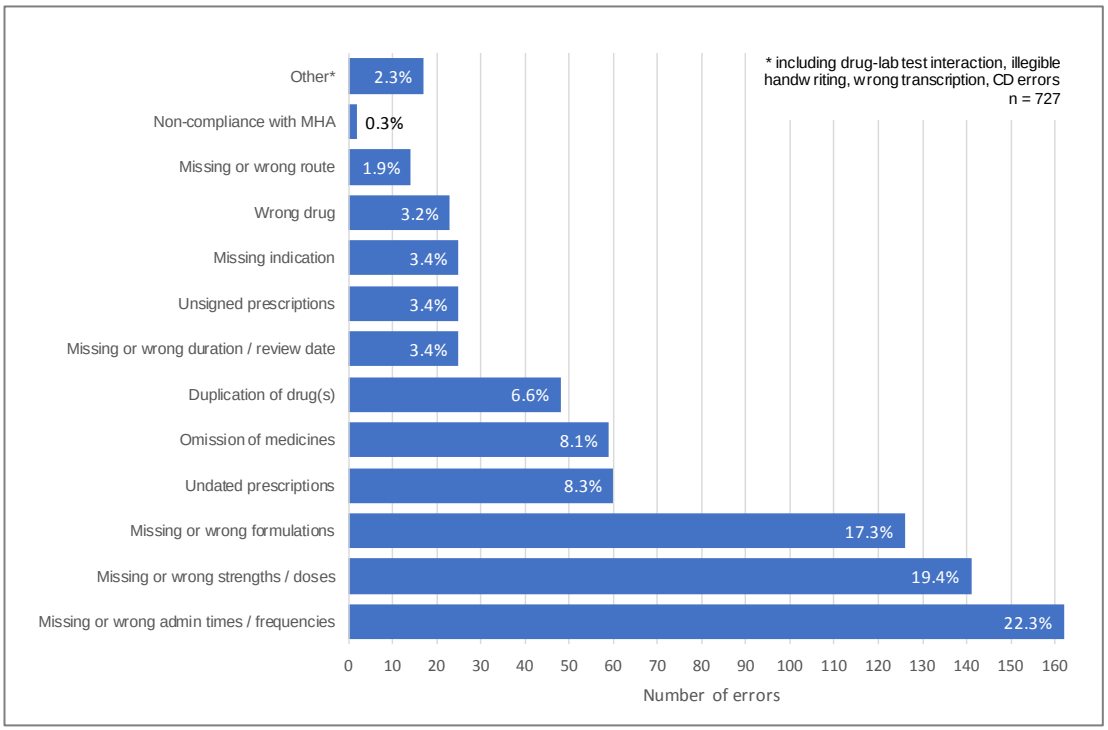


Figure 3.8: Types of prescribing error

The most frequent errors types were missing or incorrect administration times/frequencies (162/727; 22.3%) including the omission of dosing intervals, treatment times, and minimum dosing intervals for PRN medication. The next most common categories of errors were missing or incorrect strengths or doses (141/727; 19.4%) and missing or incorrect formulations (126/727; 17.3%).

Errors which involved the omission of a medicine accounted for 8.1% of identified errors (59/727). Few errors involved prescription of the wrong drug (23/727; 3.2%), although drug selection was involved in those errors that related to duplication of drugs (48/727; 6.6%), which was the sixth most common category of error. More information is shown in Figure 3.8 and Table 3.8.

Missing and wrong administration times/frequencies were most commonly found in medication orders which had been written during the patient's stay (43.2%; 70/162) or on admission (30.9%; 50/162). This was also the case for errors involving missing or wrong strengths and doses with 50.0% (71/142) and 29.6% (42/142) occurring during the patient's stay and on admission, respectively.

Table 3.8: Types of prescribing error by stage in the patient's journey

	Admission	During Stay	Re-Writing	Leave	Discharge	Not Known	Total
Missing or wrong admin times/frequencies	50	70	8	5	24	5	**162**
Missing or wrong strengths/doses	42	71	11	2	12	3	**141**
Missing or wrong formulations	20	29	59	0	17	1	**126**
Undated prescriptions	17	28	4	4	1	6	**60**
Omission of medicines	26	5	4	4	20	0	**59**
Duplication of drug(s)	11	30	5	0	0	2	**48**
Missing or wrong duration/review date	4	18	0	0	3	0	**25**
Unsigned prescriptions	4	9	3	8	1	0	**25**
Missing indication	6	14	5	0	0	0	**25**
Wrong drug	3	1	2	10	3	0	**19**
Missing or wrong route	6	4	2	0	2	0	**14**
Non-compliance with MHA	0	1	0	0	0	1	**2**
Other	3	6	2	3	7	0	**21**
Total	**192**	**286**	**105**	**36**	**90**	**18**	**727**

Signatures were most commonly omitted from medication orders written during the patient's stay (36.0%; 9/25) or for short-term leave (32%; 8/25). A greater proportion of medication orders were left undated (8.3%; 60/727), which occurred most frequently during a patient's stay (46.7%; 28/60), or on admission (28.3%; 17/60).

The most common error found amongst prescriptions which had been re-written was the omission of, or incorrect, formulations. This type of error accounted for 56.2% (59/105) of errors occurring during re-writing medication orders, and 46.8% (59/126) of errors involving missing/incorrect formulations were in re-written prescriptions. Medication orders written at the time of discharge were most commonly affected by missing or incorrect administration times/frequencies (26.7%; 24/90) and the omission of medicines (22.2%; 20/90). Errors recorded in the category of 'other' in Figure 3.8 included drug-lab test interaction, illegible handwriting, wrong transcription and controlled drug errors.

Each identified error was mapped against the categories defined in Reason's accident causation model (see Table 3.9)[23] by the researcher. However, as only a very small subset of errors was discussed with the prescriber this represents the researcher's assumptions about likely causation rather than being based on the views of the person who made the error about its causes.

Table 3.9: Types of prescribing errors by human error theory classification

Type of active failure	No. of errors (%)
Slips	86 (11.8%)
Lapses	174 (12.9%)
Knowledge-based mistakes	220 (30.3%)
Rule-based mistakes	225 (30.9%)
Violations	22 (3.0%)
	727 (100%)

Errors were classified using a system of error types proposed by Lisby *et al*[86] following a review of 203 studies, an approach which has been used by researchers in other studies.[18,19,104,121,189,257,274,307]. Most of the errors identified (430/727; 59.1%) related to the incomplete or incorrect provision of information (e.g. missing or wrong times, strengths, doses and formulations). This differed from the findings of some studies conducted in both psychiatry[147] and general hospital settings,[13,19,189,257] which identified omitted medicines on admission to be the most common type of prescribing error in their studies. In this study omission of medicines was the fifth most common

error type accounting for 8.1% of prescribing errors. However, the findings agreed with those of Haw and Stubbs[99–101] in a mental health setting, and Bobb *et al*[274] in a general hospital setting who also found that incomplete prescriptions were the most common type of errors. What is not known is whether this reflects the fact that omitted medicines were missed by the ward pharmacists when data were collected, or whether the admission and medicines reconciliation processes practiced in SEPT truly manage to avoid medicines being omitted at the time of admission.

Very few errors which were specific to a mental health setting were identified (e.g. MHA compliance or correct registration with a clozapine monitoring service; 2/272; 0.27%). Other UK studies commonly found drugs prescribed for a patient detained under the Mental Health Act without completion of the necessary authorisation to treat forms (range 16 - 26 cases; 3.1 - 12.3% of prescribing errors),[99–101] although in the more recent study by Keers *et al* only four such instances were identified (1.4% of errors).[147]

3.5.2 Decision making and prescription writing errors

Overall, prescription-writing errors (452/727; 62.2%) were more common than decision-making errors (275/727; 37.8%). The proportions were similar to those found in a general hospital setting.[14] A greater proportion of prescription-writing errors were found in three studies in a mental health setting by the research team of Haw, Stubbs and colleagues (76.3%, 87.5% and 77.4% respectively.[99–101] However, these studies classified errors relating to wrong drug, dose, frequency, formulation, treatment duration or route as prescription-writing errors (in line with Dean *et al*[25]) rather than decision-making errors (in line with Lisby *et al*[86]). The Lisby *et al* classification was used in this study and may explain the difference from the results of Haw, Stubbs *et al.* In a similar study Paton *et al* identified 58% of the errors to be clinical errors rather than clerical errors, but it is not clear whether these categories correspond to decision-making and prescription-writing errors.[128] Other studies investigating the prevalence and nature of prescribing errors in either a mental health[147] or general hospital[19,189,257] setting have not analysed the data in terms of these characteristics.

The highest proportion of decision-making errors were made by FY1 doctors, whilst higher specialty trainees and visiting consultants/GPs made a lower portion of errors which related to decision-making. The details are shown in Table 3.10.

Table 3.10: Errors involving prescribing decisions *vs*. prescription writing by prescriber grade

	Decision making	Prescription writing
Foundation Year 1	52.8%	47.2%
Foundation Year 2	30.5%	69.5%
Core Trainee (Psychiatry)	42.7%	57.3%
GP Trainee	41.5%	58.5%
Higher Specialty Trainee (Psychiatry)	24.6%	75.4%
Staff Grade	35.4%	64.6%
Consultant Psychiatrist	42.5%	57.5%
Other (Visiting Consultants/GPs)	25.0%	75.0%
Nurse Non-Medical Prescriber	33.3%	66.7%
Not known	43.8%	56.3%
Total	**37.8%**	**62.2%**

3.6 Type of medicines

Despite the study involving a cohort of patients who were primarily being treated for a mental health condition, nearly 60% of items prescribed were for non-psychotropic drugs (57.7%; 7,895/13,684). Non-psychotropic drugs accounted for nearly two-thirds of items which contained at least one error (64.0%; 403/630) but a lower proportion of errors overall (58.0%; 422/727) with multiple errors affecting one medication order more likely to be psychotropics. The error rate for non-psychotropic medicines was higher (5.1%; 403/7,895) than for psychotropic medicines (3.9%; 227/5,789). The difference between error rates was tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$, demonstrating a significant difference (χ^2 (1) = 10.648, $p < 0.001$). The error rate for regular medicines was higher (4.9%; 439/9,030) than for 'as required' medicines (4.1%; 191/4,654). The difference between these was tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. This demonstrated that the error rates for regular and 'as required' medicines were statistically significant (χ^2 (1) = 4.013, p = 0.045). The respective error rates are shown in Figure 3.9.

For psychotropic drugs, although there was a difference between the error rates for regular and 'as required' medicines (4.3% compared with 3.3%), this difference was not statistically significant when tested using Pearson's chi-squared test (χ^2 (1) = 3.684, $p = 0.055$). The same was the case for the difference between regular and 'as required' non-psychotropic drugs (5.1% compared with 5.3%) where the difference in error rates was not statistically different (χ^2 (1) = 0.828, p = 0.363).

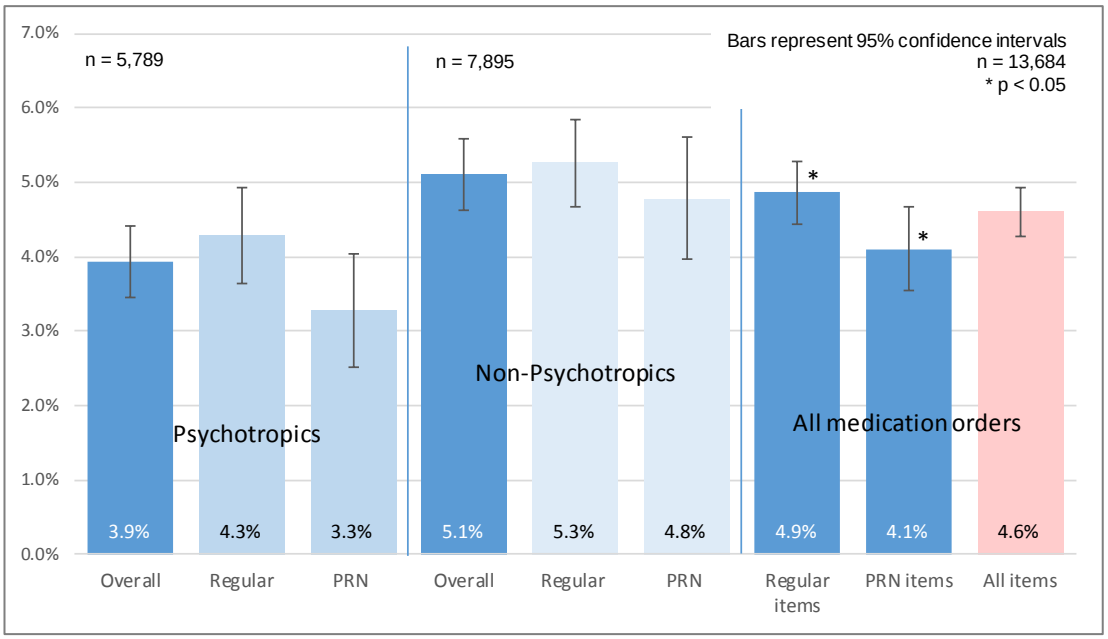


Figure 3.9: Error rates for regular and PRN items, by type of medicine

Foundation year doctors and those in their early years of core psychiatry or GP training, showed large differences between the error rates for psychotropic and non-psychotropic medication orders, although for non-psychotropic items the 95% confidence intervals were particularly large for foundation year 2 (± 3.76%) and year one core/GP trainees (± 5.22%). Details are shown in Figure 3.10.

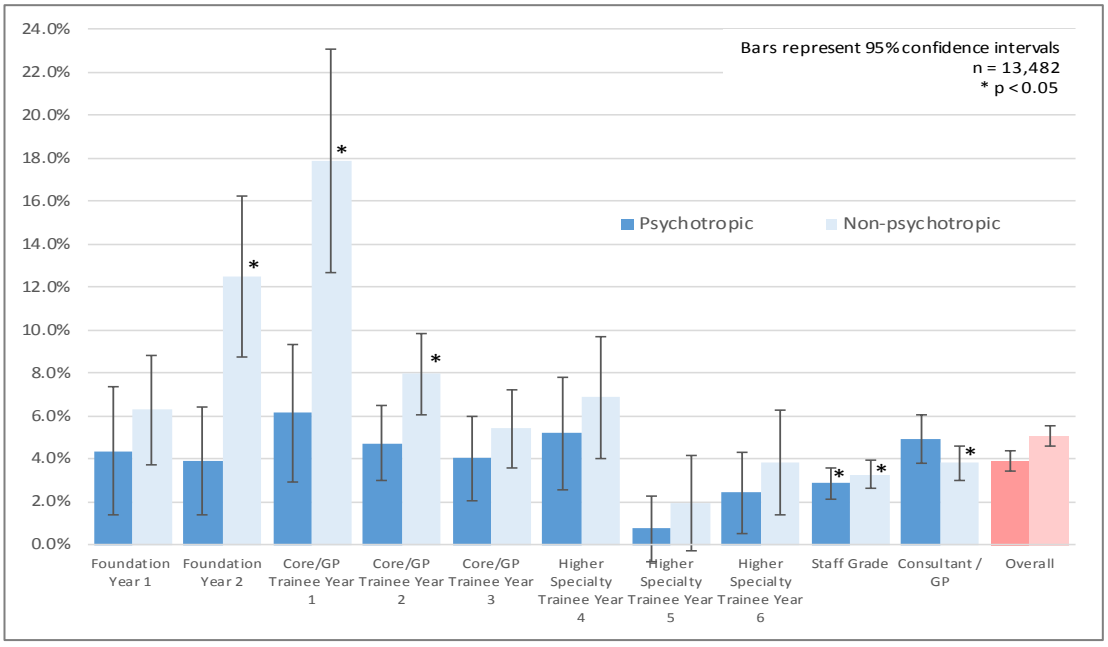


Figure 3.10: Error rate for psychotropic and non-psychotropic medicine, by prescriber type

Excluding NMPs and unknown prescribers, the differences between error rates were tested for statistical significance using the Pearson's chi-squared test, with a significance level of $p < 0.05$. A significant difference was demonstrated between the

error rates for psychotropic medicines for staff grade doctors in comparison with other prescriber grade/types (χ^2 (9) = 20.195, p = 0.017). A significant difference was demonstrated between the error rates for non-psychotropic medicines for FY2 doctors, core/GP trainees in their first year and second years of training, staff grade doctors and consultant/GPs, in comparison to other prescriber grade/types (χ^2 (9) = 151.446, *p* = 0.000).

Table 3.11: Frequency of prescribing error by medicine class

Category	Errors	
	No.	%
Psychotropics	**305**	**42.0%**
Antipsychotic drugs	81	11.1%
Hypnotics & anxiolytics	79	10.9%
Antidepressants	56	7.7%
Antiepileptic drugs	38	5.2%
Drugs used in substance dependence	27	3.7%
Drugs used in parkinsonism	16	2.2%
Drugs used in mania & hypomania	4	0.6%
Drugs for hypersalivation	2	0.3%
CNS stimulants & drugs for ADHD	2	0.3%
Non-psychotropics	**422**	**58.0%**
Analgesics	71	9.8%
Antimicrobials (all routes)	65	8.9%
Gastrointestinal	58	8.0%
Respiratory	47	6.5%
Endocrine	44	6.1%
Cardiovascular	42	5.8%
Nutrition & blood	34	4.7%
Skin (excluding antimicrobials)	24	3.3%
Eye (excluding antimicrobials)	14	1.9%
Obstetric, gynaecological & urinary tract	9	1.2%
Ear, nose & oropharynx (excluding antimicrobials)	7	1.0%
Musculoskeletal & joints	7	1.0%
Total errors	**727**	**100.0**

Errors were most commonly identified in medication orders for antipsychotics (81/727; 11.1%), hypnotics and anxiolytics (79/727; 10.9%), analgesics (71/727; 9.8%), antimicrobials (65/727; 8.9%) and drugs for the gastrointestinal system (58/727; 8.0%) The frequency of prescribing errors amongst different classes of medicine are shown in Table 3.11.

Three types of errors accounted for most of those involving antipsychotics (50/81; 61.7%). Errors most commonly related to incorrect formulations being specified or the formulation missed (20/81; 24.7%). This reflects the fact that some antipsychotics, for example, quetiapine, are available as both immediate and sustained release formulations with different dosing regimens, whilst others, for example, olanzapine, are available as standard and orodispersible formulations in different strengths. Dosing intervals and treatment times were also commonly omitted or incorrect for the formulation specified (15/81; 18.5%), and doses were omitted, incorrect for the patient, or exceeded the maximum recommended dose (15/81; 18.5%).

Hypnotics and anxiolytics were most commonly affected by missing or incorrect administration times or frequencies (23/79; 29.1%), particularly the absence of a minimum dose interval for ‘as required’ lorazepam and promethazine. Another common error was incorrect doses (15/79; 19.0%), particularly doses of lorazepam which exceeded the maximum recommended dose for older people. Together these accounted for almost half of the errors in this group of drugs (38/79; 48.1%).

Errors involving analgesics were most commonly associated with duplication of drugs (16/71; 22.5%), where paracetamol was added to the patient’s regimen when another paracetamol containing preparation was already prescribed, or *vice versa*. As many medication orders for analgesics were for ‘as required’ use, these also were highly affected by errors relating to missing or wrong administration times or frequencies including no minimum dose interval being provided (15/71; 21.1%).

Medication orders for antimicrobials (by all routes) most commonly involved errors relating to missing or incorrect durations of treatment, or absence of a review date (18/65; 27.7%). Also common were incorrect dosing intervals or frequencies, for example, trimethoprim prescribed for prophylaxis of urinary tract infection twice daily rather than the recommended once daily or co-amoxiclav prescribed twice or four times daily rather than the recommended regimen of three times daily.

One hundred and seventy different medicines were involved in the 727 errors, with more than 40% of medicines (69/170) associated with only one error. Table 3.12 shows the top 20 medicines most commonly involved in prescribing errors by order of prevalence, which between them accounted for half of errors (363/727; 49.9%). The medicines most commonly associated with errors were paracetamol-containing products and lorazepam.

Table 3.12: Medicines most commonly involved in a prescribing error (Top 20)

Medicine	Errors	
	No.	Percentage
Paracetamol (including combination products)	57	7.8%
Lorazepam	31	4.3%
Promethazine	26	3.6%
Nicotine Replacement Therapy	25	3.4%
Salbutamol	20	2.8%
Venlafaxine	19	2.6%
Mirtazapine	17	2.3%
Senna	17	2.3%
Olanzapine	16	2.2%
Zopiclone	16	2.2%
Levothyroxine	14	1.9%
Quetiapine	14	1.9%
Valproate	14	1.9%
Calcium carbonate	13	1.8%
Haloperidol	13	1.8%
Aripiprazole	11	1.5%
Chloramphenicol	11	1.5%
Metformin	11	1.5%
Risperidone	10	1.4%
Beclometasone	8	1.2%
Others	364	50.1%
Total errors	**727**	**100.0%**

Errors involving paracetamol accounted for 7.8% of all errors (57/727). Of these nearly one-quarter (13/577; 22.8%) related to missing or wrong administration times or frequencies including no minimum dose interval being provided for an 'as required' medicine, with a nearly a further third (16/57; 28.1%) due to duplication where other paracetamol-containing products were already prescribed for the patient. Missing or wrong administration times or frequencies were also the most common type of error affecting medication orders for lorazepam (9/31; 29.0%) either where no minimum dose interval had been specified for 'as required' dosing, or a minimum dosing interval of 1 hour had been specified when the recommended minimum period between doses is 2 hours. In 5 cases (16.1%) lorazepam had been duplicated on the prescription, either on two separate drug charts or as both regular and 'as required' medication on the same chart, which together exceeded the maximum recommended dose.

The majority of prescribing errors involved medicines for oral administration (71.9%; 523/727), with errors involving medicines for topical use (9.4%; 68/727) and inhalation (7.7%; 56/727) also common. This reflects the fact that the intravenous route, often involved in errors in a general hospital setting is rarely used in mental health patients.

Few studies have compared the error rates for psychotropic and non-psychotropic medication, and the two studies that have identified different results. One study identified a higher error rate for psychotropic medication (2.5% *vs*. 2.0%)[101] whilst the other, like the current study, found the error rate to be higher for non-psychotropic medication (2.9% *vs*. 1.5%).[100]

Relatively few studies have reported on the individual drugs or drug classes involved in prescribing errors.[18,99,101,130,148] In the EQUIP study into prescribing errors by foundation trainees in a general hospital setting, Dornan *et al*[18] reported that analgesics and antibacterial drugs were the two most common group of drugs involved in errors, which corresponded with the most common non-psychotropic drug groups in this study. In their analysis of more than 11,000 prescribing errors, psychotropic drugs were involved in a very small proportion of errors. The two most common psychotropic drug groups were hypnotics and anxiolytics, which accounted for 1.8% of errors (compared with 10.9% in the current study) and drugs used in psychosis and related disorders, which accounted for 0.9% of errors (compared with 11.7%). In studies undertaken in psychiatric inpatients all have identified antipsychotics as most commonly involved in prescribing errors,[99,101,130] reflecting the high use of these in a psychiatric setting, followed by mood stabilisers[130] or hypnotics

and anxiolytics.[99,101] Non-psychotropic drugs involved in errors were commonly those for cardiovascular disease, gastro-intestinal conditions and diabetes.

Thomas *et al* worked with a clinical panel with expertise in medication safety to arrive at a set of prescribing safety indicators for high-severity and/or high-frequency prescribing errors relevant to a general hospital setting.[308] Using an electronic Delphi consensus process,[96,97] 80 prescribing errors were identified as being of high or extreme risk and relevant to a hospital setting. Although the most frequently named drugs were antibiotics, opioids and low molecular weight heparins, 18 of the identified indicators related to psychotropic medicines, including lithium, benzodiazepines, antipsychotics and antidepressants, with clinical contraindications and drug-drug interactions featuring highly (see Appendix 18). Whilst a similar exercise has been undertaken to develop paediatric prescribing indicators,[309] to date no psychiatric prescribing indicators have been developed. None of the psychotropic prescribing safety indicators developed by Thomas *et al* were identified in the current study. However, the most commonly identified error - more than one paracetamol-containing product prescribed to a patient at a time resulting in the maximum dose being exceeded - features in the general prescribing safety indicator list. Equally some of the indicators which relate to psychotropic drugs may be considered to be a safety issue in a general hospital setting, but less so in a specialist mental health setting where the risk/benefit ratio may be different. An example would be the use of antipsychotics in the management of extreme behavioural and psychological symptoms in dementia or use of long-term antipsychotics to treat psychosis in a patient with parkinsonism.[310]

Life expectancy for those with serious mental illness is typically 15 - 20 years less than for the general population.[311] Problems managing long-term conditions and additional health risks due to high blood pressure, diabetes and obesity associated with psychotropic medicines are often compounded by lack of exercise, poor diet and smoking.[312] Government policy has set out that the physical inequalities experienced by those with mental illness should be reduced through screening and disease prevention, and “parity of esteem” be achieved between mental and physical services.[313,314] It is therefore important that patients with a mental illness receive treatment for physical health conditions that is equal to that which would be received by patients who do not have a mental illness, including in terms of instances of prescribing errors.

3.7 Comparison between sub-specialties

The highest error rates were identified for wards within learning disabilities (6.5%; 3/46) and general adult services (6.2%; 258/4,162); however, it should be noted that the number of medication orders assessed on the learning disability wards was very small, representing only 0.3% of the overall sample, and the confidence interval was therefore large (± 7.12%). The lowest error rate was identified within forensic services (3.4%; 156/4,577). The differences between error rates for different sub-specialties were tested for statistical significance using Pearson's chi-squared test, with a significance level of $p < 0.05$. This demonstrated that the error rates for each of general adult services and forensic services were significantly different from the overall sample (χ^2 (4) = 40.361, p = 0.000) (see Figure 3.11).

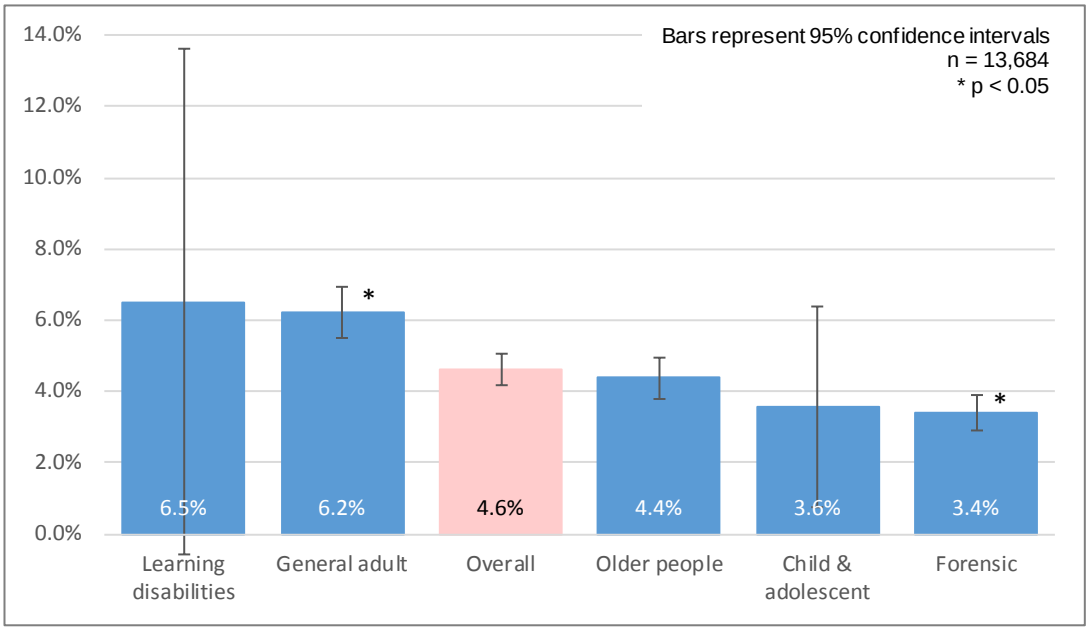


Figure 3.11: Prescribing error rate by sub-specialty

No other studies have compared prescribing error rates between psychiatric sub-specialties. As the confidence intervals for two - learning disabilities and CAMHS - where large due to small sample sizes it would be inappropriate to draw conclusions about their prescribing errors rates. However, for general adult and forensic services where the difference in error rates where statistically significant, this may reflect both the increasing acuity and fast turnover of general adult patients, and the fact that transfers of care within forensic services are relatively rare and carefully planned when they do occur.

3.8 Clinical significance of errors

During data collection, pharmacists recorded an opinion on the potential clinical significance for 665 of the 727 errors identified (91.5%). Of these 27 (4.1%) were classified by the ward pharmacist as falling within the potentially 'severe' category, using the method described in Section 2.3.5. A panel of four experienced healthcare professionals evaluated 625 (86.0%) of the 727 errors identified. Legal issues were assumed to have no clinical significance and were excluded from this process to reduce the workload on panel members. All panel members failed to evaluate at least a small number of errors during the review process with one panel member evaluating just under three-quarters of the errors sent to them (72.5%; 454/626). The categorisations made by the ward pharmacists and expert panel members are shown in Table 3.13.

Table 3.13: Potential clinical significance scores

	minor (< 3)	moderate (3 - 7)	severe (> 7)
Ward pharmacist (n=665)	452 (68.0%)	186 (28.0%)	27 (4.1%)
Expert panel (n=625)	338 (54.1%)	278 (44.5%)	9 (1.4%)

Pharmacists also recorded whether the patient had experienced any harm due to the error in 689 of the 727 errors (94.8%). Only three errors (0.4%), detailed below, were judged to have resulted in actual patient harm:

- A patient was prescribed pregabalin capsules 300 mg twice daily, but only the 10 pm administration time was circled on the drug chart. The dose was administered once daily for three days before the error was identified. Nursing staff reported that the patient was very aggressive with volatile mood which was attributed to the omission of three morning doses of pregabalin.
- A patient was prescribed promethazine tablets 50 mg up to four times daily, as required for aggression and agitation. The maximum dose is 100 mg in 24 hours and the patient had been complaining of palpitations, which can be a side effect of promethazine.
- A patient was readmitted to a mental health ward following a transfer to the acute hospital. The transfer paperwork indicated that the patient should receive six days of treatment with co-amoxiclav 625 mg three times daily for an infection. This was not prescribed on transfer and six doses (2 days treatment) were missed before the error was detected. During this period the

patient's blood glucose levels were erratic requiring additional treatment with rapid-acting insulin, which was attributed to the untreated infection.

The degree of inter-rater agreement between panel members was tested using a two-way random type C intra-class correlation for those errors where all four panel members had provided a clinical significance score. Cronbach's alpha demonstrated good correlation ($0.9 > \alpha \geq 0.8$) between the four panel members with $\alpha = 0.829$ ($n = 443$).

Table 3.14: Number of errors by potential clinical significance and prescriber grade (average score)

Prescriber grade/type (N=716)	Potential clinical significance			
	Minor	Moderate	Severe	Total
Foundation Year 1	19 (55.9%)	15 (44.1%)	0	34
Foundation Year 2	38 (67.9%)	18 (32.1%)	0	56
Core Trainee (Psychiatry)	65 (59.6%)	43 (39.4%)	1 (0.1%)	109
GP Trainee	47 (50.0%)	47 (50.0%)	0	94
Higher Specialty Trainee (Psychiatry)	43 (7.54%)	13 (22.8%)	1 (1.8%)	57
Staff Grade	109 (61.9%)	64 (36.4%)	3 (1.7%)	176
Consultant Psychiatrist	74 (56.0%)	53 (40.2%)	5 (3.8%)	132
Other (Visiting Consultants/GPs)	28 (70.0%)	12 (30.0%)	0	40
Nurse Non-Medical Prescriber	2 (66.7%)	1 (33.3%)	0	3
Not known	8 (5.3%)	7 (46.7%)	0	15
Total errors	**433 (60.5%)**	**273 (38.1%)**	**10 (14.0%)**	**716**

Inter-rater agreement was also tested for those errors where a clinical significance score had been provided by the ward pharmacist and all four panel members. This demonstrated acceptable correlation ($0.8 > \alpha \geq 0.7$) between ward pharmacists and panel members with $\alpha = 0.785$ ($n = 396$). As Cronbach's alpha demonstrated acceptable inter-rater agreement between the ward pharmacist and panel members, a single average score was used to assess the potential clinical significance of errors caused by different prescriber grades, shown in Table 3.14.

Although absolute numbers were small, errors with the potential for greatest clinical significance were generally made by more senior and experienced prescribers, with 80% (8/10) of severe errors made by staff grade doctors or consultants. However,

when the difference between scores assigned by prescriber grade was tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$, no significant difference was demonstrated (χ^2 (18) = 23.983, $p = 0.156$).

The differences between scores assigned by stage of prescribing were tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. Errors with a minor and moderate potential severity occurring during rewriting prescriptions and discharge demonstrated a significant difference from other categories (χ^2 (10) = 45.614, $p > 0.000$). The potential clinical significance of errors by stage of prescribing is shown in Table 3.15.

Table 3.15: Number and rate of errors by stage of prescribing

Stage of prescribing (n=716)	Potential clinical significance			
	Minor	Moderate	Severe	Total
Admission	107 (56.6%)	80 (42.3%)	2 (1.1%)	189
During Stay	172 (61.4%)	105 (37.5%)	3 (1.1%)	280
Rewriting	84 (80.8%)*	19 (18.3%)*	1 (1.0%)	104
Leave	22 (61.1%)	12 (33.3%)	2 (5.6%)	36
Discharge	35 (39.3%)*	53 (59.6%)*	1 (1.1%)	89
Not known	13 (72.2%)	4 (22.2%)	1 (5.6%)	18
Total errors	**433 (60.5%)**	**273 (38.1%)**	**10 (14.0%)**	**716**

* Errors of this type occur more commonly in this prescribing stage ($p < 0.05$)

Prescriptions which were rewritten during the patient's inpatient stay demonstrated a greater proportion of minor errors, and a smaller proportion of moderate errors than would be expected. Prescriptions written at discharge demonstrated more errors with the potential for a moderate clinical significance, and a smaller proportion than expected of minor errors.

Although acceptable correlation had been demonstrated between ward pharmacists and all four panel members the pattern of scores did differ. For nearly four-fifths of the errors (79.0%; 574/727 errors), a potential clinical significance score was available from both the ward pharmacist and as an average score from the expert panel. The distribution of scores assigned by ward pharmacists and expert panel members for these errors is shown in Figure 3.12. The difference between scores assigned by ward pharmacists and the expert panel were tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. This demonstrated a

significant difference between the scores assigned by ward pharmacists and those assigned by the expert panel. (χ^2 (2) = 26.99, p < 0.000).

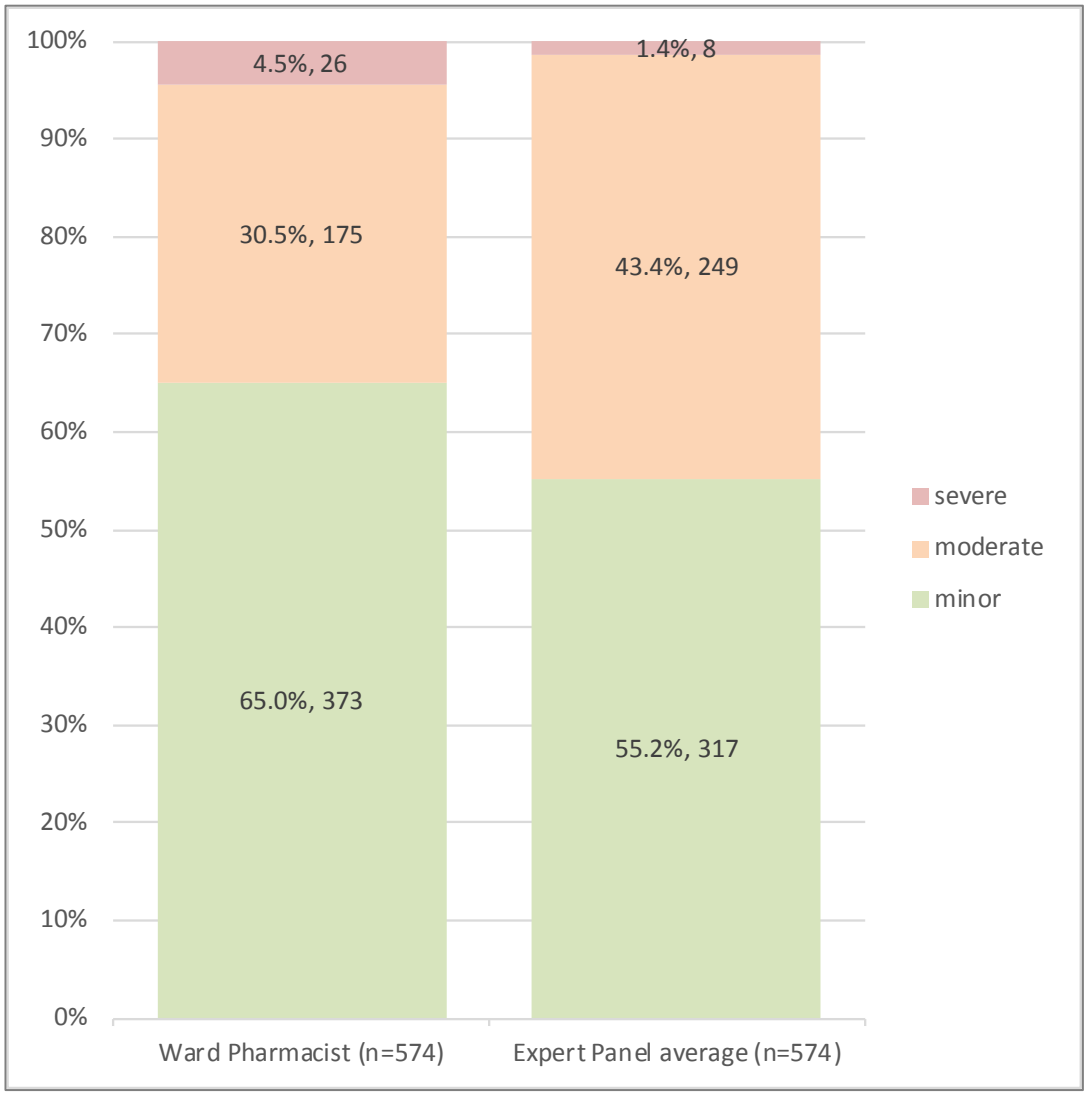


Figure 3.12: Clinical significance scores assigned by ward pharmacists and expert panel to errors rated by both

Ward pharmacists assessed significantly more errors as 'severe' and 'minor' than the expert panel, but significantly less as 'moderate'. Panel members only had details of the actual error available to them and did not have information on the context of the error in the wider management and circumstances of the patient. The details of those errors considered to be 'severe' by either group are shown in Appendix 19. Some of the differences in scores recorded by the ward pharmacist and the expert panel are likely to be due to their different perspectives. Ward pharmacists are able to place the individual prescribing error in the context of the patient's entire medication regimen, presenting clinical condition and co-morbidities, and may also have anticipated actions of their pharmacy and nursing colleagues in preventing the error from reaching

the patient. Expert panel members were looking at each error in isolation, unaware of other patient's condition and other medication. One of the panel members provided additional comments with their responses which indicated that they had rated the potential significance of the errors based on the assumption that pharmacy would intervene with many of the errors.

> *"What I found most challenging was that the context was missing. It made me realise how much of the 'bigger picture' is considered when prescribing, e.g. age of patient, clearance, other medications. Without these I think it is possible that we may underestimate harm."*

> *"Pharmacy would pick up errors and contact the prescriber"*

It has also been suggested that level of clinical seniority, and therefore experience, influences clinicians perception of the severity of errors, with the outcome and potential consequences the main influences on assessment of severity.[315] In the current study, whilst the ward pharmacists had more knowledge of the outcome of the errors, and were of varying levels of seniority and therefore clinical expertise, panel members with greater clinical expertise will have had a greater understanding of the likelihood of the resultant harm. It has also been suggested that doctors tend to grade clinical impact lower than pharmacists and nurses, whilst nurses grade errors higher than pharmacists, which confirms the importance of obtaining a multidisciplinary perspective when assessing errors for research purposes.[316]

In 1999, Dean and Barber[253] sought to develop a reliable, validated method for scoring the severity of medication errors based on potential patient outcomes. They specifically wanted to identify the minimum number of reviewers needed to produce reliable scores along with whether scores were affected by the profession of the reviewers. Thirty healthcare professionals were sent brief descriptions of 50 drug administration errors, selected from a range of sources, with approximately equal numbers of cases considered to be minor, moderate and severe, and including 16 errors with known clinical outcomes. Scoring was undertaken using a visual-analogue scale from 0 to 10, with 0 representing an incident with no potential effect on the patient, and 10 with the potential to cause death.

Using generalisability theory to establish the reliability of the process, Dean and Barber found that at least four reviewers were required to achieve a generalisability coefficient of 0.8 or above, which was considered to represent an acceptable level of reliability. For the 16 medication errors of known outcome, they found a clear

relationship between mean severity scores of the reviewers and actual patient outcome, confirming the validity of the method. The authors concluded that any four reviewers from the population of experienced pharmacists, medical staff and nursing staff would be acceptable, as the professional discipline of each judge contributed little to the variance in scores between individual reviewers. However, they suggested that in practice at least one reviewer be selected from each discipline to facilitated ownership of the results. This method[253,263] has been extensively used, in its original or adapted form, for assessing the severity of prescribing errors.[104,260,307,317,318] This was the method chosen for assessment of severity in the current study, and instructions for ward pharmacists and panel members were supplemented with examples from past research.[16,20,44,180,261]

Assessing the severity of prescribing errors increases the clinical relevance of a study's findings compared with studies which only report prevalence or incidence rates.[319] Methods for severity assessment described in the literature are usually based on either actual patient outcome,[320–322] potential patient outcomes[13,16,20,44,253,323,324] or a combination of both.[12,180,325–327] Garfield *et al* undertook a systematic review which described the tools used in studies to assess prescribing error severity.[319] They identified 60 publications which included an assessment of the severity of prescribing errors and 40 assessment tools. However, two-thirds of studies (40/60; 67%) made use of original or adapted versions of four tools developed by Dean and Barber,[253] Folli *et al*,[180] the UK's National Patient Safety Agency (NPSA),[320] and the US National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP).[328]

Garfield *et al* assessed the reliability, validity and acceptability of the tools they had identified. The authors proposed that an ideal tool needs to be specific to medication error severity, relatively easy and not too time-consuming to administer, reliable and validated in different healthcare systems. They concluded that only two of the many tools that they reviewed had acceptable validity and reliability: the NCC MERP index as adapted by Forrey *et al*,[329] and the tool developed by Dean and Barber.[253] However, the NCC MERP tool, although widely used in the US is not well known in the UK, and the Dean and Barber tool was used in the current study.

Despite using different classification systems, past studies have generally shown that a large proportion of the prescribing errors identified are classified as minor. In a general hospital setting this proportion has been in the region of 40%,[18,19,257,287] whilst mental health studies have considered a slightly higher proportion to be minor,[147] insignificant,[99,100] or negligible.[101] The highest proportion found by Stubbs *et al* who

classified 64.5% of the prescribing errors to be insignificant with a further 24.2% of minimal significance.[99] A similar proportion of errors were considered to be minor by the ward pharmacists (65.0%), whilst the expert panel considered a lower proportion to be minor errors (55.2%).

More variation appears in the proportion of errors considered to be serious and life-threatening. In one of the early prescribing error studies Lesar *et al* identified 20.1% of errors as 'potentially fatal or severe or potentially serious', although they did not distinguish between those categories.[20] More recent general hospital studies have tended to identify a lower proportion (typically less than 10%) as serious or life-threatening,[18,19,257] although two studies by Dean *et al* identified serious error rates of approximately 20%.[13,14] This may reflect the specialties covered by these studies, or a difference between teaching and non-teaching hospitals. Studies have noted that very few errors cause actual harm or required patient monitoring.[189] In their study involving three mental health trusts, Keers *et al* classified 6.6% (19/281) of prescribing errors as serious and 0.3% (1/281) as potentially life-threatening.[147] Smaller scale studies, have found higher levels of serious errors,[99,100] and noted that serious errors were more likely to be committed by junior than senior doctors.[100] However, another larger scale study from the same authors, assessed that serious and life-threatening errors accounted for 4.3% of errors, noting that more serious errors involved non-psychotropic than psychotropic drugs.[101] This lower level of serious prescribing errors may be due to several factors, including less use of drugs in a psychiatric setting by the intravenous route where the consequences of errors can be serious, less requirement for undertaking calculation of doses, patients who are less physically unwell, and use of more restricted range of medicines. Additionally, habitual deviation from standard regimens in order to illicit a response in individual patients, may make it more difficult to identify potentially serious errors.[330] Ward pharmacists assessed 4.5% of errors as severe, whilst the four members of the expert panel rated 1.4% of errors to fall into this category (see Figure 3.12).

3.9 Pharmacist interventions

Pharmacists recorded the action they took in response to the error in 84.6% of cases (615/727). In most cases (289/615; 47.0%) the pharmacist was able to provide clarification or make minor amendments without reference to a prescriber. The pharmacist contacted a prescriber in 27.3% (168/615) of cases, leaving a formal intervention note asking the prescriber to resolve the error in a further 85 cases

(85/615; 13.8%) where either the error did not require an urgent resolution, and/or they were unable to contact the prescriber (see Table 3.16).

Table 3.16: Pharmacy interventions

Action taken by pharmacist	No. of cases	Proportion of errors where resolution detailed
Resolved by pharmacist	289	47.0%
Contacted prescriber	168	27.3%
Left intervention note to resolve	85	13.8%
Alerted nursing staff	16	2.6%
Other (including more than one of above)	57	9.3%
Total	**615**	**100.0%**

Where the pharmacist contacted a prescriber, this may not have been the original prescriber who made the error. For example, it may have been necessary to ask another prescriber to change the prescribing error made by a colleague when the original prescriber was not available.

3.10 Summary of findings

The overall error rate was lower than the 6.3% seen in a similarly designed study published in 2014 by Keers and colleagues[147] in three mental health hospitals in the North West of England, but higher than rates identified in two earlier studies.[100,101]

Relatively newly qualified staff made proportionally more errors. However, prescriber grades with the highest error rates prescribed a small proportion of prescriptions, with prescriptions written by FY1s and FY2s accounting for less than 8% of all prescriptions. Specialty trainees who had the second highest error rates accounted for nearly one third of items.

Higher errors rates were seen in prescriptions written at transitions in care. However, prescription types with the highest error rates - those written at discharge and admission - also accounted for less than one-third of all prescriptions.

Errors most commonly involved missing/incorrect doses, frequencies and formulations. Most errors involved antipsychotics, hypnotics and anxiolytics and analgesics. Only a small proportion of errors were considered to have the potential to be serious – less than 5%. Most were promptly intercepted and resolved, with 61% before any dose had been administered and a further 11% after only one dose.

Chapter 4. Causes of prescribing errors: results and discussion

4.1 Introduction

A qualitative approach which has been used in other studies to explore the causes of prescribing errors was used.[26,27,113,167,172] During every third data collection period ward pharmacists distributed invitations to participate in an interview to 46 of the 54 prescribers who had made a prescribing error (see Figure 4.1). Invitations were followed up by email or telephone within 96 hours of the initial invitation, and where acceptable to the prescriber a mutually convenient time for an interview was agreed. Some prescribers were invited more than once, but if they had completed an interview already, they were not followed up a second time to minimise disruption to service provision. Invitations continued to be issued until a high degree of consistency had been achieved between responses, after which no further interviews were conducted.

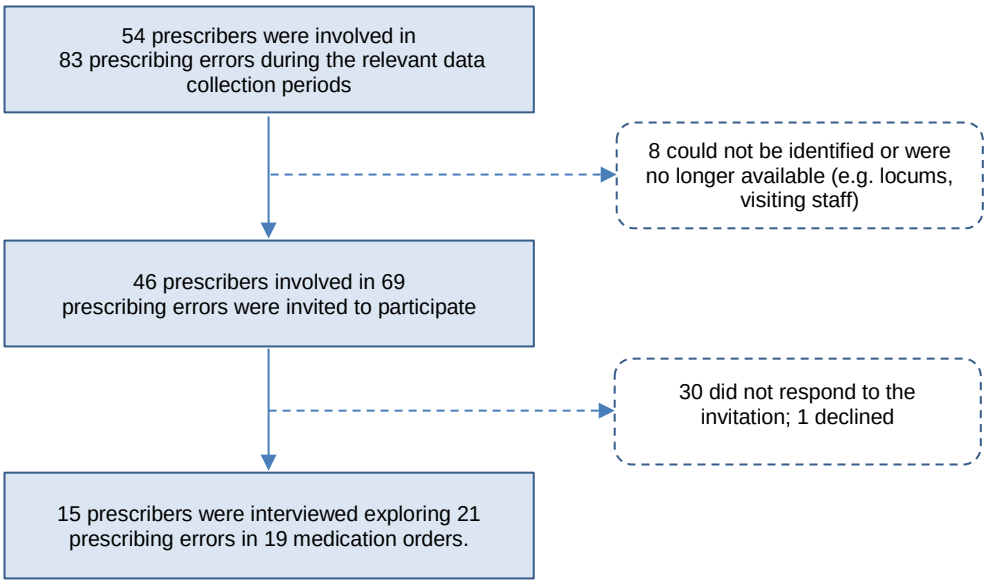


Figure 4.1: Participant sampling, recruitment and response rate

Fifteen of the invitees agreed to take part in a face-to-face, semi-structured interview (32.6%). Most interviews (66.7%; 10/15) discussed only one prescribing error, four involved two errors, and one involved three errors. Five further errors had been highlighted to these prescribers prior to interview but were not covered as time constraints on the interviewee did not allow further discussion.

Interviews lasted on average 22 minutes (range 14 to 36 minutes). Due to the availability of either the interviewee and/or researcher, the mean time between the error being identified and interview taking place was 11 days (range 1 - 24 days),

which was longer than desirable, and may have influenced recall of the error(s) being discussed. Participants included foundation trainees, core and specialty trainees, staff grade doctors and consultants representing a cross-section of prescribers. The majority (60.0%) were female, and most were in the 40-49 age bracket (40.0%). The demographics of those who participated in interviews are shown in Table 4.1.

Table 4.1: Demographics of interviewees

Demographics	No.	% (n=15)
Gender		
Male	6	40.0%
Female	9	60.0%
Age (years)		
21 - 29	4	26.7%
30 - 39	2	13.3%
40 - 49	6	40.0%
50 - 59	1	6.7%
> 60	1	6.7%
unknown	1	6.7%
Grade of prescriber		
Foundation trainee (FY1; FY2)	4	26.7%
Core/GP Specialty trainee (CT1-3; GPST1-3)	3	20.0%
Higher Specialty trainee (ST4-6)	-	-
Staff Grade	4	26.7%
Consultant Psychiatrist	4	26.7%
Other Medical	-	-
Nurse Non-Medical Prescriber	-	-

In all cases, the prescriber was unaware that an error had taken place until they were contacted by the ward pharmacist as part of the study. In all but one case, the prescribers agreed that the issue which had been brought to their attention was a prescribing error, as exemplified by the following quote:

> *"Initially when I thought about it when I first got the email, I kept thinking "so what is it I did wrong?" I had to read it a couple of times, and I thought, umm well, "it's not an error, it's an omission". But then if you are looking at the definition, yeah, it's an error."* (P50, staff grade)

Of the 21 errors discussed, three (14.2%; 3/21) occurred during the admission process, four (19.0%; 4/21) at discharge or when a patient was going on a period of leave, and the remainder (66.7%; 14/21) during the patient's stay, either when the drug chart was re-written or when treatment was initiated or altered (see Table 4.2).

Table 4.2: Prescribing errors discussed during the interviews

Type of active failure	Type of prescribing error	Brief description of error	Prescriber	Stage of prescribing	Underlying themes
Slips	Omission of treatment time; wrong dose	**Promethazine** 8 mg prescribed instead of 50 mg; no administration time(s) circled on the drug chart.	P13 Consultant	During stay	Workload, staffing levels, distractions, stress, team dynamics
	Wrong dose	Regular dose of **promethazine** 25 mg twice daily prescribed at discharge when intended to be 'as required'.	P35 Consultant	Discharge	Workload, distractions, stress, lack of attention to task
	Wrong dosing interval	**Adcal-D3®** one tablet daily prescribed at discharge when one tablet twice daily was intended.	P147 Core Trainee	Discharge	Workload, distractions, lack of attention to task, knowledge,
	Wrong dosing interval	**Glipizide** prescribed as once daily at night, but with three administration times circled, when it should have been three times daily.	P148 GP Trainee	Admission (OOH)	Workload, distractions, confidence, stress, patient characteristics, information from patient/carer
	Wrong dosing interval	**Co-codamol** 8/500 prescribed as twice daily, but four administration times circled on the drug chart.	P175 Staff Grade	During stay	Patient characteristics, information from patient/carer, distractions, stress, tiredness
	Wrong dose	**Promethazine** 50 mg four times daily 'as required' prescribed, when maximum daily dose is usually 100 mg.	P167 Foundation Year 2	Re-write	Workload, working pattern, confidence, lack of attention to task, tiredness, stress,
	Wrong dosing interval	**Metformin** 1 gram twice daily prescribed, but only one administration time circled on drug chart.	P64 Foundation Year 2	Admission (OOH)	Workload, working pattern, distractions, information from patient/carer, tiredness, unfamiliar task, confidence
Lapses	Unsigned prescription	Prescription for dispersible **aspirin** was unsigned by prescriber.	P96 Foundation Year 1	Re-write	Workload, staffing levels, Prescribing circumstances, distractions, lack of attention to task, tiredness,
	Omitted when clinically indicated	**Ferrous fumarate** was unintentionally omitted on admission to hospital, despite having been identified during medicines reconciliation.	P13 Consultant	Admission	Workload, staffing levels, distractions, stress, team dynamics, prescribing circumstances
	Omitted when clinically indicated	**Omeprazole** was unintentionally omitted from the discharge prescription, despite having been prescribed during inpatient stay.	P13 Consultant	Discharge	Workload, staffing levels, distractions, stress, team dynamics, prescribing circumstances

Table 4.2: Prescribing errors discussed during the interviews (continued)

Type of active failure	Type of prescribing error	Brief description of error	Prescriber	Stage of prescribing	Underlying themes
Knowledge-based mistakes	Wrong dose; wrong maximum dose	Nitrolingual® sublingual spray prescribed with a dose of 200 micrograms and a maximum daily dose of 400 micrograms. (NB: one spray = 400 micrograms)	P17 Core Trainee	Admission (OOH)	Working pattern, confidence, tiredness, communication, stress, hunger & thirst, information from patient/carer, distractions,
	Omission of strength; omission of formulation	Topical **salicylic acid** prescribed with no strength, formulation or indication for use specified.	P90 Foundation Year 2	During stay	Working pattern, knowledge, confidence, patient characteristics, prescribing circumstances, workload, information from patient/carer, training
Rule-based mistakes	Omitted when clinically indicated	**Warfarin** was unintentionally omitted from the leave prescription as prescriber did not refer to all of patient's drug charts when preparing it.	P50 Staff Grade	Leave	Workload, prescribing circumstances, drug chart design, lack of attention to task,
	Omission of indication; No minimum dose interval	'As required' **Zopiclone** 3.75-7.5 mg prescribed without specifying the minimum dose interval or indication.	P136 Staff Grade	Re-write	Workload, prescribing circumstances,
	Duplication of drug	**Olanzapine** dose increased from 15 mg daily to 20 mg daily without prescription for 15 mg being discontinued.	P124 Consultant	During stay	Workload, stress, unfamiliar task, drug chart design, patient characteristics, tiredness,
	Duplication of drug	**Pramipexol** 300 micrograms three times daily prescribed without prescription for 180 micrograms three time daily on another drug chart being stopped.	P148 GP Trainee	Admission (OOH)	Workload, distractions, confidence, stress, patient characteristics, information from patient/carer
	Omitted when clinically indicated	**Ipratropium** inhaler not prescribed on admission to hospital, despite patient's own inhaler brought into hospital with them.	P25 Staff Grade	Admission (OOH)	Confidence, information from patient/carer, patient's own medicines, patient characteristics, prescribing circumstances
	Duplication of drug	**Paracetamol** 1 gram four times daily prescribed as regular medication, when already prescribed for 'as required' administration on the same drug chart.	P171 Consultant	During stay	Patient characteristics, prescribing circumstances, distractions, staffing levels, team dynamics, tiredness,
Violations	Omission of duration/review date	Duration of treatment or date on which to review a prescription for **trimethoprim** 200 mg twice daily not included on drug chart.	P25 Staff Grade	During staff	Distractions, prescribing circumstances, working pattern, workload,

OOH = Out of Hours

Thirteen of the errors (61.9%) involved non-psychotropic medicines. Four errors, made by three prescribers, involved promethazine (19.0%), one of which (promethazine prescribed with twice the recommended maximum daily dose), may have resulted in actual patient harm as the patient complained of palpations, a known side effect of promethazine. None of the others were recorded as causing any patient harm.

The ward pharmacist who identified each error, assessed the clinical significance of most to be minor (16/21; 76.2%), whilst the remainder were considered to be of moderate clinical significance (5/21; 23.8%). None were classified as severe errors.

4.2 Active failures

For each error, an active failure was identified. Rule-based mistakes were the most common (8/21; 38.1%), although knowledge-based mistakes (2/21; 9.5%) and skills-based errors (slips and lapses) also occurred. Slips (7/21; 33.3%) were more frequent than lapses (3/21; 14.2%). More details of the prescribing errors discussed are shown in Table 4.2.

4.2.1 Slips and lapses

Prescribers who made slips or lapses were unaware that they had made them and unable to explain why they had happened.

> *"I do remember writing down the whole TTA, the discharge notification, but frankly I do not remember that I had written down the wrong frequency. I don't remember that at all. When I received this, then I realised that I must have, but I couldn't remember"* (P147, core trainee)

In another case, the junior on-call doctor was asked to admit a patient who had been transferred from a ward on another site, which involved rewriting the prescription chart.

> *"I wrote up the PRN drugs, including the promethazine, and I, I'm pretty sure that this is what happened, I basically copied from the original chart. Partly. So, I think what they had put was promethazine 25 mg maximum QDS and I put 25-50 mg maximum QDS. What I normally write is promethazine 25-50 mg maximum 100 mg. So, I mixed up my usual way I would prescribe it, with what had been done at … The way I would normally do it was correct but I kind of squished the two together and came out with something that was obviously completely incorrect."* (P167, FY2)

In the quotation above, the prescriber describes making an action-based error in executing what would normally have been correctly-planned actions, resulting in a prescription with the potential for twice the normal maximum daily dose.

Prescribers who had made slips and lapses often mentioned that they were busy at the time of prescribing (7/10; 70.0%) or interrupted during the process (4/10; 40.0%), particularly if they were the only medic on duty out-of-hours. In one instance promethazine, which had been prescribed during the patient's stay on an 'as required' basis, was written as a regular medication on the discharge prescription. The prescriber remembered that she had been writing the prescription in an open plan office area, with frequent interruptions, and felt that this contributed to the error.

> *"I had the drug chart next to me. I think probably what happened is that somebody probably came and asked me something, before I wrote PRN and then said, "are those charts ready to take over", it was that kind ... I can remember where I was writing it; it was in the hub where everyone is around and usually it would be my trainee that would write the discharge TTAs but I can't remember, he was either not there that day, or he had already gone out on a visit, and I just thought to save time I would just write it out, and urhh, I was being asked lots of other questions at the same time, so I think I probably just didn't write the PRN"* (P35, consultant)

In another instance, the junior on-call doctor wrote up metformin with a frequency of twice daily, but only circled one administration time on the drug chart, resulting in the drug being given once daily for four days. She recalled that whilst writing the prescription she had been called away to deal with another patient who was exhibiting violence and aggression and had failed to complete the task when she returned.

> *"But the fact that I left the chart midway through to go and deal with it, and I was probably gone about half an hour because the patient ended up being, not the patient with the error, but the patient who was agitated ended up being restrained. There was a whole process that went with that, so I came back to the chart probably half an hour later, umm, when you are on-call it's very hard to take yourself away and prescribe - bleeps going off, the alarm going off"* (P64, FY2)

Three lapses were noted. One involved a prescription which the prescriber had forgotten to sign. As a result, one dose of aspirin 75 mg was omitted before the prescription was corrected.

> *"I remember rewriting the chart, so it wasn't a new prescription. I was rewriting the chart. And she's a lady who has been with us for quite a while and has a lot*

> *of medications for her physical health as well as her mental health. So, I think she has multiple drug charts and I remember rewriting it. I didn't, in all honesty, realise I had missed out my signature on that one."* (P96, FY1)

The other two involved omitting a medicine from the prescription either when the patient was admitted or at discharge. Prescribers mentioned prescribing "*on autopilot*" (P35, consultant) for discharge prescriptions or re-writes categorising them as "*a boring task, repetitive thing*" (P147, core trainee) and perhaps not paying as much attention to the task as in other circumstances, which may make them more prone to slips and lapses.

4.2.2 Mistakes

Two mistakes demonstrated a lack of knowledge or experience and related to prescribing, or omitting, the dose, strength and/or formulation. In one instance, the junior doctor prescribed a Nitrolingual® glyceryl trinitrate (GTN) pump spray for sublingual use 'as required' for angina pain, but incorrectly stated the dose to be 200 micrograms per spray rather than the correct dose of 400 micrograms and gave the maximum dose as 400 micrograms in 24 hours, when patients would normally receive up to three doses of one-two sprays, after which medical advice would be sought if the angina pain had not resolved.

Another junior prescriber undertaking on-call duties was asked to prescribe treatment for a patient's verrucas just before the end of the shift. She recognised that this was an area she was unfamiliar with but, despite referring to the BNF, she left the prescription simply as salicylic acid, with no information about strength, formulation or brand name, and no indication on the prescription as to the condition being treated, hoping that someone else would make the final decision.

> *So, the patient I'd seen had verrucas and I had never prescribed anything for verrucas before, so I used the BNF to try and work out what would be appropriate and under salicylic acid, which they recommended as the first line for verrucas, there were a lot of options, umm, in terms of what type, what strength etc. and the brand names for each. However, I wasn't sure which would be available within the trust and also which one, in particular, was first line ... and I thought that prescribing it as salicylic acid would allow the pharmacist to make the choice about which type to use, really.* (P90, FY2)

Most of the mistakes (6/8; 75.0%) where rule-based, either due to failing or misapplying a good rule, or applying an inappropriate rule. Three rule-based mistakes

related to duplication of medication, where the prescriber changed the patient's dose of medication but did not cancel the previous medication order. For example, a patient's dose of olanzapine was increased from 15 mg to 20 mg, without crossing through the current 15 mg dose on the drug chart. Potentially the patient could have received a dose of 35 mg of olanzapine, which exceeds the maximum recommended daily dose; this would have been likely to cause sedation, and in an extreme case, could have precipitated neuroleptic malignant syndrome.

> *"… there was a deviation from, I suppose, the accepted practice, which would have been to delete the preceding prescription, as well as perhaps, by putting a line through it, or by putting a line in the box that the nursing staff would have signed to administer."* (P124, consultant)

Another related to omitting a medicine from the leave prescription because only one of the patient's drug charts was referred to when preparing the prescription. As the omitted item was warfarin, this could have had serious consequences for the patient.

> *"[the] patient was going on leave, and I completed, umm, I was given the cards for the patient, but I didn't have the warfarin card. I filled in the back, gave it to ... and I think they ran to the pharmacy to make sure. So, the yellow card for warfarin was still sitting in the folder"* (P50, staff grade)

4.2.3 Violations

One violation was discussed during the interviews, where the prescriber had omitted to specify the duration of therapy or a review date for an antibiotic course. Such practice is recommended by local and national guidelines but is frequently omitted. Although only one interview was conducted in relation to this type of error it was found in 3.4% (25/727) instances of errors in the overall data set.

> *"I remember that I made an entry in his medical records asking the ward doctor to review the medication, just stating that I have written this medication as part of the advice from the A&E. The patient attended A&E, returned and then this was prescribed, and as per plan I put "please review" to Dr … I didn't write duration, I just said that, you know," please review the medication"."* (P25, staff grade)

As there are no studies which have systematically examined the cause of medication errors in a mental health setting all comparisons are made with studies conducted in secondary acute or primary care. However, it should be noted that there are differences in the types of drugs used and the nature of patients treated in these

settings. For example, intravenous medicines are rarely used in mental health, and patients in acute care are often more physically unwell.

Studies have tended to identify knowledge-based mistakes as the most common type of prescribing error, due either to lack of knowledge about the drug or about the patient.[15,26,173,174] Fewer studies have identified rule-based mistakes[187] or slips and lapses[27,113,188] as accounting for most errors. Although 'inadequate monitoring' was classified by Tully *et al* in their systematic analysis of the causes of prescribing errors as 'rule violations' such errors could arguably be considered rule-based mistakes (lack of knowledge of a rule or failure to apply a rule) rather than violations (an active deviation from safe practice). In common with other studies,[27,188] participants often reported that they were unaware that they had made errors, particularly slips and lapses.

4.3 Error-producing conditions

Prescribers frequently described many factors as having contributed to the prescribing error. These are presented in the following sections in accordance with the error producing conditions used in Reason's model of accident causation - work environment, individual factors, patient factors, task factors and team factors. The most frequently cited factors were team factors (15/15; 100.0%) and work environment (14/15; 93.3%).

4.3.1 Individual factors

4.3.1.1 Physical and mental health

Individual factors included those pertaining to the wellbeing of the prescriber or relating to knowledge, experience or competence, and were mentioned by all but one prescriber (14/15; 93.3%). Five prescribers cited issues relating to personal well-being such as hunger, thirst and tiredness with comments about the shift length being more difficult to manage at night, difficulties moving from days to nights, and about being more tired on a night shift as it is difficult to sleep during the day.

> *"I was hungry because it was lunchtime, but it was yes, a particular type of ward round because there were a few new admissions, so we had to review them"* (P17, core trainee)

It is generally recognised that people do not perform at their best when hungry and/or thirsty, and that the brain depends on the body for fuel in the form of glucose from the bloodstream. A meta-analysis of 36 studies reported on the effect of blood glucose

on decision making. It found that low blood glucose levels decrease the willingness to work in all non-food related situations, make decision makers more impatient, and increase the tendency to make decisions intuitively rather than deliberately. The authors conclude that low glucose levels motivate feeding-related behaviours at the expense of other potential priorities.[331] Masicampo and Baumeister tested the hypothesis that more blood glucose (brain fuel) was needed for a more effortful, rule-based task than for a less effortful process, using a specific pattern of intuitive, heuristic-based decision making and administration of a glucose-rich snack.[211] They found that providing a beverage sweetened with sugar restored the capacity for System 2 reasoning, and decreased reliance on heuristically based System 1, which they suggested was consistent with Kahneman's view that System 2 operates as a monitor of System 1 outputs where these occur as the default.[332]

Dehydration can also impact mood, perception of task difficulty, and the ability to concentrate leading to deterioration in cognitive performance and short-term memory impairment. A UK study of doctors and nurses identified that 36% were dehydrated at the start of their shift, increasing to 45% at the end, with 41% oliguric at the shift end. Cognitive function tests performed at the beginning and end of the shift were significantly impaired in dehydrated participants.[333]

One newly qualified doctor (P96, FY1) reported that having been on-call over the previous weekend, the day on which the prescribing error occurred was her eleventh day at work, whilst others commented about the impact of working at night.

> *"And you do get that, you find yourself thinking oh, goodness, I normally wouldn't struggle during the day."* (P167, FY2)

> *"I quite often do feel a bit tired on night shift, because you just don't sleep as much during the day, particularly if you are shifting from days to nights." (P167, FY2)*

Hendey *et al* found that although year one postgraduate doctors had similar day time error rates to their year two to five postgraduate colleagues, their overnight on-call error rate was significantly higher. The authors suggested that fatigue and sleep deprivation may have a more pronounced effect on prescribers early in their career, perhaps combined with less supervision during the night, or that more experienced doctors may have learned better coping mechanisms[181]

A more experienced colleague highlighted the multiple personal factors that can influence performance at work.

> *"… we are human, we get distracted, we get hungry, we haven't slept last night enough, we got upset by our children before coming to work [laughter], whereas a robot would not be affected."* (P175, staff grade)

Ten prescribers talked about stress in association with the error they had made, usually with regard to pressure to complete tasks, either because of needing to move on to the next in sometimes a long list of tasks or because someone was waiting for it to be completed.

> *"It is stressful situation, when I say stressful to you - you're the only doctor and there are so many admissions. … Here you are the one, your bleep is going on and off, on and off; medical problem, patient admission and specially somebody like complex here you have to focus, and it is stressful."* (P148, core trainee)

> *"Umm, probably stress and tiredness, to be honest. Kind of, being tired and being aware "okay, I have to do this because I've got something else to do, and…" you're a bit under pressure sometimes because if you've seen a new patient and you know that you've got other things to do on the ward, and then patients start going off to bed, and you think "Oh, but I haven't finished yet" and I might not get time to do it when they waken up in the morning before I have to hand over."* (P167, FY2)

Level of experience did not appear to make a difference, with staff grade and consultants (5/8; 62.5%) as well as more junior grades (5/7; 71.4%) reporting being under pressure when prescribing.

> *"Maybe it was again the pressure, somebody on your head. Needed immediately - you're looking at a second patient."* (P13, consultant)

> *"There was a time pressure, yeah, and there generally is somebody needs to take them all over [to the pharmacy] and they all need to be written. They don't need to be, but obviously, if there's one left over somebody has to go all the way over there and back again just for one chart, so you're trying to get them all done to go over there in one lot after handover in the morning."* (P35, consultant)

None of the participants specifically mentioned mental well-being in connection with prescribing errors, but this has been reported in other studies.[26,27,185,187–189] Burnout has been demonstrated to occur in between one-quarter and three-quarters of junior doctors,[334] with recent data suggesting that it affects both junior and senior doctors.[335]

Despite burnout increasing the likelihood of performing below average in certain performance measures[336] it does not appear to correlate with an increased rate of prescribing errors.[186] However, depression has been shown to have an impact on the rate of prescribing errors. A study among junior doctors working in paediatrics identified that 20% of participants met the criteria for depression and 74% for burnout. Doctors who demonstrated depression made significantly more prescribing errors than those who were not depressed.[186]

In a survey of senior UK-trained doctors, almost half (44%) of doctors (42% of hospital doctors) felt that working as a doctor had had an adverse effect on their own health or wellbeing. Nearly 80% of these respondents identified "stress/work-life balance/workload" as the cause, with episodes of burnout and depression attributed to them. Less than a third (28.4%) agreed that the NHS was a good employer when doctors become ill themselves.[337] High levels of stress have been found amongst junior doctors, with one study identifying mental health problems which required treatment in 11% of newly qualified doctors,[338] which may have negative effects on decision making, learning and ultimately patient care.[338,339] A longitudinal study which followed doctors from the final year at medical school to their tenth postgraduate year, found that stress relating to work-life balance increased over the period while stress associated with work (emotional pressure, time pressure and fear of complaints and criticism) decreased.[340] Increased levels of exogenous cortisol have been associated with a shift from deliberative, reflective to automatic, reflexive thinking in an experimental setting, and stress is associated with the release of cortisol and noradrenaline.[341]

4.3.1.2 Knowledge, skills and competence

A lack of knowledge about the specific drug(s) being prescribed was acknowledged by prescribers in five cases, two of which have already been described in the earlier paragraphs covering knowledge-based mistakes (errors involving Nitrolingual® spray and salicylic acid described in Section 4.2.2). Another prescriber admitted that working in the specialty of psychiatry if patients are admitted on medication for their physical health, he was less likely to know if the doses were correct.

> *"when psychiatry, I know more about them probably, and because we are concentrating on a specialty, and we think about them, and I would be, because we are the ones who are initiating them and monitoring them, so I would be more aware ... whereas she came in with all these other physical health medications which was kind of, I need to copy them down. In copying down, I wasn't thinking*

> *probably, was just copying the thing. Whereas had it been a psychotropic medication I would be thinking, this patient should receive this dose, and this, yeah."* (P147, core trainee)

A similar view was expressed by another participant who commented that:

> *"Our seniors will have sometimes limited knowledge about common physical conditions"* (P90, FY1)

Six prescribers talked about experiencing uncertainty about the item they were prescribing, or a lack of confidence in their own knowledge or ability, resulting in them following the way someone else had prescribed previously. Perhaps unsurprisingly, five of these were prescribers in training grades, with half of these being foundation trainees.

> *"I've looked at a chart that has come from another mental health hospital, and I've thought "oh, that's maybe the way I should be doing it." You know, so just lack of confidence with prescribing things that I'm less familiar with."* (P167, FY2)

> *"I wasn't confident with his writing, but I checked with the medication and it was kind of correct."* (P148, GP trainee)

> *"I'm a doctor - I should be more sure of myself, maybe more self-confident instead of relying on what other doctors prescribe and maybe they're making errors and I make errors myself following their prescription." (P17, core trainee)*

Lack of knowledge and experience has been reported in other studies as an error-provoking condition.[26–28,113,185,187,188] The preparation of medical students for their prescribing role has been criticised as inadequate and in need of updating, particularly in relation to the application of theoretical knowledge to clinical practice.[258,292,295] It has also been suggested that training in prescribing should concentrate on a core list of 80-100 drugs[342] which are those most commonly prescribed in primary and secondary care, and demonstrate a strong relationship with prescribing errors.[343,344] From a mental health perspective this list includes selective serotonin re-uptake inhibitor antidepressants (SSRIs), benzodiazepine-like hypnotics ('z-drugs'), typical (first generation) and atypical (second generation) antipsychotics, drugs used in substance misuse (methadone, nicotine), phenothiazines, sodium valproate,[343] and other antidepressants which was added in a 2018 update of the list.[344] The authors suggest that one role of a core list is to allow prescribers to develop robust System 1, decision-making processes based on pattern recognition for the safe and effective prescribing

of those drugs that make up the majority of their workload. This can be complemented by System 2 thinking when dealing with unfamiliar drugs, such as reference to information sources or consulting with colleagues.[343] During the early stages of developing prescribing expertise practitioners' interaction between System 1 and System 2 will occur, as calibration between the outputs may be refined to arrive at the final decision.[214] Prescribing familiar drugs will use System 1 processes, whilst unfamiliar drugs will require the involvement of System 2.[343] Calibration will be of particular importance in circumstances involving risky drugs, patients or situations and where lack of knowledge and experience is likely to result in errors.

In an attempt to ensure that newly qualified doctors are better prepared for their prescribing responsibilities a Prescribing Safety Assessment (PSA) was introduced in the UK in 2014, which medical students must pass. Feedback from candidates suggest that the process of preparing for the PSA engendered an enhanced sense of confidence about their future prescribing, and it is already thought to have improved undergraduate training for prescribing.[345] Although significant variation in students from different medical schools has been noted, the overall pass rate has improved during the first three years.[297]

Although not significant when adjusted for other variables, Tyssen and colleagues identified perceived lack of skills at the end of medical school to be associated with stress.[338] This resonates with the findings of studies into the causes of prescribing errors which have identified that many junior doctors do not feel that they have the adequate experience or skills for the task of prescribing[18,21,26,28,113,187] supporting the view that final-year medical students do not have sufficient prescribing competencies,[224] feel unprepared,[294,346] and that there is poor correlation between their own assessment of their prescribing skills and actual competence.[221]

In the current study all prescribers were asked about the training they had received in therapeutics and the practical aspects of prescribing. Most responded only from a clinical pharmacology and therapeutics perspective, talking about lectures they had received in the theoretical treatment of specific conditions, or experience gained whilst shadowing doctors during the clinical years of their undergraduate medical training. Three of the four foundation year doctors mentioned the Prescribing Safety Assessment and practical training they had received.

> *"But we had a lot of teaching on prescribing and prescribing errors. And a lot of practical based teaching sessions - of filling out drug charts and a scenario, what*

> *would you prescribe and then discussion of that, and there was a lot, particularly in final year, a lot of teaching."* (P96, FY1)

It has yet to be seen whether the prescribing error rates fall for junior doctors who have been exposed to the PSA and if they report more confidence and feel better prepared for their prescribing role.

4.3.2 Work environment

4.3.2.1 Workload and shift patterns

With only one exception, all prescribers made comments about the work environment in relation to the error being discussed. Workload and time pressures were the most regularly cited factors, with 13 prescribers mentioning high workload as contributing to the error. When discussing the contributory factors to three errors which he had made, one prescriber highlighted that he routinely needed to complete five or six multidisciplinary patient reviews during a half-day session, which resulted in prescribing being rushed in order to keep up with the schedule.

> *"… here you have to see five to six patients sometimes in a half day. This is a lot of pressure and upon that there's a lot of families being booked as well. Like yesterday I was put under enormous pressure. Three families were already booked, and the fourth family was on the phone and the staff brings the phone in there … "the family is on the phone and they've been asking that they want to see you". How on earth you can say no to them if they're on the phone. … we had already got four, three families, four families to see."* (P13, consultant)

Several of the prescribing errors had occurred around the Easter bank holiday weekend and prescribers described the additional workload involved in either trying to prepare for the bank holiday or catch up after the four-day break.

> *"Because it was a short week before Easter ... those weeks do tend to be a bit more intense, in that you are trying to do five days' work in four, but also patients want leave because it's a long break, so more patients would want leave."* (P50, staff grade)

> *"Yesterday was very busy because it was post-Easter weekend and I hadn't been in for four days. And currently the other FY1 - there are normally two of us here that cover [X]'s patients - and she's on annual leave at the moment, so it was just me. So yes, yesterday I was very busy."* (P96, FY1)

The terms "*busy*", "*stressful*", "*intense*" and "*pressured*" were all used during interviews to describe the workload. Workload has been highlighted as contributary to prescribing errors in a number of studies,[13,26,27,113,187–189] and a "morning dip" seen in the appropriateness of antimicrobial prescribing has been contributed to the morning rush of ward rounds.[347] Low staffing levels have been highlighted as a contributory factor to errors in several studies,[15,26,27] whilst studies have also found that the number of prescribing errors increases with the more medication orders prescribed per patient[178] or per prescriber.[179] Workforce gaps within psychiatry, coupled with falling applications for medical school places, foundation and specialty training programmes coupled with rising demand, present a significant challenge to the provision of safe patient care within the NHS.[348]

In a 2018 survey of trainees and trainers, 40% of doctors in training and 66% of more senior doctors reported that the intensity of their work was "heavy/very heavy", with many reporting that they work beyond their rostered hours.[335] A recent briefing from the British Medical Association (BMA)[348] has indicated that applications to medical school and for foundation programme training places have dropped, and fewer doctors are applying for specialty training posts. In 2017, fill rates for core psychiatry training posts were 69% nationally and 36% in the East of England, with 53% of higher specialty training places nationally filled but only 20% in the East of England.[349] Nationally 13% of consultant psychiatrist and 11% of mental health nursing posts are vacant.[350] It is therefore unlikely that staffing levels and workloads will improve in the near future.

Working on-call was mentioned by four prescribers, who highlighted being the only doctor covering several wards or disparate sites, and as a result, constantly chased by staff to see other patients.

> *"it would have occurred, around about 4.30 on Friday morning. It was the fourth shift, fourth night shift I'd worked. It was an incredibly busy evening, multiple admissions. … When you are on-call it's very hard to take yourself away and prescribe - bleeps going off, the alarm going off."* (P64, FY2)

> *"I had quite a few, like six, seven admissions and yes, it is a stressful situation for one person dealing with all these things."* (P148, GP trainee)

It has been suggested that the NHS needs to change its attitude to doctors sleeping during night shifts with planned naps of less than 30 minutes encouraged to improve patient care and safety.[351] It has also been noted that, despite the implementation of

the European Working Time Directive (EWTD) the working patterns expected of doctors would not be accepted in other high risk industries such as rail or aviation.[352] Previous work has identified that pilots are less likely to deny the effects of fatigue on performance than healthcare staff; 60% of doctors stated that they perform effectively in critical situations even when fatigued, compared with 26% of pilots.[353] In the 2018 annual survey of trainees, one fifth of doctors in training reported that their working pattern left them feeling short of sleep during work on a daily or weekly basis, a proportion which has remained relatively constant for the last seven years. Perhaps surprisingly a similar proportion of the medical training supervisors (i.e. senior doctors) also reported the same experience, suggesting that around 20% of doctors are struggling with fatigue.[335]

Studies of doctors' performance have shown that acute and chronic fatigue has a significant impact on neurobehavioral response times,[354] the ability to correctly detect adenoma during colonoscopy[355] and risk of sustaining a needlestick injury[356]. In an Australian study, Westbrook *et al* found that prescribing error rates were significantly higher for doctors who reported less than average sleep in the previous 24 hours compared with those who reported normal sleep.[357] Hendey *et al* compared the error rates for medication orders written overnight by doctors on-call, those written following an overnight on-call period, and during normal daytime duties; they found an increased error rate for overnight and post on-call prescribing compared to prescribing undertaken during the day. The authors suggested that their observations may be due to the onset of fatigue during the middle of the night, verbal orders after awakening from brief sleep ("sleep inertia"[358]) or degradation of performance associated with circadian nadirs.[181] Although most of the research has been undertaken in the US and in doctors working much longer hours than are normal in the UK, where the EWTD restricts working patterns, the principle that fatigue and sleep deprivation have an impact on performance remains valid.

A recent survey of nearly 8,000 US healthcare workers, which investigated work-life balance, teamwork and safety climate, identified that positive work-life balance was associated with better teamwork and safety environments. The authors revealed that doctors and nurses reported the greatest work-life imbalance, with respondents in the bottom work-life balance quartile reporting that during the last week 84.5% had skipped a meal, 82.5% had worked through a shift without any breaks, 79.4% had changed family plans because of work, 72.6% had difficulty sleeping and 70.4% had arrived home late from work.[359] The 2017 NHS Staff Survey found that 58.3% worked

unpaid additional hours, 38.4% reported stress, and 52.9% reported working while being unwell.[360]

4.3.2.2 Task switching and distractions

Prescribers regularly described having to simultaneously deal with multiple tasks and experiencing distractions, and not having anywhere quiet that they could use when prescribing.

> *"And even over here when you are writing a drug chart twenty people are there, not twenty, I mean three or four. One is talking about something, somebody is coming and just opening the door in the middle. There's quite a lot of disturbance all the time."* (P13, consultant)

> *"Distraction is one of the other causes, sometimes we do multiple things together so when I do a drug chart I'm talking with a nurse, or you know, thinking that the patient was unwell, so it might cause a distraction."* (P17, core trainee)

> *"He had the fall when I arrived and was just in the middle of prescribing, so he had the fall ... I found him on the floor, so it was a little bit ... And I knew that I was expected for a new admission on [another ward]."* (P25, staff grade)

> *"this does happen quite often that you are sort of trying to write up TTAs and somebody, and because I'm the consultant as well, people will come in and ask you lots of different things, there will be queries about patients or somebody rings up."* (P35, consultant)

Experimental psychology studies have demonstrated the detrimental effect of interruptions and task switching, often referred to as "multitasking" on performance.[361,362] Observational studies have shown that in the emergency department, healthcare professionals are interrupted between 5 and 6 times per hour (on average every 11 minutes) by colleagues or telephone and bleeper calls, spend as much as 30% of the time dealing with multiple tasks and demands simultaneously, and fail to return to nearly one in five tasks.[363,364] Negative associations were identified between mental workload and perceived quality of care.[364] Whilst it is recognised that the unique characteristics of the emergency department may exacerbate the rate and severity of medication errors,[57] task switching and distractions are likely to have an impact in all clinical settings.

4.3.3 Patient factors

Factors relating to the patient themselves were mentioned by 14 prescribers, the most frequent being characteristics of the patient. Several of the patients involved were

suffering from dementia and unable to communicate any information about their medication, whilst others were uncommunicative due to their mental state. Communication issues and unfamiliarity of the prescriber with patients seen out-of-hours or when working on-call may partially explain the higher incidence of prescribing error on admission to hospital seen in this and other studies.

4.3.3.1 Communication

Patients admitted to a mental health facility are frequently confused, either as a result of organic disease (e.g. dementia) or due to the manifestation of functional mental illness such as schizophrenia and bipolar affective disorder, which can present as thought disorder, hallucinations, delusional beliefs, disordered speech, impaired cognition, bizarre behaviour or inaction, apathy and withdrawal. All can make it very difficult to elicit a medication history from the patient.

Medication brought into hospital with the patient was felt to be both a benefit and a hindrance depending on the circumstances. Where patients had either a comprehensive list of their repeat medication with them or a set of clearly labelled medication, this was used as a basis for prescribing.

> *"But if the patients have their drugs with them, and some of them do, then I just do it from it, from the box." (P64, FY2)*

However, some patients or their carers, presented with a handwritten '*aide-mémoire*' or a selection of assorted medication, and this could cause confusion and take considerable time for the prescriber to decipher.

> *Now, with her case, it was really confusing. I guess I had to spend a lot of time to sort out the medication, because her partner got a list of medication with his handwriting and I didn't have all the GP letters … and they brought scattered medication with them with a box which, and also if you look at her drug charts I had to put in three different drug charts because of timing, because no, "I want it this time, because I've been told by the neurology consultant." It was quite intense."* (P148, GP trainee)

One prescriber chose not to prescribe a particular inhaler for a patient because the one that they brought with them did not bear a label to identify it as theirs.

> *"I was not comfortable prescribing it without being labelled, but I saw that he had a history of using it, … I assumed that he was using it, I didn't know why or for how long, so I put something PRN in case he needs something to help with the*

shortness of breath." (P25, staff grade)

Prescribers in other studies have highlighted lack of access to systems which should aid prescribers, particularly out-of-hours.[113] It was clear from interviews that prescribers within the trust do not have access to the Summary Care Record (SCR), although the trust's pharmacy team routinely access it to aid medicines reconciliation. The SCR is created from GPs' clinical information systems and kept up to date in real time as patients' GP records are updated, with 98% of practices using the system. It holds information about current medication, allergies and adverse reactions to medicines; additional information such as significant medical history, care plans and patient wishes, or preferences can be added. Access to the SCR is intended to make care in non-GP settings safer, reducing the risk of prescribing errors.[365] Availability of this resource, particularly out-of-hours, would have been likely to prevent the errors described above where items were either incorrectly prescribed or omitted due to lack of information about the patients' medication on admission.

Despite the labelling recommendations of the National Patient Safety Agency,[366] endorsed by the Royal Pharmaceutical Society,[367] that the actual container (e.g. inhaler, bottle or tube of cream) should be labelled rather than the secondary outer container, many community pharmacies continue to label the outer container of such medicines, which are then discarded and the labelling information lost. Recommended labelling practice by the community pharmacists would have prevented the omission of the inhaler in the instance described above.

4.3.3.2 Patient characteristics

Prescribers have reported that concerns about whether the patients are providing accurate information can contribute to prescribing errors.[113]

Two prescribers mentioned the risk of drug-seeking behaviour in patients; in one case describing the risks of being misled by information provided by the patient or their carer.

> *"Sometimes you can get misled from patients, or partner. Somebody says "I'm on that" but you don't have the information, so you can fall in trap and then you write something which patient may not be, especially mental health … So, I had experience like that, so you try to avoid them say "okay, I need a written proof from GP or consultant"."* (P148, GP trainee)

In the other, the error arose due to a slip when reducing the dose of codeine being received by a patient with suspected drug-seeking behaviour. The prescriber had intended to reduce codeine intake by decreasing from two tablets four times a day containing 30 mg codeine/500 mg paracetamol to the same regimen with tablets containing 8 mg codeine/500 mg paracetamol, in the hope that the patient would not notice the reduction. Inadvertently, the frequency was reduced to twice daily as well as the dose.

Other factors mentioned included patients who were unfamiliar to the prescriber, either because they were newly admitted, or normally under the care of other teams, especially during on-call duties. Interestingly, one prescriber highlighted the opposite situation contributing to an error. He described the patient as someone that he had looked after in the community and was well known to him. As a result, there had been a jovial ending to the interaction.

> *"there had been this bit of banter between us, so I was quite relaxed - perhaps not as focused as I might have been in writing it."* (P124, consultant)

In studies, prescribing for patients who are clinically complex, those who are unhelpful or difficult, and those who have language difficulties have been reported to result in prescribing errors.[172] Experimental research has demonstrated that patients' disruptive behaviours can impair diagnostic reasoning,[368] potentially due to limited cognitive resources needing to be allocated to processing the emotion-provoking behaviours of difficult patients at the expense of processing clinical findings (the 'resource depletion' hypothesis).[369] Such affective factors could also influence doctors in decision making about treatment options, and it has been suggested that knowledge of such issues should be incorporated into clinical training.[370]

4.3.4 Task factors

Factors relating to the task of prescribing were raised by five prescribers; four highlighting issues relating to the drug chart and one to access to resources to support prescribing.

4.3.4.1 Prescription charts

Interviewees talked about various aspects of the drug chart which may have contributed to their error. Alongside the main inpatient drug chart, the trust used separate charts for insulin, anticoagulants and clozapine initiation, which have a removable adhesive strip so that they can be attached to the main chart. One prescriber, who had omitted warfarin from a leave prescription because she had not

looked at the anticoagulant chart as well as the inpatient chart, commented that there needs to be a way of keeping everything together, suggesting the adhesive strip is not used.

> *Umm, when you think about it afterwards you think well it might not just have been warfarin, it could have been insulin couldn't it; anything that is on separate charts. I think it would be... I don't know how you'd do it.... if everything was clipped together in some way. Umm, but I don't know how you would do that because obviously when things get rewritten.* (P90, staff grade)

Another prescriber, who had entered different information into the frequency instruction on the drug chart to the number of administration times specified, highlighted that in other places he had worked, there had only been one of these included on the drug chart.

> *"In different - in their charts, they don't have a specific box where you put how many times per day a medication will need to be taken. They only have, and it's clear from the chart, you circle how many hours and how many lines you put and that makes it quite clearly understandable - is it twice daily, three times daily, four times daily? But you here, you have that extra box."* (P175, staff grade)

A third explained that he had previously worked with a drug chart that was designed to allow changes to the dose, rather than needing to discontinue the instruction and write a new medication order if details of a drug change.

> *"you know the medication you prescribe, you can't alter it - you have to cross it off. … So, each time the consultant changes the dose you have to block it out, go down and that wastes extra page. You be writing again and again same thing, whereas … they have one drug chart, kind of like, there is three columns. So, you can amend it and you can amend the dose easily and you still keep the same recording."* (P148, GP trainee)

It was clear that prescribers found the variety of prescription charts they encounter in different organisations a challenge, and this has been raised in previous studies of prescribing errors.[13,26] The contribution of prescription chart design and familiarity to prescribing errors has been demonstrated experimentally, with differences in design associated with significant variations in error rates.[371] Both the British Pharmacological Society (BPS) and the authors of the EQUIP report into causes of prescribing errors have recommended the introduction of a standard national prescription chart throughout the NHS.[18,372]

This approach was taken in Australia in 2006 and, despite being criticised by some as inferior to their previous drug chart,[373] significantly reduced prescribing errors,[374] although it has been recognised that more still needs to be done to address the causes of errors and ensure compliance with the National Inpatient Medication Chart (NIMC).[375] Interestingly, in a randomised cross-over study of prescribing writing, those participants who took longer to complete prescriptions under the simulated conditions made fewer errors, perhaps suggesting that when prescribing on unfamiliar documentation they took extra care and double-checked their prescriptions,[371] or that slower, more deliberative, System 2 thinking was being employed. However, there has been no introduction of a standard NHS drug chart in the UK. Although standards have been developed for their content,[376] the move has been towards the implementation of electronic prescribing systems[377] with the aim of a paperless NHS by 2020.[378]

4.3.4.2 Availability of resources

One prescriber commented that there can be a lack of awareness about the availability of, or how to access, trust prescribing guidelines.

> *"I think it can be a combination of, urhh, awareness of resources such as trust guidelines. If you don't know they are available or where they're available that can stop you writing the medication that's available within the trust. Your own training and knowledge limitations, I suppose."* (P90, FY2)

Access to resource materials has been highlighted in other studies, including unavailability of drug reference materials such as the hospital formulary or treatment guidelines[13,114,185]; in some instances prescribers have admitted knowing of a protocol's existence but not bothering to refer to it for the information which would have prevented the error.[27]

4.3.5 Team factors

Team factors were mentioned by all interviewees. These included the role of different members of the team, incomplete handover of tasks to other staff, and assumptions about the role of others in sorting out problems.

4.3.5.1 Cultural barriers

Comments from more junior prescribers suggested that there may be a culture of not challenging the prescribing of senior staff, even if there is a concern that they may have made an error.

> *"A lack of self-confidence from doctor's point of view. Sometimes even if we are right we don't trust in our self and also the fact that we don't challenge, we follow others, especially if they come from other specialists or other doctors, we follow their instruction without challenging them even if we probably should."* (P17, core trainee)

Similar reluctance to challenge more senior doctors has been observed in other studies, due either to a lack of confidence (as here), a reluctance to display ignorance,[13] or a feeling that it was incorrect for a junior doctor to have a different opinion to their superiors,[26,185] resulting in errors due to following instructions from other staff.[113] Although this has been raised in other studies[13,26,27,185] none of the interviewees mentioned that supervision from superiors was inadequate. However, comments were made by two consultants about the ability of junior doctors to prescribe:

> *"We have junior doctors, but we don't have junior doctors. The junior doctor should have been here now, he's not here yet, and nobody's here to ask them. When you ask them, and they are doing something, they are doing this or ... Because I think I can save more time in that. Because if I ask juniors they take ... one script they take ages. So, I mean, I think that "why don't I write it myself" that will save me five minutes. Five minutes is a lot here"* (P13, consultant)

> *"I probably wouldn't ask them to write a prescription if they were like a CT1 or 2, maybe a 3 could do it. F1 or F2 I wouldn't ask them to do it. But at the same time, they are asked to write prescriptions on admission."* (P124, consultant)

This may suggest that opportunities are not taken to develop the prescribing skills of more junior doctors, with the attitude that it is quicker and easier for senior staff to do it themselves; in which case doctors in training are going to struggle to develop the knowledge and skills required of them as they progress.

Very few of the prescribers (4/15; 26.7%) had discussed the error they had made with anyone else or formally reflected on it in any way. Three of those who had were trainees, who had discussed it with their supervisor or recorded it in their learning portfolio.

> *I've reflected on it though in my portfolio, and I've discussed it with Dr … so I've discussed it with her. (P64, FY2)*

> *"there's a few things that I'm thinking that I will write down from this, so, just for my own reflection. So, yes, absolutely. I think it's really important to just reflect on the fact that it's happened and think myself about why it happened." (P167, FY2)*

Only one other prescriber indicated that they had discussed the error with medical and nursing members of their team to try and prevent a similar occurrence in the future.

> *"I've spoke to the nurse who I was in ward round with, because I think they probably ran down to pharmacy with the drug card, and I've said to them it's something we need to be more aware of. I've spoken to the junior that I had with me, so I think it is something we are probably going to be a bit more alert to."* (P50, staff grade)

4.3.5.2 Assumptions about the actions of others

Interview participants seemed to have an over-reliance on others sorting out errors, either by leaving messages for someone to complete a task left unfinished or assuming that someone else would identify and rectify the error that they had made.

One prescriber, who made an error while on-call out-of-hours, suggested that they were not really responsible for the error, or that someone else should have identified it.

> *"so, it is a way of sharing the responsibility with the doctor who looks after the patient and the pharmacist who reviews the medication … ward doctor and the pharmacist could be more vigilant, with prescriptions out-of-hours especially to review the need, the duration, and if they are happy with the medication prescribed. … I think prescribing is really shared within the team, the medical team, between the duty doctor and ward doctor and pharmacist."* (P25, staff grade)

> *"I remember that I made an entry in his medical records asking the ward doctor to review the medication, just stating that I have written this medication as part of the advice from the A&E. The patient attended A&E, returned and then this was prescribed, and as per plan I put "please review" to Dr X. I didn't write duration, I just said that, you know, "please review the medication"."* (P25, staff grade)

Ambiguities about responsibility for patients,[26,27,189] lack of clarity about who is responsible for the different stages of prescribing, with initiation the responsibility of senior staff during normal hours, but left to junior staff out-of-hours[26] and poor communication and handover[13,113] have been found in previous studies.

4.4 Latent failures

Latent failures arise due to the organisational decisions about systems and processes which create an environment where error-producing conditions and active failures can occur. Not all qualitative studies of prescribing errors have considered latent conditions as factors associated with errors.[172]

4.4.1.1 The importance placed on prescribing

Two previous studies have found that some doctors take the attitude that prescribing, especially rewriting drug charts, is not an important task. Dean *et al* commented that directions from senior staff to "put them on drug X", leaving out details of dose, form, frequency, route and duration, leaves the acquisition of such knowledge in a chasm between medical school and employment and sends a message that these aspects of treatment are unimportant.[27] Meanwhile Coombes *et al* found that prescribing was generally described as a "job" or a "chore"[26] indicating the unimportance placed on this task as a key element of patient care.

Some of the prescribers interviewed talked about not always giving their full attention to the task of prescribing, especially when rewriting drug charts, or writing discharge prescriptions.

> *"Sometimes your mind tends to wander off when you're doing something very mechanically, and just copying charts. You try to bring yourself back and then you have all those other things in your mind - "oh I have to look at this patient, or …" These thoughts start to come in and you might, your attention starts, sort of, starts wavering. … Probably there's more scope for error."* (P147, core trainee)

> *"I think the risk is that, yeah, you do it on autopilot because it is just transferring information from one place to another, and it's quite easy to switch off a bit mentally, …"* (P35, consultant)

However, another junior doctor recognised this as an area of risk and described consciously trying to think about each item before rewriting it.

> *"I'm not just, kind of, blindly, going "ok copy". It's a case of that's what they've had there, but I'm responsible for what this patient has now. So, I really have to just think about it, think about what you are writing. Is this appropriate now? Rather than just assuming oh, they're on the same medications so … [interrupted by on-call phone]" (P167, FY2)*

One prescriber mentioned that he did not feel confident to ask others not to interrupt him while he was prescribing and that this increased the risk of errors.

> *"You will start doing something and there will always be people coming and starting to talk about something else and it's not fully possible to say, "Let me finish this. Wait until I finish, then I'll..." I don't know, I haven't felt that it would always be appropriate to take that approach just to make sure I don't make a single mistake, because you work in a team and if I start saying to everybody let me finish this first and I'll come back… "* (P175, staff grade)

This may have been an individual perception or may indicate an unhealthy attitude to safe practice which has been learned during practice in this or other settings.

4.4.1.2 Unfamiliar situations

Prescribers also found themselves in unfamiliar situations which led to errors. One FY2 doctor described having to deal with paper prescription charts for the first time in an on-call situation. Her four-month psychiatry rotation was in a community-based clinic where she was used to writing FP10 prescription forms, and during her FY1 rotations she had worked at sites that used electronic prescribing systems, yet on-call she was faced with an unfamiliar paper drug chart.

> *"I have never used paper charts before this. Umm, last year I was on entirely e-prescribing so when you select BD* [twice daily] *it forces you to pick two times. I don't use it in my normal day-to-day base life, I use FP10s, so actually, I have probably … only used fifteen charts in my entire career. … Yes, I've had lessons on how to fill in paper charts, yes, I've seen them, I've done them in exams, but I wouldn't say that they are particularly part of my day-to-day work at the moment, … in the community I have my green pad."* (P64, FY2)

Another, far more experienced doctor also found himself in unfamiliar territory, when he was asked to undertake an emergency review of patients to try and release bed capacity. It had been more than five years since he worked as an inpatient consultant and changes to the drug chart had occurred in that time.

> *"What I remembered was thinking, "Oh, I don't recognise the prescription card", because it had changed since I had been on the ward previously, so that threw me a bit, because I had to pay attention to the boxes and everything which were different to what I had been used to."* (P124, consultant)

4.4.1.3 Information systems

Prescribers who had made errors relating to the dose, strength or administration times of medicines mentioned that these errors might not have been possible if they had been using an electronic prescribing system, as such systems have inbuilt defences which prevent many errors, rather than handwritten drug charts. This was especially the case for relatively junior medical staff who had experience of using such systems previously.

> *"It was helpful because you could double check; while prescribing you could double check, you know, the correct dose and that was very helpful."* (P17, core trainee)

> *"Um, last year I was on entirely e-prescribing so when you select BD it forces you to pick two times. … Um, and that, with the hospitals I've trained at most of them were on e-prescribing.* (P64, FY2)

> *"… because it wouldn't, you know, it wouldn't have let me make that error. It wouldn't have let me prescribe."* (P167, FY2)

Electronic prescribing (EP), electronic prescribing and medicines administration (ePMA), and computerised physician order entry (CPOE) systems (which may also include orders for laboratory tests and radiology) have been introduced as the use of technology in healthcare has increased in popularity. Although electronic prescribing has existed in primary care for more than 30 years, deployment in secondary care remains patchy[379] with most acute trusts in 2011 reporting use of paper-based prescribing on the majority of wards[380] and only 13% using electronic prescribing across all adult medical and surgical wards.[381] Ahmed *et al* summarised the evidence for the impact of inpatient electronic prescribing on patient safety, considering systematic and narrative reviews undertaken between 2000 and 2015. They identified that most studies demonstrated a decrease in errors following system introduction, although some new errors associated with drop down menus and alert fatigue had been introduced by such systems. Few of the primary studies had been conducted in the UK with most from the US.[379]

Six of the errors covered in interviews occurred at the point of admission. The lack of access to clinical information about patients' medication regimens prior to admission was cited by prescribers as a factor, particularly out-of-hours.

> *"I think we don't have access to the GP record our self. We can have access to our SEPT [record] if they have been discharged and this kind of thing, but I do not have access to the GP record.* (P148, GP trainee)

Despite key patient medication being available via the SCR, none of the prescribers had access to this system, which would have allowed them to check what the patient should be taking. This has already been discussed in Section 4.3.3.1 on communication.

4.5 Defences

Pharmacists, nursing staff and other doctors were frequently mentioned as defences preventing errors reaching the patient. For 61.9% (13/21) errors discussed in interviews, the number of doses reaching the patient had been recorded. In six cases (28.6%) the error had been intercepted by a pharmacist before reaching the patient; but in the remainder (7/21; 33.3%) at least one dose had been administered or omitted before the error was rectified.

Several prescribers made statements which hinted at others being to blame for not intercepting their error, rather than taking responsibility themselves for having made an error in the first place, suggesting that they are consciously or subconsciously expecting others to act as the barrier to any prescribing error reaching the patient.

> *"the ward doctor and the pharmacist could be more vigilant, with prescriptions out-of-hours especially, to review the need, the duration, and if they are happy with the medication prescribed."* (P25, staff grade)

> *"I would presume the patient would have been seen the following morning by a consultant or a registrar, but I don't know in what depth they check the charts. I don't know, normally that's how on a medical [ward] you would have picked up that."* (P64, FY2)

Even out-of-hours, advice was available from pharmacists which could have helped avoid some of the prescribing errors, yet prescribers were not necessarily aware of how to contact the on-call pharmacist.

Few previous studies have commented on the final stage in Reason's model of accident causation - the defences or barriers which prevent the error reaching the patient.[23] Where defences were mentioned, these included pharmacists, nurses, other doctors and prescribers re-checking their own prescribing.[13,27,185] In their study, Dean *et al* identified that pharmacists were the principle line of defence, identifying

and rectifying all of the errors found and mentioned in 16 of the 44 interviews undertaken. They noted that doctors welcomed help from pharmacists both in identifying errors and having an educational role to the individuals involved. However they noted that this could also lead to complacency as some junior doctors trusted the pharmacists so much that they would sometimes not bother to look up doses.[27]

Several of the doctors interviewed mentioned that they had put in place changes to their own processes as a result of the error.

> *"I think that I'm just a little bit more careful. And I think I have probably looked up a few more things in the BNF since it happened. Even if I think " I'm 99% sure I know what that dose is" I've actually gone "hang on a minute" and I've just gone [mimes referring to a book] or I've had a look on the phone just to double check with things. And I think with PRNs where you're maybe giving a range of doses, I'm kind of double checking if I've given a range that the maximum dose. I haven't put it in terms of how many times a day, I've put it in terms of the dose, even with things like ibuprofen. Often, I've previously put 400mg TDS or maximum TDS, and I've 400, you know, I've put the maximum dose in milligrams. Because I think that's probably bit clearer." (P167, FY2)*

Similar self-initiated defences were mentioned by study participants in two studies. Participants in an Australian study suggested that staff should exercise greater personal vigilance and should always check and double check their actions,[188] whilst one Nigerian prescriber mentioned "silently reading out the order to herself before signing it".[185]

Checking and double checking of the type described by participants in these studies demonstrates calibration through use of a conscious cognitive debiasing strategy[212] allowing metacognition (thinking about one's thinking) so that the clinician can deliberately detach themselves from the immediate context of the clinical decision, and reflect upon the thinking process.[382]

4.6 Summary of findings

The study found almost equal numbers of mistakes involving the planning of actions, and skills-based slips and lapses, although mistakes were more commonly knowledge-based and action-based slips were more common than memory-based lapses.

As with other studies into the causes of prescribing errors, this study showed that errors are usually associated with multifactorial causes. Factors cited by interview

participants did not differ substantially from those identified in other secondary care settings. Whilst the complexity of error causation makes it unlikely that simple solutions are possible, there is one area where local change could have a significant impact on prescribing errors. Providing access to the SCR for doctors working on-call and out-of-hours to facilitate access to accurate information about newly admitted patients' medicines would have prevented several of the errors which occurred.

Chapter 5. Decision-making characteristics of prescribers: results and discussion

5.1 Response rates

One hundred and ninety-one questionnaires, in electronic or paper format, were distributed to prescribers who had been identified during the quantitative data collection exercise. Seventy-two questionnaires were returned either fully or partially completed, 12 of which were excluded as only demographic information had been provided (response rate 31.4%; 60/191). Table 5.1 provides a breakdown of the responses.

Table 5.1: Questionnaire responses

Questionnaires	No.	%
Distributed (via SurveyMonkey or on paper)	191	100.0
Returned (via SurveyMonkey or on paper) Recipient did not agree to participate Recipient agreed to participate	81 9 72	42.4 4.7 37.7
Excluded as only demographics provided	12	6.3
Fully or partially completed response	60	31.4
Fully completed Cognitive Reflection Test Rational-Experiential Inventory Need for Cognition	51 51 59 59	26.7 26.7 30.9 30.9

Analysis was undertaken of 51 fully completed questionnaires and a further 9 in which demographics had been provided and at least one other section completed.

5.2 Participant characteristics

The majority of participants were male (53.3%) and most commonly within the age range 40 - 49 years (36.7%) with consultant psychiatrists (26/60; 43.3%) the most highly represented category. Respondents had been a registered healthcare professional for a mean of 16.4 years (SD 11.9; range 1 - 45 years) and a prescriber for 15.7 years (SD 12.3; range 1 - 50). It is possible that the mean ‘years as a registered healthcare professional’ is higher than ‘years as a prescriber’ as some respondents who originally qualified overseas may have answered this from the perspective of registration in the UK. Further details of the demographic distribution of respondents can be found in Table 5.2.

Table 5.2: Characteristics of survey participants

Demographics	No.	% (n = 60)
Gender		
Male	32	53.3%
Female	28	46.7%
Age (years)		
21 - 29	7	11.7%
30 - 39	16	26.7%
40 - 49	22	36.7%
50 - 59	9	15.0%
> 60	6	10.0%
Number of years in practice	Mean	
As a registered healthcare professional	16.4	
As a prescriber	15.7	
Grade of prescriber		
Foundation trainee (FY1; FY2)	9	15.0%
Core/GP Specialty trainee (CT1-3; GPST1-3)	10	16.7%
Higher Specialty trainee (ST4-6)	4	6.7%
Staff Grade	9	15.0%
Consultant Psychiatrist	26	43.3%
Other Medical	1	1.7%
Nurse Non-Medical Prescriber	1	1.7%

Participants mean scores are shown in Table 5.3. The mean number of correct answers for the original 3-item version of the Cognitive Reflection Test was 1.6 (SD 1.1) and for the 8-item version, which included five questions which were less likely to have been previously seen by participants, the mean score was 4.1 (SD 2.2). Results for the 8-item CRT demonstrated modest internal consistency (Cronbach's alpha $0.7 > \alpha \geq 0.6$) with $\alpha = 0.611$ (n = 51).

Table 5.3: Descriptive data for key variables

Variable	Mean (SD)
Cognitive Reflection Test (CRT) (n=51)[§]	
Score (3-item version)	1.6 (1.1)
Score (8-item version)	4.1 (2.2)
Rational Experiential Inventory (REI-40) (n=59)[§]	
Rationality (total score)	**3.7 (0.4)**
Rational ability	3.7 (0.4)
Rational engagement	3.7 (0.5)
Experientiality (total score)	**3.1 (0.4)**
Experiential ability	3.2 (0.5)
Experiential engagement	3.1 (0.4)
Need for Cognition (NCS) (n=59)[§]	
Need for Cognition score	16.5 (15.0)

[§] The CRT was completed by 51 of the 60 respondents who returned full or partially completed questionnaires. The REI-40 and NCS were completed by 59 of the 60.

For the Rational Experiential Inventory, the mean score on the rationality scale was 3.7 (SD 0.4) and on the experientiality scale 3.1 (SD 0.4), each out of a maximum score of 5. Cronbach's alpha demonstrated good correlation ($0.9 > \alpha \geq 0.8$) for both the rationality scale ($\alpha = 0.819$; $n = 59$) and the experientiality scale ($\alpha = 0.814$; $n = 59$). Cronbach's alpha also demonstrated good correlation for the Need for Cognition Scale ($\alpha = 0.808$; $n = 59$). The mean score was 16.5 (SD 15.0) on a scale running from -72 to 72.

5.3 Cognitive Reflection Test

Responses were received from 51 respondents who had completed the Cognitive Reflection Test (CRT) element of the questionnaire (51/191; 26.7%). The majority were male (51.0%) with a modal age range of 40 - 49 years. Most respondents (22/51; 43.1%) were consultant psychiatrists.

Table 5.4: Comparison of mean CRT score on the basis of demographics

Sample	Mean 3-item CRT score (SD)	*p*	Mean 8-item CRT score (SD)	*p*
Gender				
Male (n=26) **Female (n= 25)**	1.7 (1.1) 1.5 (1.1)	0.507	4.3 (2.3) 3.9 (2.2)	0.436
Age				
21 - 29 (n=7) **30 - 39 (n=15)** **40 - 49 (n=18)** **50 - 59 (n=7)** **60 and over (n=4)**	1.4 (1.3) 1.4 (1.1) 1.8 (1.0) 2.0 (1.3) 1.0 (1.4)	0.551	3.3 (2.2) 4.0 (2.3) 4.7 (1.7) 4.4 (2.1) 2.8 (3.6)	0.389
Respondent type				
Foundation trainee (n=9) **Core/GP trainee (n=10)** **Higher specialty trainee (n=4)** **Staff grade (n=5)** **Consultant/GP (n=22)** **Nurse NMP (n=1)**	1.2 (1.2) 1.2 (1.0) 1.8 (1.3) 1.2 (1.3) 2.0 (1.1) 1.0 (-)	0.310	3.4 (2.5) 3.5 (1.7) 4.8 (2.2) 3.0 (2.9) 4.9 (2.0) 3.0 (-)	0.317
	1.6 (1.1)		**4.1 (2.2)**	

Further details on the demographic distribution of respondents can be found in Table 5.4. Using the non-parametric Kruskal-Wallis test, with a significance level of $p < 0.05$, demonstrated that there was no statistically significant difference in CRT scores by gender, age or prescriber grade on either the 3-item or 8-item versions of the test (see Table 5.4). Further details about the CRT can be found in Section 1.7.2.

Table 5.5: Distribution of answers given for the CRT

Item 1. A bat and a ball cost £1.10 in total. The bat costs £1.00 more than the ball. How much does the ball cost?		
Correct response (5p)	20	39.2%
Errors 'Intuitive' incorrect answer (10p)	27	52.9%
Other incorrect answers	4	7.8%
No response	-	-
Item 2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?		
Correct response (5 minutes)	27	52.7%
Errors 'Intuitive' incorrect answer (100 minutes)	21	41.2%
Other incorrect answers	3	5.9%
No response	-	-
Item 3. In a lake, there is a patch of lily pads. Every day the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?		
Correct response (47 days)	34	66.7%
Errors 'Intuitive' incorrect answer (24 days)	13	25.5%
Other incorrect answers	4	7.8%
No response	-	-
Item 4. Mary's mother has four children. The youngest three are named Spring, Summer and Autumn. What is the oldest child's name?		
Correct response (Mary)	29	56.9%
Errors 'Intuitive' incorrect answer (Winter)	19	37.3%
Other incorrect answers	2	3.9%
No response	1	2.0%
Item 5. If you flipped a fair coin 3 times, what is the probability that it would land "heads" at least once?		
Correct response (87.5%; 7/8)	11	21.6%
Errors 'Intuitive' incorrect answer (12.5%; 1/8 or 37.5%; 3/8)	6	11.8%
Other incorrect answers	34	66.7%
No response	-	-
Item 6. If John can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how long would it take to drink one barrel of water together?		
Correct response (4 days)	31	60.8%
Errors 'Intuitive' incorrect answer (9 days)	6	11.8%
Other incorrect answers	14	27.5%
No response	-	-
Item 7. Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in the class?		
Correct response (29 students)	20	39.2%
Errors 'Intuitive' incorrect answer (30 students)	20	39.2%
Other incorrect answers	11	21.6%
No response	-	-
Item 8. A bear loses 20% of its weight during hibernation. If it weighs 100 kilos after hibernation, how many kilos did it weight before?		
Correct response (125 kilos)	38	74.5%
Errors 'Intuitive' incorrect answer (120 kilos)	8	15.7%
Other incorrect answers	4	7.8%
No response	1	2.0%

Table 5.5 shows the responses given for each of the eight questions. Items one to three are the original 3-item version of the CRT. Only one question, item 1, which is probably the most well-known of the CRT questions, received more 'intuitive' incorrect

answers than correct ones, although item seven received the same number of correct and 'intuitive' incorrect answers.

Responses to item 5 were more likely to be incorrect than correct, but not due to respondents providing the 'intuitive' incorrect answer. Whilst 15 respondents correctly answered all three of the original CRT questions, only three correctly answered all eight questions; two of these were consultants, and one was a foundation trainee. Two respondents answered all eight questions incorrectly; these were a foundation trainee and a staff grade doctor. In both cases, six of their responses were the 'intuitive' incorrect answer. The distribution of responses is shown in Figure 5.1.

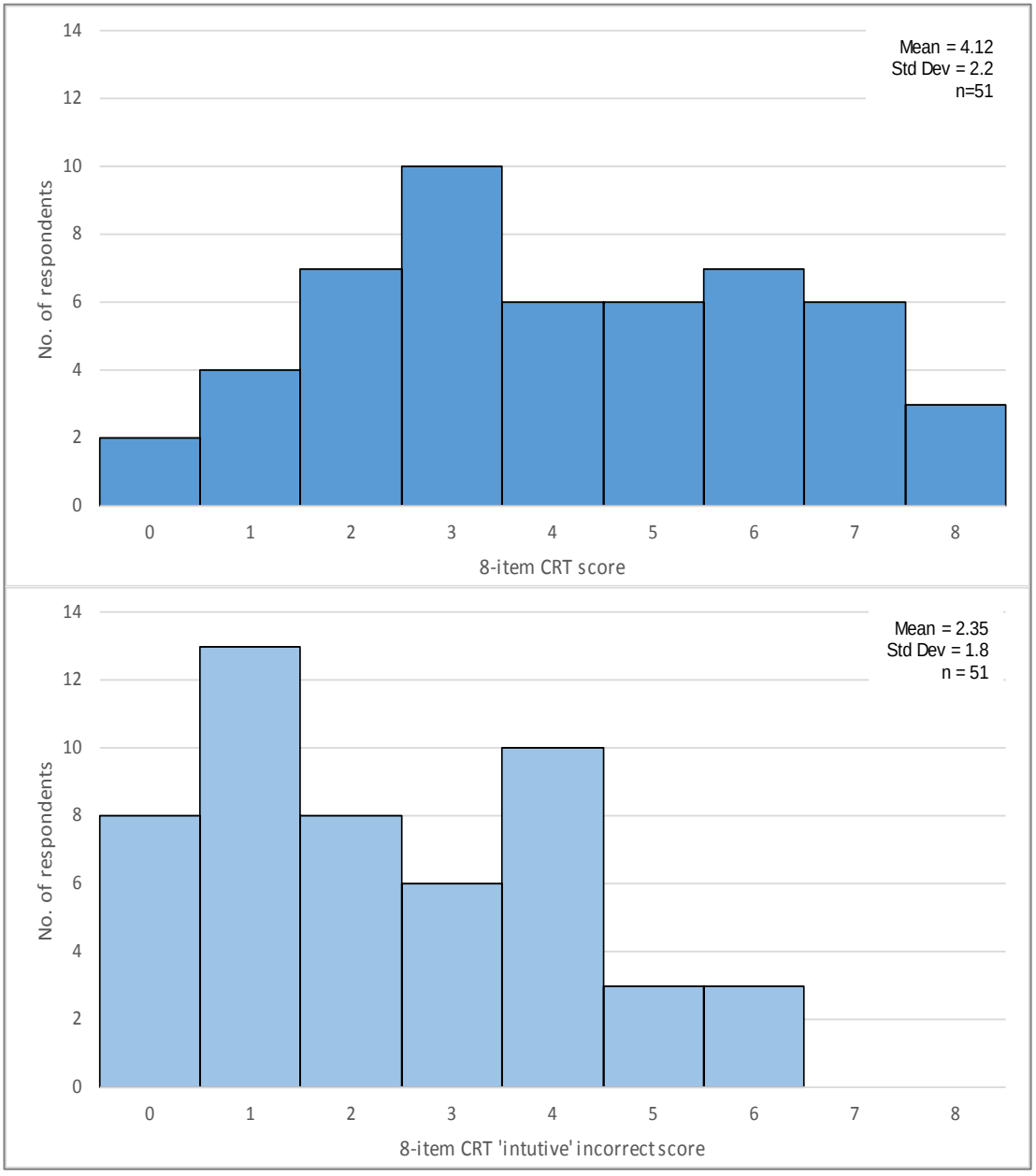


Figure 5.1: Distribution of Cognitive Reflection Test (CRT) scores

Frederick[226] administered the original 3-item CRT to more than 3,000 respondents in 35 separate studies, as part of a questionnaire including measures of various decision-making characteristics. The mean score was 1.24 with 33% of respondents classified as 'low' scorers (all questions incorrect) and 17% as 'high' scorers (all questions correct); most of the subsequent analysis concentrated on the two extreme groups rather than 'intermediate' scorers (those who achieved one or two correct answers). Men scored significantly higher than women ($p < 0.0001$), with women's incorrect answers tending to be the 'intuitive' incorrect answer. Those with high CRT scores were found generally to be more patient when time preferences were tested, and more willing to gamble when risk taking was tested. Although an 8-item CRT was mentioned, no results were provided for that version. The mean 3-item CRT score of the 51 prescribers in the current study was 1.6, higher than found in the original study, with a lower proportion of 'low' scorers (21.6% *cf.* 33%), and a higher proportion of 'high' scorers (29.4% *cf.* 17%). Although the mean scores for both the 3-item and 8-item versions were higher in male than female participants, the differences were not significant.

Haigh[383] noted that the validity of the CRT depends on participants being blind to its objectives. If pre-exposed, participants may not answer with their first response but be more likely to engage System 2 thinking in arriving at the answer, because they recognised them as "trick questions'. Also, with only three questions there is an opportunity for participants to memorise the answers if they have seen them before. His study, in which more than half of participants reported prior exposure to at least one CRT problem, found a significantly higher mean score in those with prior exposure than those who had none (2.36 *vs*. 1.48; $p < 0.001$). He argued that the standard three-item version had become a "victim of its own success". Similar effects have been found in other studies,[384,385] and as a result, extended or alternative versions of the CRT have been developed with up to seven items.[266,384,386] Toplak *et al*[266] developed a 4-item version (CRT4) as a substitute for the original CRT as well as combining the two to produce a 7-item CRT (CRT7). In their sample of 160 university recruits the 'intuitive' incorrect response was given as the modal response for all three of the original questions, accounting for 85.6%, 75.2% and 60.0% of answers for the bat and ball, widgets and lily pad problems respectively. It was also the modal response for the CRT4 questions, but was less dominant at 31.1%, 51.9%, 41.9% and 53.1%.

An 8-item version of the CRT was used in the current study with five additional questions provided by Professor Frederick (personal communication; 05 May 2014). The 'intuitive' incorrect answer to the three original questions was provided by 52.9%, 41.2% and 25.5% of respondents respectively, with only the bat and ball question having it as the modal response. The 'intuitive' incorrect answer was given for the five new questions 37.3%, 11.8%, 11.8%, 39.2% and 15.7% of the time and was only the modal answer for the class question (item 7). This may reflect prior exposure to the original questions, and/or a greater tendency amongst participants in the current study to override the 'intuitive' incorrect response. Using a similar approach to Frederick's of low, intermediate and high scorers with the 8-item version, 25.5% were 'low' scorers (two or less correct answers) while 31.4% were 'high' scorers (six or more correct answers), similar proportions to those for the original 3-item CRT.

It has been claimed that numeric ability is strongly correlated with correctly answering CRT questions and that it is actually a measure of calculation rather than cognitive reflection. Sinayev and Peters suggested that numeracy is "the key mechanism" that explains the association between CRT performance and decision making.[228] However, Liberalli *et al* concluded that while those with computational ability can generate answers to the problems, the finding that CRT correlates with Need for Cognition scores but not Faith in Intuition scores supported the interpretation that the CRT captures monitoring, inhibition and editing processes.[387] This was supported more recently by Pennycook and Ross, who stated that "if someone does not have the disposition or willingness to think analytically, they will not fully exercise their cognitive ability and will not do as well on the problem" and "if someone does not have sufficient cognitive ability it will not matter how much time and effort they are willing to spend thinking about the problem".[388] They highlighted that the CRT indicates a *disposition* or *propensity* to think analytically, in *addition* to having the cognitive ability, and not primarily a measure of numeric ability; although it has been reported that algebraic cueing improved responses to the bat and ball problem.[389] CRT scores have also been associated with a range of other variables such as religious disbelief, paranormal disbelief, improved scientific understanding and reasoning, and belief in evolution.[388,390]

All of the participants in the current study were healthcare professionals, all but one medically qualified, amongst whom the level of numeracy (i.e. cognitive ability) would be expected to be high. Equally, clinical training should introduce a degree of analytical ability which together, may explain the lower proportion of 'low' scorers and

higher proportion of 'high' scorers on both the 3-item and 8-item CRTs when compared with studies which used largely university undergraduates as the sample population. Steiger and Reips demonstrated that educational qualifications were a predictor of CRT score, with the potential for a ceiling effect amongst the highly educated.[385] Studies which administered the CRT to 165 medical trainees and 56 consultants[233,234] and 209 medical undergraduates and doctors[391] reported average scores of 1.49 and 1.86 respectively, which straddle the mean reported in this study. Foundation and core/GP trainees tended to give fewer correct answers (43% and 44% respectively), whilst the lowest proportion of correct answers (38%) were provided by staff grade doctors (see Table 5.6).

The relationship between the number of correct scores on the 8-item version of the CRT and prescriber grade (which in most cases reflects the level of experience of the individual) was explored using the one-tailed non-parametric Spearman's correlation coefficient (r_s). This demonstrated a correlation coefficient, r_s, of 0.243 (95% confidence interval -0.013 to 0.497) significant at $p < 0.05$ and suggested a weak positive correlation between the level of experience and the ability to correctly answer the questions which comprise the CRT.

Table 5.6: CRT Scores for the 8-item version

Respondent Type (n = 51)	Mean Score (SD)	Mean no. "intuitive" incorrect answers (SD)	Proportion of responses that were for: Correct answer	'Intuitive' incorrect answer	Other incorrect answers
Foundation trainee (n=9)	3.4 (2.5)	3.7 (2.1)	43%	46%	11%
Core/GP specialty trainee (n=10)	3.5 (1.7)	2.6 (1.3)	44%	33%	24%
Higher specialty trainee (n=4)	4.8 (2.2)	1.8 (1.7)	59%	22%	19%
Staff grade (n=5)	3.0 (2.9)	3.0 (2.1)	38%	38%	25%
Consultant/GP (n=22)	4.9 (2.0)	1.6 (1.5)	61%	20%	19%
Nurse NMP (n=1)	3.0 (-)	4.0 (-)	38%	50%	13%
Overall	**4.1 (2.2)**	**2.4 (1.8)**	**51%**	**29%**	**19%**

The relationship between the number of 'intuitive' incorrect scores on the 8-item version of the CRT and prescriber grade was also explored using the one-tailed non-parametric Spearman's correlation coefficient (r_s). This demonstrated a weak negative correlation coefficient, r_s, of -0.344 (95% confidence interval -0.592 to -0.0.87) significant at $p < 0.01$ and suggests a moderate correlation between level of

experience and the ability to suppress the 'intuitive' incorrect answers. This is demonstrated in Figure 5.2.

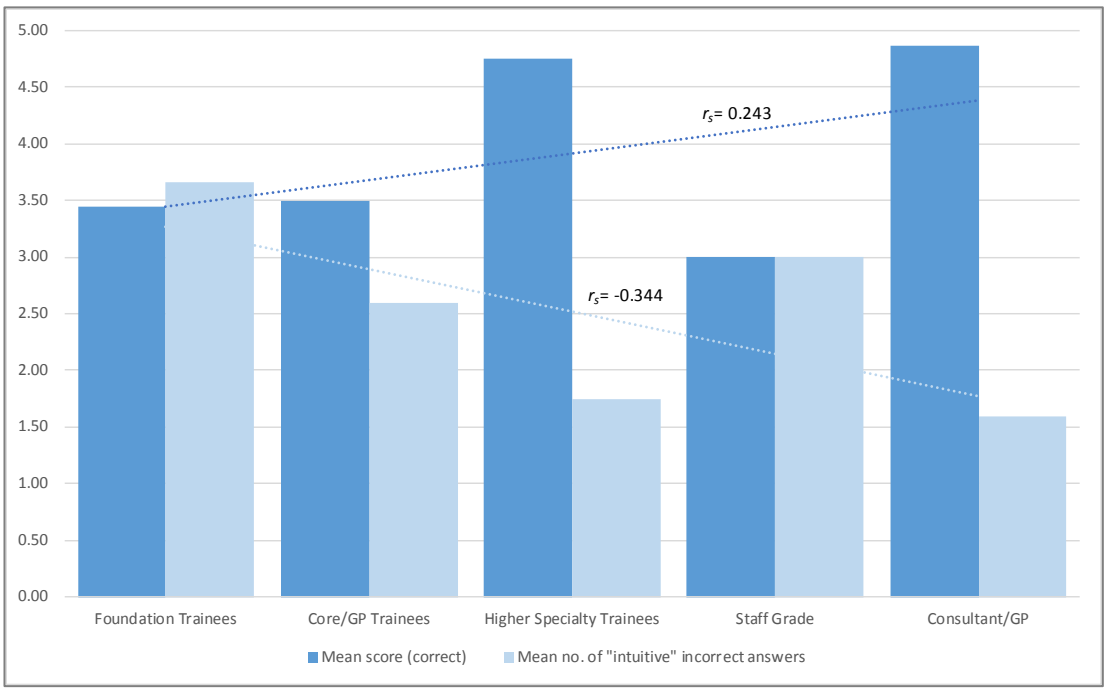


Figure 5.2: CRT scores by prescriber grade/type

Prescribing error data, collected by ward pharmacists as described in Section 2.3, were available for 40 of the 51 respondents who had completed the Cognitive Reflection Test element of the questionnaire. Respondents had prescribed 3,361 medication orders containing 155 prescribing errors, exceeding the total sample size needed to identify a "small" expected effect size with 95% confidence and 90% power.

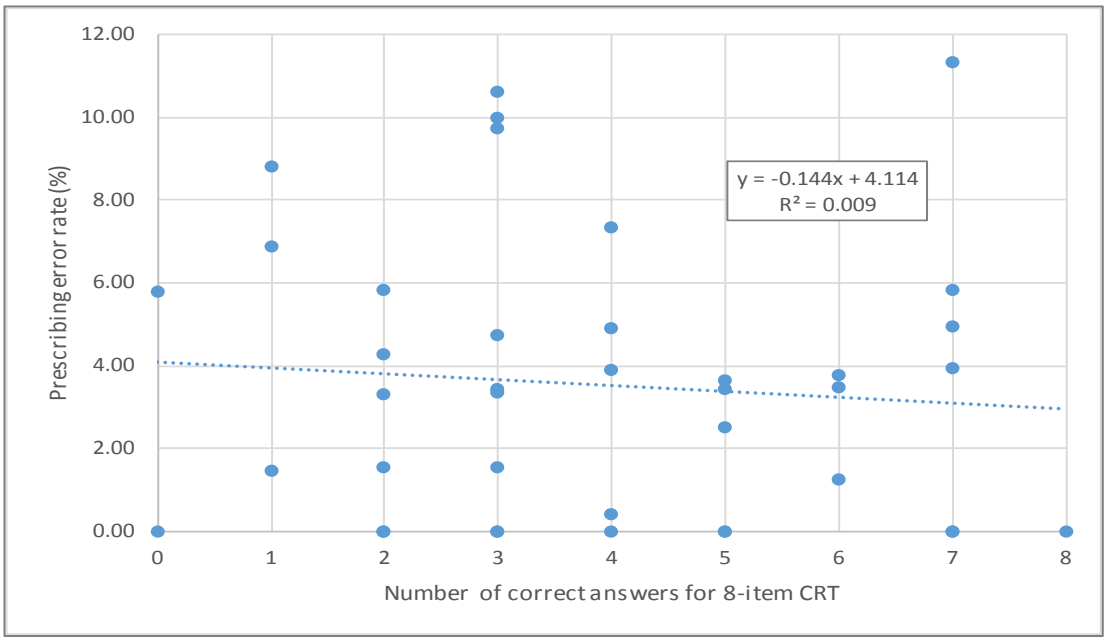


Figure 5.3: CRT scores and prescribing error rates

Scatterplots were prepared to show the number of correct answers on the 8-item CRT (see Figure 5.3) and the number of 'intuitive' incorrect answers (see Figure 5.4) against prescribing error rate. A trend towards a lower prescribing error rate as the number of correctly answered CRT questions increased was suggested by the regression line. However, linear regression demonstrated a correlation of $R^2 = 0.009$ which suggested that less than one per cent of the variation in prescribing error rate can be explained by CRT score alone. The statistical significance of the model was tested using ANOVA with a significance level of $p < 0.05$. This demonstrated that there was no significant effect of CRT score on prescribing error ($F_{38,39} = 0.333$, $p = 0.567$).

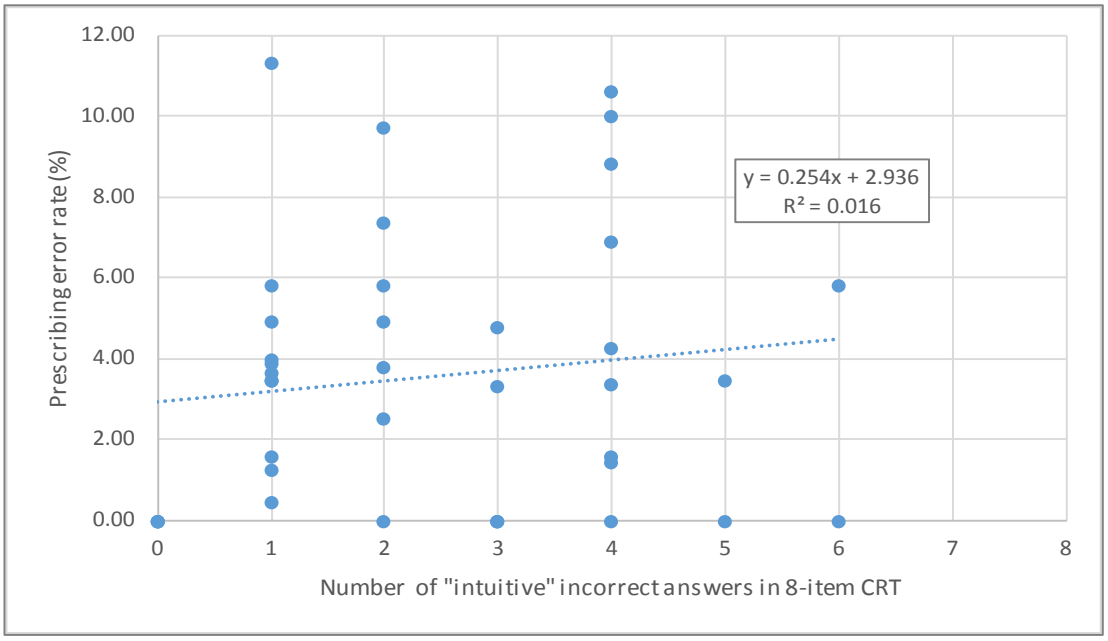


Figure 5.4: CRT 'intuitive' incorrect answers and prescribing error rates

Scatterplots were also prepared to show the number of correct answers on the 8-item CRT (see Figure 5.5) and the number of 'intuitive' incorrect answers (see Figure 5.6) against the proportion of errors which related to decision making rather than prescription writing. Decision-making errors include prescribing a drug which is inappropriate for the patient concerned - for example, due to a contraindication, documented allergy or drug interaction, and tend to be knowledge-based or rule-based errors rather than slips and lapses.

A trend towards a greater proportion of errors being due to decision making as the number of correctly answered CRT questions increased was suggested by the regression line. However, linear regression demonstrated a correlation of $R^2 = 0.013$ which suggested that only 1.3% per cent of the variation in the nature of prescribing

errors can be explained by CRT score alone. The statistical significance of the model was tested using ANOVA with a significance level of $p < 0.05$. This demonstrated no significant effect of CRT score on prescribing error type ($F_{38,39} = 0.499$, $p = 0.484$).

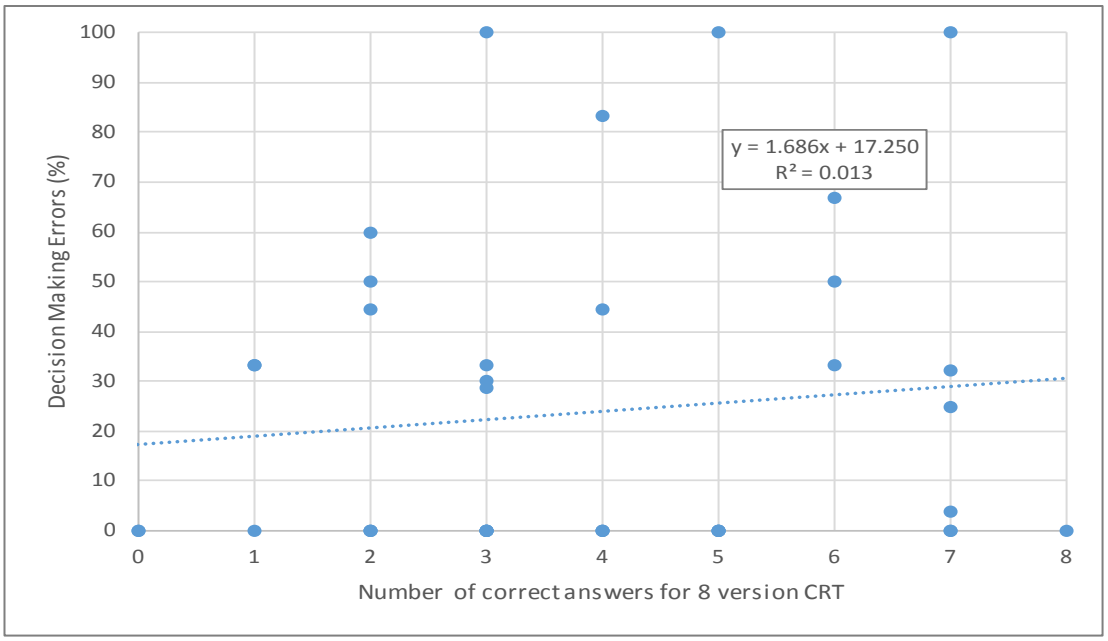


Figure 5.5: CRT scores and proportion of errors relating to decision making

A trend towards a smaller proportion of errors being due to decision making as the number of 'intuitive' incorrect CRT questions increased was suggested by the regression line. However, linear regression demonstrated a correlation of $R^2 = 0.015$ which indicates that only 1.5% of the variation in prescribing error rate can be explained by the number of incorrect answers given on the CRT alone.

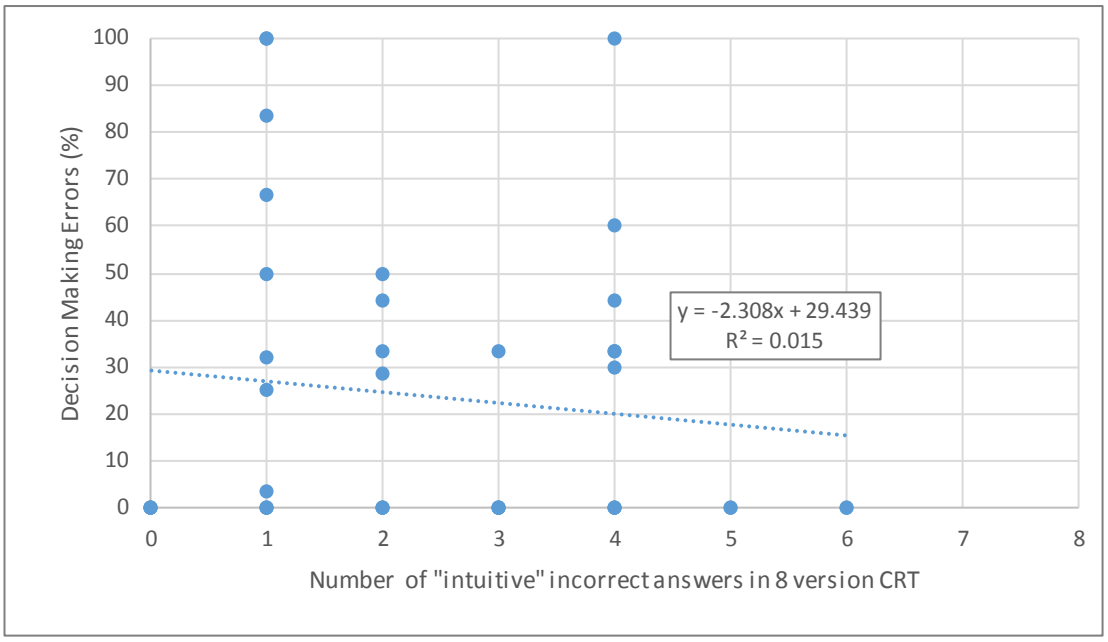


Figure 5.6: CRT 'intuitive' incorrect answers and errors relating to decision making

The statistical significance of the model was tested using ANOVA with a significance level of $p < 0.05$. This demonstrated no significant effect of the 'intuitive' incorrect CRT answers on prescribing error type ($F_{38,39} = 0.577$, $p = 0.452$).

Kinnear and Wilson hypothesised an association between committing clinical errors and settling for the 'intuitive' incorrect answer to a cognitive puzzle. They asked clinicians to answer a question about drug doses, based on the bat and ball problem of the CRT, as a measure of their propensity for "quick and casual" decision making, and also to self-report the number of clinical errors committed in the previous two weeks. Fifty-nine percent of participants reported that they had committed an error, while 67% gave the 'intuitive' incorrect answer to the problem. The authors noted that as the puzzle had been presented in a medical context, it could be argued that it behaved as a surrogate for a drug calculation and reflected the potential for committing prescribing errors. As in the current study, the authors found no statistically significant difference between correct or 'intuitively' incorrect answers and clinical errors.[392]

To test the hypothesis that clinicians who tended towards greater cognitive reflection would be less likely to prescribe antibiotics for acute respiratory infections, Pineros *et al* administered the 3-item CRT to 50 primary care clinicians and compared their answers with clinician-level antibiotic prescribing rates. The proportions of 'high' and 'low' CRT scores were closer to the original Frederick results[226] than for the current study, with 31% of clinicians answering all questions incorrectly and 22% answering all correctly. Contrary to their expectations, the authors found a U-shaped association between cognitive reflection and antibiotic prescribing. They concluded that there may be a 'sweet-spot' of cognitive reflection for appropriate antibiotic prescribing for acute respiratory infections, and suggested that clinicians with low CRT scores may tend to give in to patient pressure for antibiotics, demonstrating unreflective decisions; whilst high scoring clinicians may overthink the patient's presentation.[393]

A novel computer-mouse cursor-tracking application used to administer the CRT demonstrated that participants were often initially drawn towards the 'intuitive' incorrect answer, even when the correct answer was ultimately chosen, supporting the view that intuitive processes are activated and then inhibited in order to provide a correct response.[394] Similar results have also been found using eye-tracking to analyse the attention of participants in conflict problems analogous to the bat and ball problem.[395] The practice of mindfulness mediation has been shown to positively influence analytical thought processes, with individuals who listened to a mindfulness

recording answering CRT questions more analytically than those who did not.[396] In addition, a significant correlation has been found between response times and the total number of CRT items correctly answered; longer response times were weakly associated with better performance, although different results were seen with each CRT item. The authors suggested that although cognitive miserliness (being unwilling to go beyond default and invest cognitive effort to solve the problem) is part of the explanation, the different CRT items measure different cognitive and dispositional constructs, with "slower not always better". They also recommended that other measures, such as the REI and NCS, should continue to be used by researchers to provide insight into cognitive processes, rather than relying on the CRT alone to differentiate between those whose performance may be changed through training, and those who elect not to be analytical and who may not be changed through interventions.[397]

5.4 Rational Experiential Inventory

Responses were received from 59 respondents who had completed the Rational Experiential Inventory (REI-40) element of the questionnaire (59/191; 30.9%). The majority were male (54.2%) with a median age of 40 - 49 years. Most respondents (27/59; 45.8%) were consultant psychiatrists or GPs with a special interest in mental health. Further detail on the demographic distribution of respondents can be found in Table 5.7. The mean rational score for all prescribers was 3.7 (SD 0.4) and the mean experiential score was 3.1 (SD 0.4). The difference of 0.6 (95% CI 0.4 - 0.7) between these mean scores was shown to be statistically significant using the non-parametric Wilcoxon matched-paired signed-rank test ($z = -5.64$, $p < 0.001$, $r = -0.73$). Data reliability was good for both the rationality and experientiality scales with Cronbach's $\alpha \geq 0.8$ (see Section 5.2), similar to figures of 0.888 for rationality and 0.893 for experientiality found by Djulbegovic *et al* in a sample of doctors[233] and of 0.90 and 0.87 for rationality and experientiality respectively described in the original work on the REI-40 by Pacini and Epstein.[200] More details about the REI-40 can be found in Section 1.7.2.

The differences in mean rational and experiential scores were compared for each category. Both male and female prescribers tended more towards rational decision making than towards experiential decision making, with statistically significant differences between the two scores calculated using the non-parametric Wilcoxon matched-paired signed-rank test (males, $z = -4.45$, $p < 0.001$, $r = -0.58$; female $z = -3.44$, $p = 0.001$, $r = -0.45$). Male participants scored higher for rationality (3.8; SD 0.3

vs. 3.6; SD 0.4), while female participants scored higher on experientiality (3.2; SD 0.4 *vs*. 3.6; SD 0.4). However, the non-parametric Kruskal-Wallis test, with a significance level of $p < 0.05$, demonstrated that there was no statistically significant difference in rational or experiential scores by gender (see Table 5.7).

Similarly, all age groups apart from one showed a statistically significant difference between rational and experiential scores, when analysed using the non-parametric Wilcoxon matched-paired signed-rank test, with a tendency towards rational decision making. Although prescribers in the age group 21 - 29 years demonstrated a higher mean score for rationality than for experientiality, the difference was not statistically significant ($z = -1.52$, $p = 0.128$, $r = -0.57$). The non-parametric Kruskal-Wallis test, with a significance level of $p < 0.05$, demonstrated that there was no difference in rational or experiential scores by age group (see Table 5.7).

Table 5.7: Comparison of mean REI-40 scores on the basis of demographics

Sample (n=59)	Mean rational score (SD)	*p*	Mean experiential score (SD)	*p*
Gender				
Male (n=32) **Female (n= 27)**	3.8 (0.3) 3.6 (0.4)	0.493	3.1 (0.4)* 3.2 (0.4)*	0.143
Age				
21 - 29 (n=7) **30 - 39 (n=16)** **40 - 49 (n=21)** **50 - 59 (n=9)** **60 and over (n=6)**	3.7 (0.5) 3.5 (0.5) 3.7 (0.3) 3.8 (0.4) 4.0 (0.2)	0.097	3.3 (0.3) 3.1 (0.3)* 3.5 (0.5)* 3.2 (0.5)* 3.2 (0.3)*	0.416
Respondent type				
Foundation trainee (n=9) **Core/GP trainee (n=10)** **Higher specialty trainee (n=4)** **Staff grade (n=8)** **Consultant/GP (n=27)** **Nurse NMP (n=1)**	3.5 (0.6) 3.6 (0.4) 3.6 (0.3) 3.8 (0.3) 3.8 (0.3) 3.7 (-)	0.539	3.4 (0.3) 2.9 (0.2)* 3.2 (0.3)* 3.2 (0.5)* 3.1 (0.4)* 3.3 (-)	0.069
	3.7 (0.4)*		**3.1 (0.4)***	

* the difference between rational and experiential scores was statistically significant, $p < 0.05$

For all grades of prescriber, there was a tendency towards rational decision-making over experiential decision making. However, when analysed using the non-parametric Wilcoxon matched-paired signed-rank test, the difference in mean rational and experiential scores was not statistically significant for foundation trainees ($z = -0.771$, $p = 0.441$, $r = -0.26$). The non-parametric Kruskal-Wallis test, with a significance level of $p < 0.05$, demonstrated that there was no difference in rational or

experiential scores by prescriber grade (see Table 5.7). The greatest differences between the mean rational and experiential scores were found for male prescribers, those aged over 60, and prescribers who were consultants/GPs and core/GP trainees.

Cognitive-Experiential Self Theory (CEST) suggests that reasoning follows a dual processing model with the world interpreted through the simultaneous use of two systems – rationality and experientiality (see Section 1.7). The Rational Experiential Inventory (REI) was developed to reliably measure an individual's preference for rational or experiential thinking styles.[199,200] In a sample of healthcare workers, Sladek *et al*[398] described 'gender differences' evident across a wide age span, with men preferring rational reasoning and women preferring experiential reasoning. A small negative association was also found between age and scores on both scales, although this was non-significant for overall rationality and rational engagement.

In the current study's sample, involving 59 respondents, a similar pattern was found, with male participants preferring rational reasoning more than female, and female participants preferring experiential reasoning more than males. However, these gender differences were not statistically significant, and both genders showed a significantly greater score for rationality than experientiality (see Table 5.7). When analysed in decile age groups, the difference between mean rational and experiential scores was statistically significant for all age groups apart from those aged below 30 years. The same pattern was found for prescriber type, where there was no statistical difference between mean rational and experiential score for foundation trainees. This may be an artefact due to the small numbers involved (seven participants in the 21 - 29 age group, and nine in the foundation trainee category), but may also be due to the stage in the pathway from novice to expert, reflecting that much of the thinking in these groups is still of the rational, System 2 type which through repetition, may become intuitive (System 1) and move to the control of the experiential mode.[398]

The Kolmogorov-Smirnov test was used to determine whether the distribution of scores differed from a normal distribution. The rationality scores, $D(59) = 0.122$, $p < 0.05$ were non-normal and negatively skewed (-1.114 ± 0.519) towards higher scores. However, the experientiality scores, $D(59) = 0.096$, $p = 0.200$ did not deviate significantly from the norm and were not skewed (0.053 ± 0.234). The distribution of scores is shown in Figure 5.7. A similar pattern for the distribution of experientiality scores was found for a large sample of emergency physicians in Canada; although the rationality scores in that study were normally distributed but skewed towards

higher scores. The authors noted that emergency physicians who had undergone specialty training had higher mean rationality scores that those who had undergone emergency training in family medicine, but found no statistically significant difference between emergency physicians based on the number of years in practice.[232]

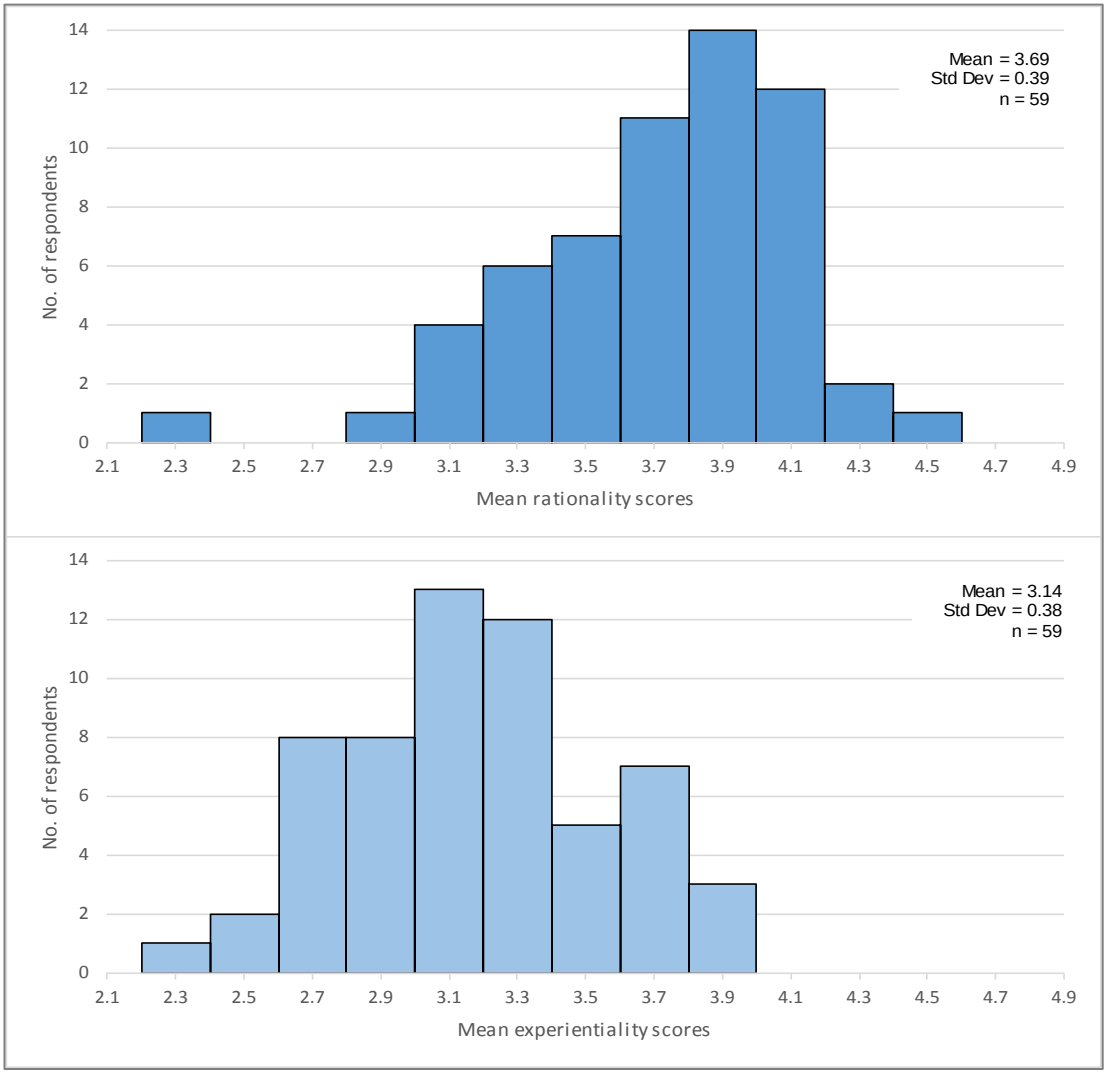


Figure 5.7: Distribution of Rational Experiential Inventory (REI-40) scores

Overall, trust prescribers favoured rational decision making over experiential decision making although the differences varied by prescriber grade. For overall rationality scores, the scores for doctors in training (foundation, core/GP and specialty trainees) were generally lower than those for staff grade and consultants, although, as described above, this difference was not significant. This trend was repeated for rational ability and to a lesser degree, rational engagement. Consultants and core/GP trainees had the lowest overall scores for experientiality, although again, this difference was not significant. The lowest score for experiential ability and

engagement was seen in core/GP trainees. The full data for the REI-40 sub-scales are shown in Table 5.8.

Table 5.8: Comparison of detailed REI-40 scores on the basis of prescriber grade

Sample (n=59)	Rationality			Experientiality		
	Mean	Ability	Engagement	**Mean**	Ability	Engagement
Foundation trainee (n=9)	**3.5 (0.6)**	3.4 (0.5)	3.5 (0.8)	**3.4 (0.3)**	3.4 (0.2)	3.4 (0.4)
Core/GP trainee (n=10)	**3.6 (0.4)**	3.7 (0.4)	3.5 (0.5)	**2.9 (0.2)***	3.0 (0.3)	2.8 (0.2)
Higher specialty trainee (n=4)	**3.6 (0.3)**	3.5 (0.2)	3.7 (0.5)	**3.2 (0.3)***	3.2 (0.3)	3.3 (0.5)
Staff grade (n=8)	**3.8 (0.3)**	3.8 (0.4)	3.8 (0.4)	**3.2 (0.5)***	3.3 (0.6)	3.0 (0.5)
Consultant/GP (n=27)	**3.8 (0.3)**	3.8 (0.3)	3.7 (0.4)	**3.1 (0.4)***	3.2 (0.5)	3.1 (0.4)
Nurse NMP (n=1)	**3.7 (-)**	3.8 (-)	3.6 (-)	**3.3 (-)***	3.6 (-)	3.0 (-)
	3.7 (0.4)	3.7 (0.4)	3.7 (0.5)	**3.1 (0.4)***	3.2 (0.5)	3.1 (0.4)

* the difference between rational and experiential scores was statistically significant, $p < 0.05$

A number of other studies have reported REI-40 scores in samples drawn from qualified or student healthcare professionals (see Table 5.9) [230–238] Surprisingly, the current study sample contrasts quite markedly from several other samples involving doctors, although the results were similar to those found in the original Pacini study of undergraduate students.[200] Higher mean rationality scores were demonstrated by a small sample of trainees and consultants,[231] emergency physicians[232] and cardiologists,[230] although lower rationality scores were found in another, much larger, sample of trainees and consultants.[233,234]

Table 5.9: Comparison of mean REI-40 scores with other study samples

Sample	Mean rational score (SD)	Mean experiential score (SD)
Physicians (n=221)[233,234]	2.98 (0.53)	2.29 (0.58)
College students (n=399)[200]	3.39 (0.61)	3.52 (0.47)
This study (n=59)	**3.69 (0.39)**	**3.14 (0.38)**
Senior nurses (n=50)[238]	3.79 (n/a)	3.40 (n/a)
Paramedics (n=904)[235]	3.86 (0.42)	3.41 (0.42)
Student pharmacists (n=114; n=51)[236,237]	3.9 (0.5)	3.3 (0.5)
Doctors (trainees and consultants) (n=32)[231]	3.91 (0.43)	3.04 (0.54)
Emergency physicians (n=434)[232]	3.93 (0.35)	3.33 (0.49)
Cardiologists (n=74)[230]	3.93 (0.37)	3.05 (0.53)
Student paramedics (n=267)[235]	3.97 (0.42)	3.36 (0.46)
Consultants (n=49)[238]	4.00 (n/a)	3.07 (n/a)
Hospital managers (n=53)[238]	4.02 (n/a)	3.29 (n/a)

There was a smaller difference between the mean rational and experiential scores than between the scores for doctors found in other studies,[230,233,238] but it was similar to that found for emergency physicians,[232] pharmacy students,[236,237] and student paramedics.[235] Samples of doctors in other studies were drawn from medical and surgical specialties, including cardiology,[230,231] emergency medicine,[231,232] geriatrics,[231] intensive care,[231] orthopaedics,[231] paediatrics,[231,233,234] obstetrics and gynaecology,[233,234] radiology,[233,234] ophthalmology,[233,234] and surgery.[231] A very small number of psychiatrists (12/221; 5%) were involved in the studies by Djulbegovic *et al*.[233,234] In one study, Sladek *et al* specifically excluded consultants working in mental health.[231]

The lower rationality scores seen in this study may reflect that psychiatry is practiced by a different type of doctor. A qualitative study of decision-making processes in psychiatry identified that clinical intuitive (a 'feeling' or 'hunch') were important when psychiatrists described decisions relating to symptom presentation and diagnosis, but less so in relation to medication and treatment choices; the authors highlighted that psychiatrists have relatively few objective tools to verify or refute their hypotheses.[399] Bloch argued that the 'art of psychiatry' is as important to patient care as the practice of evidence-based medicine with the interplay of biology, psychology, social circumstances and spiritual life more relevant than in any other medical specialty,[400] a view supported by others.[401,402] The difference between the practice of psychiatry and other medical specialties may explain the lower rationality scores seen in the current study.

Sladek *et al* explored the thinking dispositions of key decision makers in hospitals, comparing senior consultants, nurses and health managers. Managers had a significantly higher preference for rationality than nurses, while consultants had a lower preference for experientiality than either nurses or managers. The authors suggested that when addressing multiple professional groups it may be beneficial to prepare two versions of any message, with one targeting the rational processing mode and the other the experiential processing mode.[238]

Following a meta-analysis of 89 studies looking at decision performance and decision experience, Phillips *et al* concluded that decision performance was positively associated with reflection and negatively associated with intuition. They also identified a significantly stronger positive relationship between thinking style and decision performance when the task and the processing system matched with, for example, tasks that required logic or analysis, performed better by those who scored highly on

rationality. The authors concluded that having strong tendencies to use both types of thinking may be an "optimal individual thinking style"; particularly if the individual is able to identify the best type of thinking for the task in hand, and adapt their decision-making approach to match.[403]

In the current study, very few respondents provided free text comments in their questionnaire responses, but those that did also suggested that they may alter their predominant thinking style to suit the situation. Comments are shown below:

> *"Cognitive styles may vary depending on situation; I can switch between modes" (P31, consultant/GP)*
>
> *"As a doctor I like to be able to logically justify but I have learnt that gut instinct can support this, especially by highlighting things that need to be considered and may otherwise be missed, so long as it is part of an overall logical process" (P42, consultant/GP)*
>
> *"There appears to be a false dichotomy between intuition and thought. Theories of expert problem solving suggest pattern recognition and intrinsic knowledge are important which could manifest as intuition but instead reflect processes of thought borne of knowledge, awareness and experience" (P47, consultant/GP)*

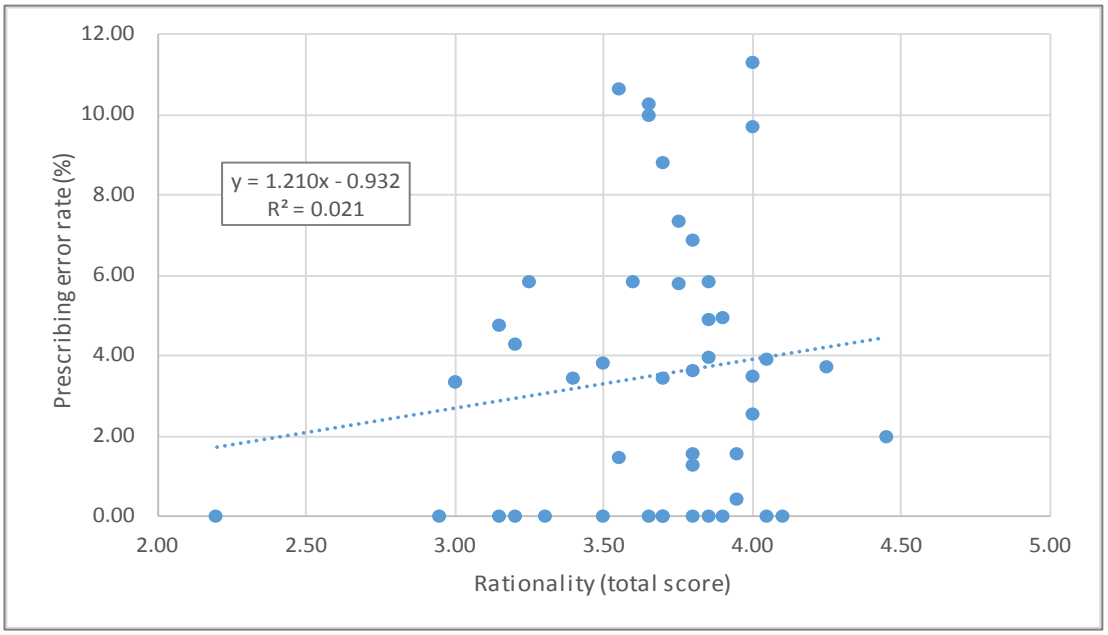


Figure 5.8: REI-40 rationality scores and prescribing error rates

Prescribing error data, collected as part of an earlier element of the study (see Section 2.3), were available for 47 of the 59 respondents who had completed the Rational Experiential Inventory element of the questionnaire. Respondents had prescribed 4,024 medication orders containing 180 prescribing errors, exceeding the total sample

size needed to identify a "small" expected effect size with 95% confidence and 90% power. Scatterplots were prepared to show the total rationality (see Figure 5.8) and total experientiality scores (see Figure 5.9) against the prescribing error rate for each individual.

Trends towards a higher prescribing error rate with higher rationality scores and lower experientiality scores were suggested by the regression lines. However, linear regression demonstrated a correlation of $R^2 = 0.021$ for the rationality score, and $R^2 = 0.001$ for the experientiality score which suggested that only 2.1% of the variation in prescribing error rate can be explained by the rationality score and less than one per cent by the experientiality scores alone.

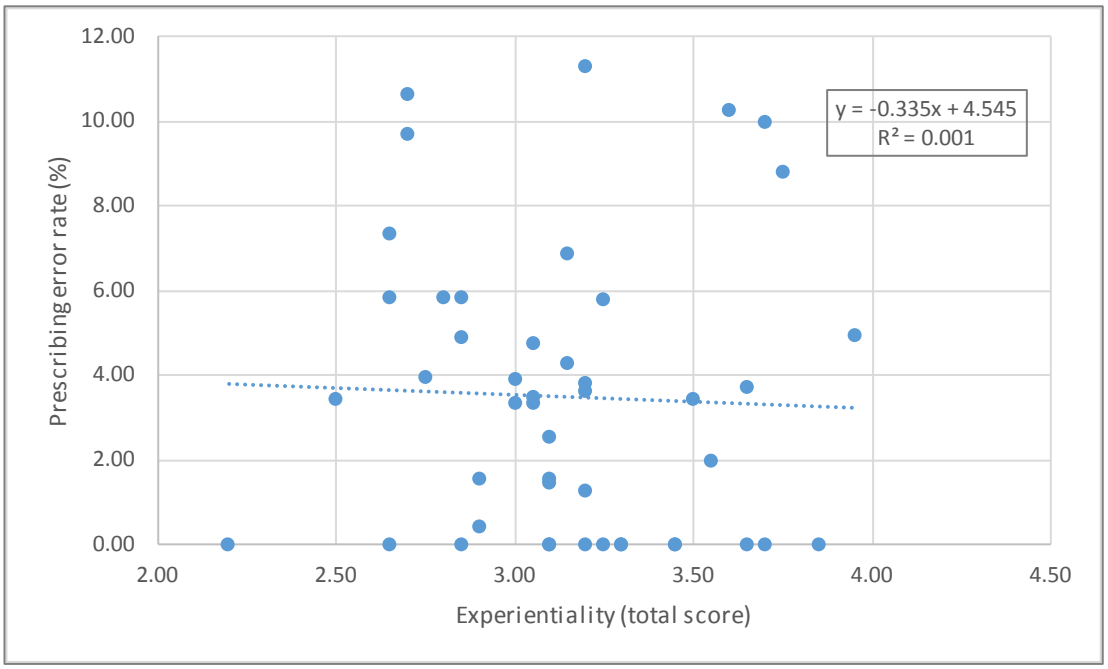


Figure 5.9: REI-40 experientiality scores and prescribing error rates

The statistical significance of each model was tested using ANOVA with a significance level of $p < 0.05$. These demonstrated that there was no significant effect of either the rationality score ($F_{45,46} = 0.948$, $p = 0.335$) or the experientiality score ($F_{45,46} = 0.083$, $p = 0.774$) on prescribing error rates.

A trend towards a greater proportion of errors being due to decision making with higher rationality scores was explored. Linear regression demonstrated a correlation of $R^2 = 0.055$ which suggested that only 5.5% per cent of the variation in the nature of prescribing errors can be explained by rationality score alone. The statistical significance of the model was tested using ANOVA with a significance level of

$p < 0.05$. This demonstrated that there was no significant effect of rationality score on prescribing error type ($F_{45,46} = 2.609$, $p = 0.113$).

No correlation was suggested by the regression line for the experientiality score which demonstrated a correlation of $R^2 = 0.000$. The statistical significance of the model was tested using ANOVA with a significance level of $p < 0.05$. This demonstrated that there was no significant effect of experientiality score on prescribing error type ($F_{45,46} = 0.001$, $p = 0.975$).

Research has found that thinking dispositions are related to the decision-making behaviours of individual doctors, including the application of clinical guidelines,[230] and compliance with infection control requirements.[231] It has been demonstrated that doctors with a higher preference for rational thinking are more likely to be guideline-concordant, whilst those with a higher preference for experiential thinking are more likely to be guideline-discordant.[230]

Djulbegovic *et al* assessed physicians' individual differences in cognitive style in relation to accuracy on a conditional inference task, using six scales measuring different aspects of cognitive style. They found that physicians capable of supressing an immediate intuitive response (CRT) and scoring higher on rational thinking (REI-40) made fewer inferential mistakes in the clinical scenarios. Whilst postulating that better decision making leads to better patient outcomes, the authors suggested that it would be interesting to correlate the cognitive scale scores of doctors with patterns of diagnostic testing and treatment prescribing.[233]

In the current study, no statistically significant relationship was found between higher scores on either the rational or experiential scale and prescribing error rates. This may be due to the small sample size, with prescribing data and REI-40 scores only available for 47 participants. However, it may indicate that prescribing is a complex task involving decisions which may be handled differently in diverse situations and may not be easily associated with the prescriber's dominant decision-making style, despite it having been suggested that those who favour rationality may be more receptive to evidence-based approaches.[404]

5.5 Need for Cognition Scale

Responses were received from 59 respondents who had completed the Need for Cognition Scale (NCS) element of the questionnaire (59/191; 30.9%); one respondent completed the NCS who did not complete the REI-40 and *vice versa*. The majority

were male (54.2%) with a modal age range of 40 - 49 years. Most respondents (27/59; 45.8%) were consultant psychiatrists or GPs with a special interest in mental health.

The mean NCS score for all prescribers was 16.9 (SD 15.2). Further detail on the demographic distribution of respondents can be found in Table 5.10. For more details about the NCS see Section 1.7.2. The non-parametric Kruskal-Wallis test, with a significance level of $p < 0.05$, demonstrated that there was no difference in mean scores by gender, age or prescriber grade (see Table 5.10).

Table 5.10: Comparison of mean NCS score on the basis of demographics

Sample (n = 59)	Mean NCS score (SD)	*p*
Gender		
Male (n=32) **Female (n= 27)**	15.5 (12.1) 18.6 (18.2)	0.144
Age		
21 - 29 (n=7) **30 - 39 (n=15)** **40 - 49 (n=22)** **50 - 59 (n=9)** **60 and over (n=6)**	23.9 (12.0) 7.9 (18.8) 17.3 (11.8) 20. 6 (15.9) 24.3 (11.1)	0.085
Respondent type		
Foundation trainee (n=9) **Core/GP trainee (n=10)** **Higher specialty trainee (n=4)** **Staff grade (n=8)** **Consultant/GP (n=27)** **Nurse NMP (n=1)**	13.4 (25.2) 6.6 (12.3) 11.8 (12.9) 21.1 (10.0) 21.6 (11.9) 12.0 (-)	0.067
	16.9 (15.2)	

The Kolmogorov-Smirnov test was used to determine whether the distribution of scores differed from a normal distribution. The need for cognition scores, $D(59) = 0.094$, $p = 0.200$ did not deviate significantly from the norm. However, it appeared to be negatively skewed (-1.192 ± 0.311) towards scores greater than zero. The distribution of scores is shown in Figure 5.10.

Unlike the CRT and potentially the REI, the NCS has been found to be gender neutral[405] and no statistically significant difference was found in the mean scores for male and female participants in this study. The relationship between age and need for cognition has been examined in a number of studies and a weak association found; although small individual-level changes in NCS scores can occur over time.[406] No difference by age group was found in this study. However, it has been suggested that association by age may be confounded by education, as a reliable relationship has

been found between need for cognition and educational status. Cacioppo *et al* queried whether this was in fact due to self-selection with those with a high need for cognition more likely to pursue education.[407]

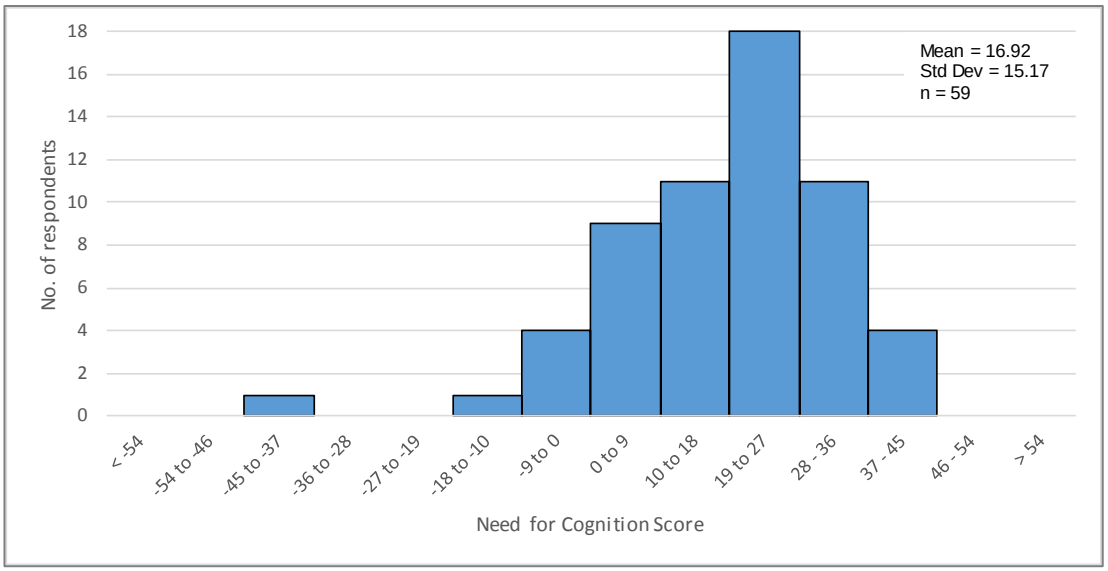


Figure 5.10: Distribution of Need for Cognition (NCS) scores

Few studies have applied the NCS to samples of doctors. In an investigation of thinking styles in physicians, Djulbegovic *et al* reported a mean score for a sample of trainees and consultants of 4.2 (SD 0.7).[234] However, they quoted scale dimensions for the NCS of 1 to 6 which does not correlate with the original 9-point Likert scale (-4 to +4) with reverse scoring developed by Cacioppo and Petty,[239] which was used in the current study. It is therefore not possible to make comparison between the results.

The NCS has been used in a multitude of studies. In 1996 Cacioppo *et al* reviewed its use in over 100 empirical studies in the little over a decade since it had been developed,[407] and a meta-analysis by Phillips *et al* of studies which assessed thinking styles and decision making identified many which have used the NCS (abbreviated as NFC in their paper).[403] Using undergraduate or general population samples, many have included the NCS as part of a battery of tasks but reported the association between different measures rather than absolute numbers, or used scales adapted to match the other tools used. For example, although West *et al* cited a mean NCS score of 69.0 (SD 12.2) their study used a scale of 1 to 6 in order to match the Actively Open-Minded Thinking Scale within which questions were intermixed, and no clarity was provided about reverse scoring.[408] The same scoring approach was adopted by Toplak *et al* which quoted a mean NCS score of 68.6 (SD 10.4).[266]

It has therefore not been possible to make direct comparisons with the mean NCS scores found in other studies. However, the distribution found in this study can be compared with general findings using the NCS. Significant correlation has been found between the 18-item NCS and variables such as high quality and adaptive decision making[409] and accurate and consistent decision making.[410,411] Dunphy *et al* found that obstetricians who scored highly on NCS were more likely to have better maternal and neonatal outcomes. They suggested that this may be due to clinicians with high need for cognition being linked to higher levels of metacognition, developed thought processes, and self-evaluation being more likely to critically evaluate potential strategies before reaching a decision[412] Studies have shown that individuals with high need for cognition scores recall more of the information that they are exposed to than those with low scores.[407]

While the absolute mean score cannot be meaningfully compared with others, this study found NCS scores which were normally distributed but skewed towards scores greater than zero, thus suggesting that the study sample showed a tendency to organise, abstract and evaluate information.[239]

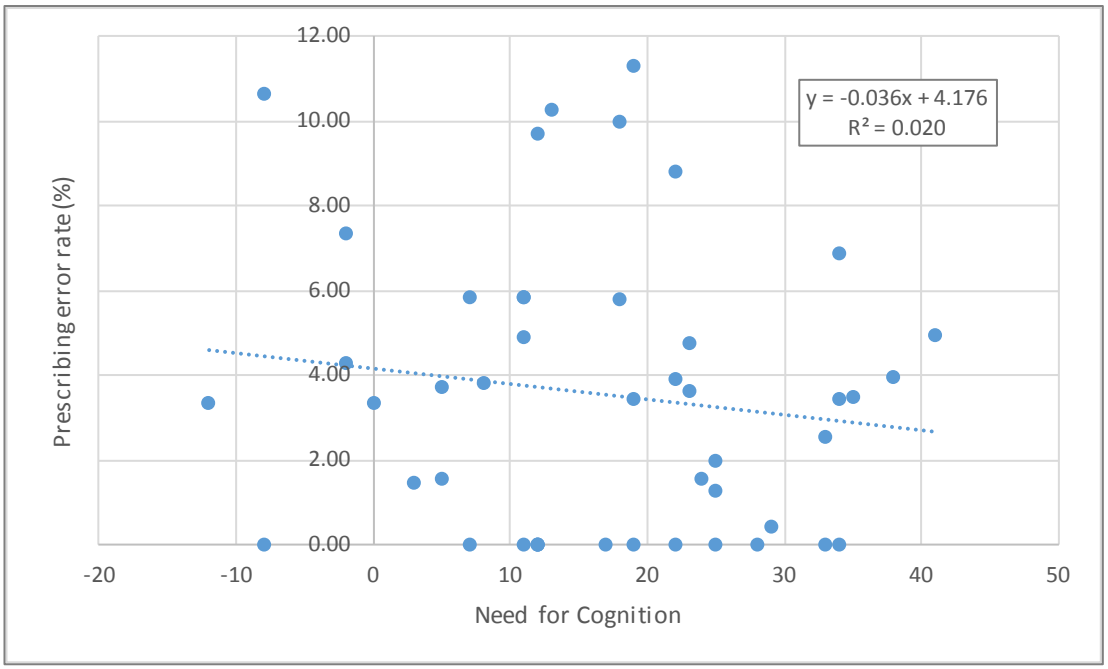


Figure 5.11: NCS scores and prescribing error rates

Prescribing error data, collected previously, were available for 45 of the 59 respondents who had completed the Need for Cognition element of the questionnaire. A scatterplot was prepared to show NCS score (see Figure 5.11) against the prescribing error rate for each individual. Respondents had prescribed 3,973

medication orders containing 177 prescribing errors, exceeding the total sample size needed to identify a "small" expected effect size with 95% confidence and 90% power.

A trend towards a higher prescribing error rate with lower NCS score was suggested by the regression line. However, linear regression demonstrated a correlation of $R^2 = 0.019$ which suggested that less than 2 per cent of the variation in prescribing error rate can be explained by need for cognition alone. The statistical significance of the model was tested using ANOVA with a significance level of $p < 0.05$. This demonstrated that there was no significant effect of the NCS scores on prescribing error ($F_{43,44} = 0.838$, $p = 0.365$).

A trend towards a greater proportion of errors being due to decision making with higher NFC scores was explored. Linear regression demonstrated a correlation of $R^2 = 0.012$ which suggested that only 1.2% per cent of the variation in the nature of prescribing errors can be explained by NFC score alone. The statistical significance of the model was tested using ANOVA with a significance level of $p < 0.05$. This demonstrated that there was no significant effect of NFC score on prescribing error type ($F_{43,44} = 0.547$, $p = 0.463$).

5.6 Summary of findings

No significant differences in CRT scores were found by gender, age or prescriber grade. The mean score on the classic 3-item version of the CRT was marginally higher than found in the original study with less 'low' scorers and more 'high' scorers as would be expected in a sample of highly educated participants. Educational attainment has been shown to be a strong predictor of CRT score. Participants may have had prior exposure to the original version of the CRT as the 'intuitive' incorrect was the modal answer in only two of the eight questions, a pattern which differed from other studies.

Few past studies have administered the CRT to medical staff. In those that have, a U-shaped relationship was shown in relation to appropriate antibiotic prescribing, but no correlation found with self-reported clinical errors. The current study demonstrated a weak positive correlation between level of experience and CRT scores. Despite a slight trend, there was no statistically significant effect of CRT score or the number of 'intuitive' incorrect answers on either prescribing error rate or the number of prescribing errors which related to decision making.

Overall, participants demonstrated statistically higher REI-40 scores for rationality than experientiality, although this was less pronounced for women than for men. Unlike other studies, the difference between men and women was not significant. There were no significant differences between rationality or experientiality scores by age or prescriber grade, with only the youngest/least experienced categories showing a non-significant difference between rationality and experientiality scores.

This is thought to be the first study to explore REI-40 scores in psychiatrists and the patterns found differed markedly from some other studies involving doctors, but less so from other sample populations. No relationship was found between REI-40 scores on either scale and prescribing error rates. It is also thought to be the first study to explore NCS scores in psychiatrists and a high ‘need for cognition’ was demonstrated amongst this population. No relationship was found between NCS score and prescribing error rates.

Scores on validated scales designed to measure thinking dispositions do not appear to provide a prediction of prescribing error performance, suggesting that accurate and appropriate prescribing involves more factors than can be captured by measurement of thinking dispositions.

Chapter 6. Educational intervention: results and discussion

6.1 Introduction

The educational session was attended by 47 medical staff. The breakdown of participants by prescriber grade is shown in Table 6.1. The turnover of medical staff was such that very few of the participants were working within the trust throughout the entire period of pre- and post-intervention prescribing data collection (see Appendix 20), and prescribing data were collected for only 32 of the session participants.

Table 6.1: Prescriber grade of educational intervention attendees

Participant Grade	No. attending session	No. pre-session prescribing data available	No. post-session prescribing data available	No. pre- & post- session prescribing data available
Foundation trainee	9	0	4	0
Core/GP specialty trainee	10	4	8	3
Higher specialty trainee	8	4	5	2
Staff grade	3	2	2	1
Consultant	17	8	7	6
Overall	**47**	**18**	**26**	**12**

No prescribing data were collected for 15 participants. For six participants data were available only for the first data collection period and for a further 14 participants only for the second period. Data for both periods were available for only 12 participants; as a result, limited comparisons could be made.

6.2 Evaluation of training session by attendees

Of the 47 attendees, 19 (40.4%) completed a short questionnaire before and after the session. The percentage of positive responses ‘agree’ and ‘strongly agree’ to a series of 11 statements about decision making increased for 10 of them. All respondents agreed or strongly agreed that the programme had provided them with a good understanding of decision making, whilst 94.4% (18/19) felt that the content was relevant to their training or practice and would be useful to their work. All felt that they would be able to apply the knowledge learned.

The differences in mean pre- and post-session scores were compared for each statement using the non-parametric Wilcoxon matched-paired signed-rank test. Statistically significant differences between the two scores were identified for statements two, six, seven, nine and 10. The difference in overall scores was also

statistically significant (z = -3.559, p = 0.000, r = -0.82). The respective scores, on a 5-point Likert scale and the proportion of positive responses for each statement are shown in Table 6.2.

Table 6.2: Scores and percentage positive responses to each statement

(n = 19)	Before session		After session	
	Average score (SD)	Positive responses	Average score (SD)	Positive responses
Statement 1 - An understanding of decision making is important in my clinical practice	4.7 (0.5)	100%	4.8 (0.4)	100%
Statement 2 - I often make decisions based on my intuition	3.8 (1.0)	52.6%	4.0 (0.8)*	73.7%
Statement 3 - Different people use different styles to gather information	4.0 (0.8)	84.2%	4.3 (0.6)	94.7%
Statement 4 - I understand the way in which I gather information to inform decision making	4.0 (0.6)	78.9%	4.2 (0.6)	89.5%
Statement 5 - If I can't make a decision I consult a colleague	4.3 (0.5)	94.7%	4.5 (0.5)	100.0%
Statement 6 - I don't have enough time to stay up-to-date on important clinical topics	3.3 (1.1)	36.8%	3.7 (1.0)*	63.2%
Statement 7 - Decision making can be influenced by cognitive biases	3.8 (0.8)	78.9%	4.5 (0.5)*	100.0%
Statement 8 - Keeping up-to-date with information on clinical topics is a key aspect of decision making	4.2 (0.7)	84.2%	3.8 (1.0)	73.7%
Statement 9 - I understand the different processes involved in decision making	3.5 (0.8)	52.6%	4.3 (0.5)*	100.0%
Statement 10 - I often make decisions on 'auto-pilot'	3.2 (0.8)	31.6%	3.7 (0.7)*	68.4%
Statement 11 - I use the best available evidence to inform my decision making	3.6 (1.1)	63.2%	4.0 (0.5)	84.2%
Overall	**3.8 (0.3)**		**4.2 (0.3)***	

* the difference between the pre- and post-session score was statistically significant, $p < 0.05$

The need for a healthy degree of scepticism to be fostered amongst medical students has been highlighted[413] and several studies have investigated the impact of decision-making training for undergraduates.[382,414,415] Bhatti[413] suggested that raising awareness of cognitive biases and equipping medical students with cognitive debiasing strategies will improve the future quality of care and therefore patient outcomes. The author cited the GMC's view that medical students should be able to systematically reflect on their practice and translate that reflection into action,[416] asserting that medical students need to be equipped with the skills of critical thinking. A recent survey in the US reported that most students enter undergraduate clinical training years with at best a fair knowledge of the key clinical reasoning concepts and

that, despite respondents reporting that clinical reasoning should be taught in all phases of medical education, it is offered by only a minority.[417] It is probable that a similar situation exists in the UK.

Harendza *et al* implemented a clinical reasoning course, addressing six learning outcomes, as part of the final year undergraduate medical training. The course was delivered as 16, two-hour seminars using 32 patient cases collected from clinical practice to illustrative different cognitive errors. In a self-assessment questionnaire completed before and after the course, students assessed themselves significantly better at all eight of the skills which play a role in clinical reasoning. Students were also assessed on the same clinical case at the beginning and end of the course. Although post-course case presentations contained fewer errors and more differential diagnosis, the difference was not significant.[414] Chew *et al* noted that cognitive debiasing may be "easy in theory yet difficult in practice" and can often slow down the whole clinical decision-making process. In a quasi-experimental study, final-year medical students completed a 90-minute tutorial on cognitive biases and debiasing strategies and were introduced to a checklist to facilitate metacognition. Two weeks later, those exposed to the tutorial scored significantly higher than students in a control group on five clinical case scenarios, designed to contain common cognitive biases.[382] However, a study of final-year medical students using observations of performance and semi-structured interviews, concluded that the impact of teaching decision-making cognitive theory, during a 6-week 'Preparation for Practice' block, was not clear in relation to making diagnosis, prioritisation and asking for help.[415]

Clinical decision-making training has also been reported in a postgraduate setting. A study of GPs, GP trainees and nurse practitioners who participated in decision-making workshops demonstrated significant self-reported improvements in the theory and applied theory of decision making.[270] Meanwhile in Pennsylvania, a curriculum consisting of three sessions delivered over one academic year was undertaken by year two internal medicine residents (equivalent to FY2 trainees in the UK). Outcomes were evaluated using the Diagnostic error Knowledge Assessment Test (D-KAT), completed at the beginning and end of the course, and designed to test knowledge of cognitive errors and their application in clinical vignettes. Whilst pre- and post-course D-KAT results were used as the primary outcome, the D-KAT results from year three residents were also used as a control group. Post-course scores on the D-KAT test were "modestly" but significantly improved compared with pre-course scores and higher than those of the year three control group.[418] Houchens *et al* investigated

techniques that are demonstrated by exemplary clinical educators to cultivate clinical reasoning in an inpatient setting. From interviews and focus groups with educators and learners, and direct observations of clinical teaching they identified four themes:

- simplification, organisation and prioritisation when dealing with information;
- accessing prior knowledge and contextualising it using schemas and illness scripts;
- thinking aloud to verbalise thought processes, provide rationale for management plans, and share mistakes;
- medical scholarship, critically analysing and connecting the literature with patient presentations, and using evidence to support clinical decision making.[419]

It is probable that the actions and behaviours of clinical and educational supervisors are as important in teaching clinical decision making as formal interventions about the theory of clinical decision making.

As shown above, most studies researching ways to improve clinical decision making have concentrated on diagnosis. However, Jenkins and Youngstrom examined the impact of a cognitive debiasing intervention on decision-making errors in paediatric bipolar disorder, where the outcome measures included treatment decisions as well as diagnosis. Participants undertook a brief web-based educational intervention which comprised an overview of the condition, education on common cognitive pitfalls and corrective strategies; a control group just received the overview of the condition. Participants in the intervention group showed significantly better overall judgement accuracy and made fewer decision-making errors, even after controlling for experience and profession. The authors noted that cognitive error, particularly search satisficing (premature discontinuation), appeared to be associated with premature treatment decisions, with more accurate judgement leading to a more conservative and methodical approach.[420]

6.3 Prescribing errors

Prescribing error data were collected by ward pharmacists before and after the educational intervention. A total of 7,953 medication orders were reviewed pre-intervention (period one), and a further 5,731 post-intervention (period two). Less than one-sixth of medication orders (14.4%; 1,974/13,684) were written by the 32 prescribers who attended the education session, compared with 85.5%

(11,710/13,684) which were written by the 180 prescribers who did not (see Table 6.3).

For the 32 prescribers who attended the session and for whom data were available, the number of medication orders was very slightly less than the calculated sample size (pre- and post-intervention) of unpaired observations required to test, with 95% confidence and 90% power, for a reduction of 50% from the pre-intervention prescribing error rate (see Section 2.6.6).

Analysis was undertaken for these 32 participants on the basis of unpaired data. For the small number for whom pre- and post-intervention data were available paired comparisons were also undertaken.

6.3.1 Analysis of unpaired data

For those who did not attend the educational session, and all prescribers overall, the difference in error rates between the two periods demonstrated no statistically significant difference when tested using the Pearson chi-squared test, with a significance level of $p < 0.05$.

Table 6.3: Prescribing error rates pre- and post-intervention

Prescriber		Pre-intervention (period 1)	Post-intervention (period 2)	Total	*p*
Did not attend educational session (n = 180)	Items written/omitted No. with errors Error rate (95% CI) (%)	6,826 348 5.1 (4.6-5.6)	4,884 234 4.4 (3.8-5.0)	11,710 561 4.8 (4.4-5.2)	0.066
Attended educational session (n = 32)	Items written/omitted No. with errors Error rate (95% CI) (%)	1,127 28 2.5* (1.6-3.4)	847 41 4.8* (3.4-6.2)	1,974 69 3.5 (2.7-4.3)	0.005
All prescribers (n = 212)	Items written/omitted No. with errors Error rate (95% CI) (%)	7,953 376 4.7 (4.3-5.2)	5,731 254 4.4 (3.9-4.9)	13,684 630 4.6 (4.3-4.9)	0.415

* the difference between pre- and post-intervention error rates was statistically significant, $p < 0.05$

For the 32 participants for whom prescribing data were available, data were available for 18 prescribers for period one, 26 prescribers for period two, and 12 prescribers for both periods. Data collected during the pre-intervention data collection period demonstrated a prescribing error rate of 2.5% (28/1,127) compared with a post-intervention error rate of 4.8% (41/847). Full details are shown in Table 6.3. This was tested for statistical significance using the Pearson chi-squared test, with a significance level of $p < 0.05$. This demonstrated a significant difference between the error rate pre- and post-intervention (χ^2 (1) = 7.958, $p < 0.05$).

Although there was a statistically significant difference between the pre- and post-intervention prescribing error rates in the group who attended the educational session, the error rate was higher in the post-intervention group than in the pre-intervention group. This is likely to be explained by the fact that the two samples were not matched pairs, and their composition was quite different (see Table 6.1 and Table 6.4).

Table 6.4: Comparison of samples for those attending educational session

Participant Grade	Pre-intervention sample		Post-intervention sample	
	No. medication orders (% of sample)	No. medication orders with errors	No. medication orders (% of sample)	No. medication orders with errors
Foundation trainee	-	-	34 (4.0%)	0
Core/GP specialty trainee	249 (22.1%)	8	342 (40.4%)	26
Higher specialty trainee	273 (24.2%)	7	139 (16.4%)	3
Staff grade	199 (17.7%)	7	54 (6.4%)	1
Consultant	406 (36.0%)	6	278 (32.8%)	11
Overall	**1,127 (100%)**	**28 (2.5%)**	**847 (100%)**	**41 (4.8%)**

In the group for whom pre-intervention prescribing data were available, 22.1% of the medication orders were written by junior doctors likely to be within the first five years of practice (foundation, core and GP trainees) whilst 53.7% were written by experienced doctors (staff grade and consultants). In the post-intervention group, twice the proportion of medication orders (44.4%) were written by junior doctors with an associated higher number of errors, as might be expected from the earlier findings of this study, where early-years prescribers had the highest error rates amongst prescribers.

In contrast, experienced doctors accounted for a lower proportion of the medication orders written in the post-intervention sample. Other reasons that may have led to the results observed include the small size of the sample of medication orders written by prescribers who attended the educational session (14.4%; 1,974/13,684) compared with the overall sample, and the large 95% confidence intervals produced as a result (see Table 6.3). During the first data collection period, the highest error rates were demonstrated by foundation year 2 (12.3%; 33/269) and GP trainees (9.8%; 59/602), with the lowest rates shown by core specialty trainees (3.0%; 34/1,143) and higher specialty trainees (2.2%; 14/637). During the second data collection period, the highest error rates were demonstrated by core (9.6%; 73/761) and GP trainees (9.3%; 20/216), with the lowest rates shown by staff grade (1.8%; 42/2,291) and other

prescribers (0.5%; 2/389). Error rates by prescriber grade for both periods are shown in Figure 6.1.

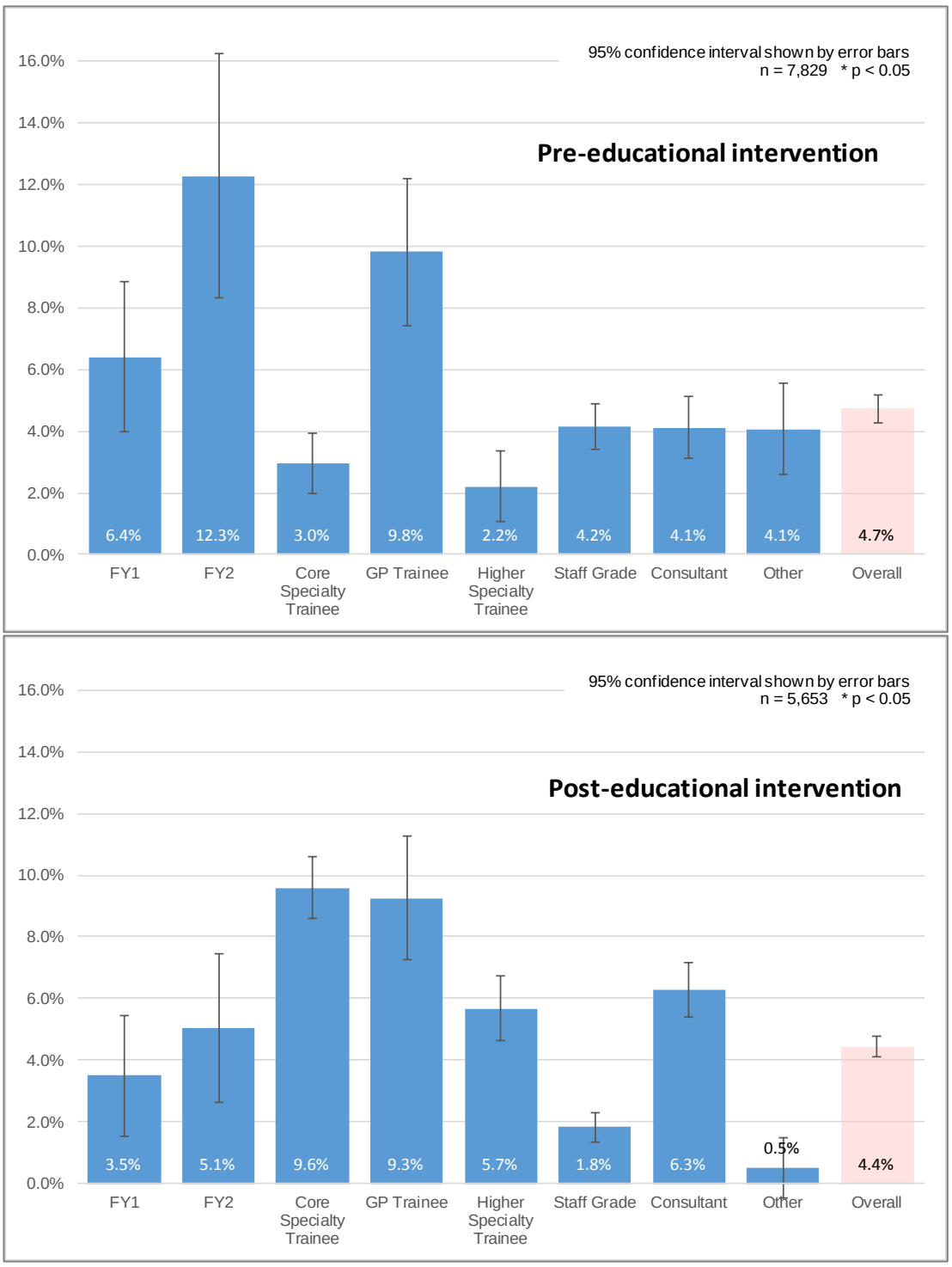


Figure 6.1: Prescribing error rates by prescriber grade

During the first data collection period, most errors were associated with discharge prescriptions (7.1%; 41/577), followed by prescriptions written on admission (6.5%; 92/1,414). During the second data collection period, discharge prescriptions were still associated with the highest rate of errors (8.5%; 40/469), followed by admissions

(5.9%; 71/1,199). Error rates by prescribing stage for both periods are shown in Figure 6.2.

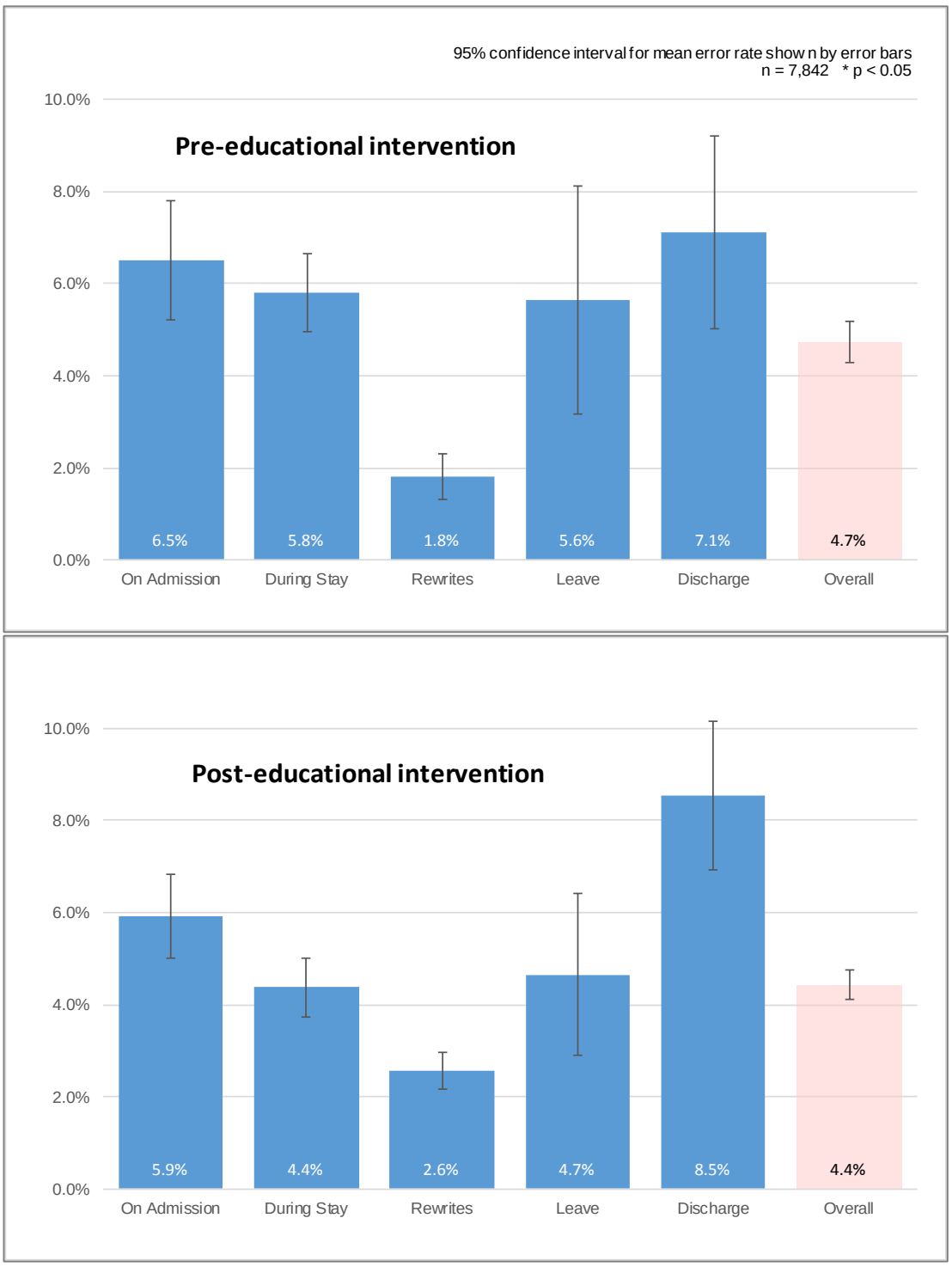


Figure 6.2: Error rate by prescribing stage

Analysis of unpaired data demonstrated a statistically significant difference in the prescribing error rates pre- and post- intervention, but not a reduction in prescribing errors, likely to have been due to the difference in composition of the unpaired samples.

6.3.2 Analysis of paired data

Data were only available for 12 prescribers for the periods both before and after attendance at the educational session on decision making. Of these, two prescribers (prescribers 3 and 93) had no prescribing errors identified during either period, and a further five had no recorded prescribing errors in one of the two periods (prescribers 9, 10, 15, 21 and 83). Pre- and post-intervention data for the 12 prescribers is shown in Table 6.5.

Table 6.5: Pre- and post-intervention numbers of medication orders with and without errors

Prescriber	Pre-intervention			Post intervention			
	Total medication orders	Medication orders with errors	Error rate (%)	Total medication orders	Medication orders with errors	Error rate (%)	Change in error rate
3	87	0	0.0%	20	0	0.0%	0.0
6	193	6	3.1%	62	1	1.6%	-1.5
9	169	5	3.0%	17	0	0.0%	-3.0
10	74	3	4.1%	12	0	0.0%	-4.1
15	44	0	0.0%	20	1	5.0%	+5.0
21	102	2	2.0%	48	0	0.0%	-2.0
33	117	1	0.9%	50	1	2.0%	+1.1
67	80	1	1.3%	39	3	7.7%	+6.4
83	18	1	5.6%	13	0	0.0%	-5.6
93	22	0	0.0%	20	0	0.0%	0.0
147	107	4	3.7%	15	4	26.7%	+23.0
171	12	1	8.3%	111	8	7.2%	-1.1
	1,025	**24**	**2.3%** (1.4 - 3.2)	**427**	**18**	**4.2%** (2.3 - 6.1)	**1.9**

In both this group of prescribers as a whole, and for some individual prescribers, the total number of medication orders written in the two periods differed considerably (period one, 1,025; period two, 427). For example, prescriber 147 wrote 107 medication orders during period one, but only 15 in period two. The mean prescribing error rate for these 12 prescribers was 2.3% (95% CI 1.39 - 3.21; 24/1,025) for period one and 4.2% (95% CI 2.3 - 6.1; 18/427) for period two. This difference in error rates was not statistically significant when tested using the Pearson chi-squared test, with a significance level of $p < 0.05$ (χ^2 (1) = 1.697, $p < 0.193$).

Whilst the intervention undertaken in the current study did not result in a significant reduction in prescribing errors, many other studies have investigated interventions aimed at improving prescribing and reducing errors; these suggest that interventions need to be more complex than that reported in this study. It has been suggested that interventions need to be at three levels to improve prescribing: training, standardisation of process and environment, and accompanied by a cultural change to recognise prescribing as a complex, technical task.[421] Several recent systematic reviews have reported on educational interventions to improve prescribing[422,423] or reduce medication-related harm,[424] and the Health Foundation published a rapid collation of the evidence for educational approaches, initiatives relating to roles and personnel, and tools to reduce prescribing errors.[251] Interventions to address the occurrence of prescribing errors need to reflect knowledge about both the causes of errors and the circumstances in which they occur.[425]

Brennan and Mattick considered 64 studies of hospital-based interventions and were particularly interested in studies which focused on new prescribers. The authors reported that most interventions were multifactorial, using several types of intervention, although educational materials were the most popular. They found that the same types of strategies, for example, specific feedback to prescribers, were successful in some studies but ineffective in others. Therefore, they suggested that no firm conclusions could be drawn about the most effective types of intervention, and noted that few interventions were tailored to meet the needs of new prescribers.[422] Kamarudin *et al* identified 47 studies exploring educational interventions to improve prescribing competency, although 20 involved medical students rather than qualified doctors; 10 were hospital-based. The authors suggested that limited conclusions could be drawn due to the quality of the studies reviewed, and noted that high quality studies were needed which consider long-term changes in prescribing habits to assess the effectiveness of educational interventions.[423] Similar conclusions were drawn by Bos *et al* in a recent review, which looked particularly at 15 studies reporting an impact on medication-related patient harm. The authors highlighted that studies were small, with short follow-up and poor methodology. However, they did note that those studies where education was part of a multifaceted approach all reported positive outcomes, whilst only four of seven studies involving an educational intervention alone were positive. The authors concluded that educational sessions should be combined with other approaches to improve medication safety[424] Didactic approaches do not appear to produce changes in prescribing behaviour.[426]

Studies have identified that prescribers are frequently unaware that they have made an error.[13,18,27] With feedback considered the "cornerstone of effective teaching",[427] it is perhaps unsurprising that prescribers continue to make prescribing errors if they rarely know that they have made them. In addition, a culture has been reported amongst pharmacists of not using formal incident reporting systems to capture every error they encounter because the high prevalence makes this "too cumbersome and time consuming".[428] Whilst pharmacists understand the importance of incident reporting this is principally driven by actual patient harm, meaning that most incidents are not reported. Therefore, another source of potential feedback to prescribers is largely lost.

Qualitative studies have shown feedback on prescribing to be positively received by doctors,[429–431] with prescribers describing feedback as "essential in order for them to calibrate their prescribing appropriately".[430] However, pharmacists have reported anxiety that delivering such feedback will damage interprofessional relationships.[432] Current arrangements for feedback are generally informal, opportunistic, and inconsistent, with errors usually corrected by pharmacists without feedback to the prescriber.[13,431,432] Interviews with prescribers have identified that feedback is most beneficial when timely and provides a benchmark against which to compare their own behaviours and knowledge. Email feedback was felt likely to be least effective at changing prescribing behaviour.[430] The findings of a study by Reynolds *et al* supported this assertion. They investigated fortnightly prescribing advice emails that addressed a common and/or serious error. Whilst focus group findings suggested increased doctor engagement with safe prescribing, no difference was found in prescribing error rates compared with a control site, and the authors concluded that producing a measurable reduction in prescribing errors needed a multifaceted approach.[278]

Studies have found that individualised education and feedback improved prescribing and reduced errors. In a recent UK study, pharmacists who had received additional training on the theory, impact and principles of delivering feedback, provided individualised verbal and written feedback on both overall prescribing and specific prescribing errors. Error data for two intervention wards were compared at baseline and post-intervention with two comparable control wards. Following feedback, mean prescribing error rates were significantly lower in the intervention group than in the control group, and lower at the end of the study period than at baseline.[433] McLellan *et al* investigated the impact of individualised feedback, including comparative

information, in the setting of a feedback workshop on suboptimal antimicrobial prescribing (mainly prescription writing). Suboptimal prescribing was found to be significantly lower in the intervention group than in a control group.[434] In a mental health setting, Chaturvedi *et al* provided feedback to prescribers on the quality of prescriptions written within an adult psychiatry unit. There were substantial improvements in the proportion of prescriptions which met specified standards after feedback.[435]

A number of studies have investigated interventions designed specifically to reduce antipsychotic polypharmacy rates rather than the occurrence of prescribing errors. Ungvari *et al* found that psychopharmacotherapy lectures, distribution of literature and feedback on prescribing reduced the number of patients who were prescribed more than one antipsychotic.[436] Thompson *et al* reduced levels of antipsychotic co-prescribing though use of an educational/cognitive workbook, academic detailing and reminder stickers applied to drug charts, compared with control wards which received a set of guidelines. Although they found a significantly lower chance of being prescribed multiple antipsychotics in the intervention group than the control group, there was considerable variation between units involved in the study and in the changes seen between baseline and follow-up.[437,438] Similar approaches involving guideline implementation, education and feedback, and pharmacist interventions have also been successful in changing prescribing culture and reducing antipsychotics prescribed in combination and/or above the maximum BNF recommended dose in other studies[439–441]; although one study which looked at this type of prescribing one year after an intervention found no change in the frequency of antipsychotic co-prescribing.[442] The authors of this study noted high rates of staff turnover during the period and differences in case mix between the baseline and post-intervention patient groups which may have been contributory. However, it may also have indicated that any immediate impact of the intervention was not sustained over the period of a year.

6.4 Summary of findings

In the current study, a three-hour educational intervention on clinical decision making did not reduce prescribing error rates. However, similarly to other research, it did have an impact on the self-reported understanding of decision-making processes. Statistically significant differences were demonstrated in five of the post- intervention evaluation statements, three of which related to participants' understanding of their own decision making, and two to decision-making theory.

It is likely that interventions to improve the quality of prescribing and reduce errors need to be multifaceted in design in order to recognise the complexity of the prescribing process.[443] In terms of an educational component, which could be delivered as part of the induction process or as part of ongoing postgraduate education session, the research undertaken within this study suggests that this needs to contain the following elements:

- the theory of clinical decision making, including awareness of dual process theory, incorporating the development of pattern recognition through experience and the process of calibration; cognitive biases and the application of debiasing strategies to help overcome them.
- locally identified stages in the prescribing process shown to be error-prone, particularly issues relating to errors occurring at care interfaces, and relating to particular categories of medication.
- systems locally which can be used by prescribers to help reduce errors, such as medicines reconciliation, technology, (ePMA, SCR), reporting and feedback on prescribing errors as an educational tool, how to access information sources (e.g. local formulary, guidelines, on-call pharmacist)

This educational approach should be accompanied by on-going feedback on prescribing errors to individuals (about their own errors) and prescribers in general (about patterns of prescribing errors) as without feedback prescribers cannot alter prescribing habits which they do not know are incorrect.[430] For newly qualified prescribers this could be provided by 'buddying' with a pharmacist.[444] Clinical and educational tutors have a crucial part to play in reinforcing the importance of such feedback as a learning tool.

Evidence from cognitive psychology also suggests that interventions should be designed in such a way as to target both the rational processing and the experiential processing preferences of individual participants,[238] and that a better understanding of the individual differences between doctors can contribute to the design of strategies to improve the uptake of new evidence.[404] See also the limitations discussed in Section 7.4.4.

Chapter 7. Overall discussion and conclusions

7.1 Introduction

The purpose of this study was to investigate the effect of dual process thinking and other human factors on the occurrence of prescribing errors in an inpatient mental health setting. In order to investigate this, research was undertaken in four areas. Firstly, the prevalence and nature of prescribing errors were investigated, including exploring the views of prescribers on the causes of errors that they had made. Secondly, validated tools were used to explore the decision-making characteristics of prescribers, the outcome of which were correlated with the incidence of prescribing errors by those prescribers. Finally, the impact of an educational session aimed at increasing the knowledge and understanding of prescribers on the theory behind clinical decision making was explored by comparing the prescribing error rates pre- and post-intervention. This section of the thesis explores the impact and significance of the results found.

7.2 Study objectives

The four research objectives of this study are shown below, and the key findings in relation to each are set out in the following sections:

- To investigate the prevalence and nature of prescribing errors in inpatients.
- To explore the causes of prescribing errors in hospital inpatients.
- To determine the decision-making characteristics of prescribers and whether there is a correlation between cognitive style and making prescribing errors.
- To investigate whether exposing prescribers to evidence about how humans make decisions affects the prevalence or nature of prescribing errors made.

7.3 Key findings

7.3.1 Prescribing errors

In a sample of nearly 13,700 medication orders reviewed over 24 months, 4.6% (95% CI 4.3 - 4.9%) were found to contain one or more prescribing error. This was lower than the finding of 6.3% (95% CI 5.6 - 7.1%) in a recent multi-centre study of similar design,[147] but higher than two earlier UK studies.[100,101]

Higher error rates were associated with transitions of care, which is consistent with evidence suggesting that as patients move between care providers, the risk of unintended changes to medicines can be a substantial issue.[279] Notwithstanding the importance of getting patients' medicines correct at times of transition, it was noted that those prescriptions written at admission and discharge accounted for less than one-third of all prescriptions, and that the admission error rate was substantially lower at 6.2% (95% CI 5.3 - 7.2%) than found in the major comparator study where the admission error rate was 10.7% (95% CI 8.6 - 12.7%).[147] It is suggested that this may be due to comprehensive processes within the Trust regarding medicines reconciliation.

A substantial body of evidence has identified that junior doctors have higher error rates than their more senior colleagues and are responsible for writing a large proportion of medication orders.[18,19,189] However, in the current study, whilst the highest error rates were found amongst early years prescribers, unlike in acute settings they were responsible for writing a low proportion of medication orders. A weak, but significant, relationship was found between increasing experience and decreasing prescribing error rates.

Prescribing errors more commonly involved prescription writing (62.2%) than decision making (37.8%). Errors most commonly involved the step of providing instructions for supply of the product, in particular missing or incorrect information about formulations and strengths. The error rate for medicines to be administered regularly (4.9%) was significantly higher than for 'as required' medicines (4.1%).

Overall, errors were more common in non-psychotropic medicines (5.1%) than in psychotropic medicines (3.9%) with the differences most marked in junior doctors. This supports the need for junior doctors to have a core formulary of common medicines with which they are most familiar; but probably also reflects the fact that FY2 and core/GP trainees will often be faced with unfamiliar medication regimens out-of-hours during the admission of unknown patients. Errors were most commonly identified in medication orders for antipsychotics (11.1%), hypnotics and anxiolytics (10.9%), analgesics (9.8%) and antimicrobials (8.9%). Twenty drugs accounted for nearly half of all errors, with paracetamol accounting for most (7.8%). These patterns are similar to those found in other studies.

A small proportion of errors were considered to be potentially severe and less than 1% were recorded as causing actual patient harm. Errors with the potential for

greatest clinical impact were generally made by more senior and experienced doctors although this was not statistically significant. Errors were assessed by an expert panel as well as by ward pharmacists. Despite excellent correlation between the scores given by these two groups, there were differences, with ward pharmacists more likely to assess errors as 'minor' or 'severe'. This is likely to reflect the fact that ward pharmacists were able to assess the error in context, whilst the expert panel had no access to information about the patient's complete medication regimen, clinical condition or co-morbidities.

Pharmacists intervened in the majority of cases and resolved the error before any doses were administered to the patient (61.1%), demonstrating the importance of clinical pharmacy services in a setting in which pharmacy and medicines optimisation services have traditionally been under resourced by comparison to acute trusts.[1]

7.3.2 Causes of errors

In all of the 15 interviews undertaken with prescribers who had made prescribing errors, no-one was aware of their error until contacted in relation with this study. This is in line with the findings of other studies which have indicated that generally pharmacists concentrate on identifying and correcting errors rather than providing feedback on prescribing, which would allow prescribers to learn lessons and change behaviour.[13,431,432] If feedback is the "cornerstone of effective teaching"[427] this situation is undermining the ability of prescribers to learn from their errors.

In contrast to studies which have investigated the causes of errors in an acute setting, rule-based mistakes were the most common (8/21; 38.1%), followed by slips (7/21; 33.3%) which were more frequent than lapses. Other studies have tended to identify knowledge-based mistakes as the most common type of prescribing error.[15,26,173,174]

In line with previous studies,[13,26,27,113,187–189] prescribers cited being busy, workload, time pressures, multitasking, distractions and frequent interruptions as contributory factors relating to their work environment which promoted errors. Similarly, personal wellbeing including hunger and tiredness, exacerbated by working patterns, unfamiliar situations and lone-working were also mentioned. Factors cited by interview participants did not generally differ from those identified in earlier studies in other secondary care settings.

However, one point of note from the interviews was that as electronic prescribing systems have become more common in acute hospitals, particularly teaching

hospitals associated with training medical undergraduates, more junior doctors are joining the trust for psychiatry rotations with little or no experience of working with paper drug charts. This increases the risk of them making errors in what is an unfamiliar task. In addition, the absence of summary care record access for duty doctors and those working on-call outside traditional office hours when GP surgeries are closed, increases the likelihood of errors relating to the lack of accurate information about newly admitted patients' medicines.

7.3.3 Decision making characteristics

Participants in this element of the study correctly answered approximately half of the Cognitive Reflection Test questions on both the 3-item and 8-item versions with mean scores of 1.6 and 4.1 respectively. There were no statistically significant differences by gender, age or prescriber grade, despite gender differences having been found in the original CRT study.[226] Very few participants correctly answered all questions on either version of the tool, although on the 3-item version more were 'high' scorers and less were 'low' scorers. This may have been due to past exposure to some or all of the 3-item questions as the proportions of high and low scorers on the 8-item version were similar to that found the original study. A significant, but weak, positive correlation was found between experience and the number of correct CRT answers, whilst a moderate, negative correlation was found between experience and the number of 'intuitive' incorrect answers.

Overall, participants had higher mean rationality than experientiality scores measured using the Rational Experiential Inventory. Although men tended to have higher scores for rationality, and women for experientiality, there was no statistically significant differences by gender, age or prescriber grade; although there was a non-significant trend towards higher rationality scores with grade. The difference between mean rationality and experientiality scores was significant in all groups apart from those aged 21 - 29 and foundation trainees. The rationality scores were lower than seen in most other studies involving doctors.[230–232,238] This may reflect the fact that psychiatry relies more heavily on the interplay between biology, psychology, social circumstances and spiritual life than other medical specialties; described as the 'art of psychiatry' by Bloch.[400]

It was not possible to make direct comparison between the Need for Cognition Scale scores found in this study and in others, as differing scoring systems have been employed by various authors. However, the results did show that the participants in

this sample generally showed a tendency to organise, abstract and evaluate information.

Despite apparent trends, no statistically significant relationships were identified between performance on the CRT, REI or NCS scales and prescribing error rates. Therefore, thinking dispositions do not appear to provide a prediction of prescribing error performance, suggesting that more factors are involved in accurate and appropriate prescribing decisions than can be captured by such measurement.

The null hypothesis was therefore upheld of there being no statistically significant difference in the prevalence or nature of prescribing errors made by prescribers depending on thinking style.

7.3.4 Educational intervention

Only a small number of those for whom prescribing error rate was available attended the educational session on clinical decision making (32/212; 15%). Prescribing data were only available for 68% of those who attended, and only for one-quarter of participants was it available for both the pre-intervention and post-intervention periods.

Despite a statistically significant difference in the error rates for period one and two, these largely represented prescribing by different prescribers. For those that attended the educational session and for whom prescribing data were available, the composition of the unpaired groups pre- and post-intervention were quite different. There was no statistically significant difference in the error rates for the 12 prescribers who attended and for whom pre- and post-intervention data were available.

The null hypothesis was therefore upheld of there being no statistically significant difference in the prevalence or nature of prescribing errors made by prescribers after exposure to the educational intervention about clinical decision making.

7.4 Strengths and limitations

A potential limitation of the literature review which underpinned this thesis was the opportunity for omission of relevant publications including those not indexed in the standard reference databases. This was minimised by ‘snowballing’ (searching references of references), searching the ‘grey literature’, creating automatic citation alerts for key papers and subscription to the electronic ‘table of contents’ for many journals. Only papers published in English were inspected which may have excluded publications of relevance.

7.4.1 Prescribing errors

The main strengths of this aspect of the study were the large number of medication orders reviewed (nearly 13,700), that training was provided to ward pharmacists to try and minimise variations and subjectivity in data collection, and the inclusion of only newly written items, so that medication orders would only be counted once. Data collection was limited to one UK NHS trust and results may therefore not be generalisable to other organisations or other international settings as the range of services and sub-specialties provided can vary substantially between organisations.

Although medication orders were screened by pharmacists as part of their routine work, a method commonly used in prescribing error research,[19,147,189] failure to identify and/or record errors would result in an underestimate of the actual error rate. Completion of data reporting forms for the study may have been seen as additional work and not all pharmacists may have been motivated to the same degree. Even with training, interpretation of errors by multiple pharmacists could have been subjective with variation in error detection due to individual levels of expertise and workload,[275] and subjectivity in the assignment of severity scores.[6] It was not possible to include any quality assurance check to identify missed or unrecorded prescribing errors, which has been shown to increase error identification.[256] Data collection by a combination of methods including drug chart and retrospective record review may have identified a greater number of errors,[107,155] but was beyond the resources available. Data collection fatigue was minimised by intermittent data collection one week in four.

Use of pharmacists who were familiar with the doctors working on particular wards improved the correct identification of prescribers which is a known problem with handwritten prescriptions.[278,375] The identity and grade of the prescriber was unknown in only 1.2% of medication orders in this study, less than in others studies.[19,147,189] Minimising the number of unknown prescribers is also important if feedback is to be provided to improve the quality of prescribing and reduce errors.[13,18,422] Pharmacists recorded the details of the doctor who had signed the prescription, and there is evidence to suggest that other doctors may be involved in making prescribing decisions, particularly where junior doctors are involved.[112]

Data were collected for core, GP and higher specialty trainees, although this was not originally planned when the sample size was calculated, and the target number of medication orders were not calculated for this level of granularity.

7.4.2 Causes of errors

A small number of interviews were conducted with prescribers who had made prescribing errors within one UK NHS trust. Although this may affect the generalisability of the results to mental health settings, the findings were broadly similar to qualitative studies in non-mental health settings.[26,27,113,185,187,188] The distribution of interviews across grade of prescriber was relatively even, so the results are not likely to be skewed by the views of either junior or senior doctors. However, the self-selected nature of those who agreed to participate in interviews is a limitation as the views of those who did not participate may have been different.

The inclusion of specific incidents in the interviews, rather than asking for views on errors in general is a strength of the study. Prescribers who had made errors were presenting their own explanation of what had happened to the researcher; it is recognised that attribution bias may result in participants minimising their own liability in an error and accentuating contributory factors. They may also have answered in a manner what will be viewed favourably by the researcher, demonstrating social desirability bias. This may have been exacerbated due to the role within the organisation of the researcher who, as Chief Pharmacist, may have influenced the responses given by some interviewees. However, an attempt to mitigate against this was made by recruitment via the ward pharmacist, assurance of confidentiality, participants being reminded that participation was optional and that they could withdraw at any point and an attempt on the part of the researcher to remain objective and attempt to check for genuine responses through iterative questioning. Whilst it would have been ideal to involve a third party in conducting the interviews resource was not available to facilitate this option. The 'worldview' of the researcher may have influenced the emerging themes from the interviews, although as thematic analysis was undertaken against the theoretical framework of Reason's model of accident causation[23] this should have been minimised.

Prescribers were interviewed as soon as practical after the time of their error; however, it was often not possible to undertake interviews within the original planned timescale of 96 hours. This may have increased the likelihood of recall bias, but also allows time for reflection about the incident by the prescriber.

7.4.3 Decision-making characteristics

There were a number of limitations to the element of the study relating to the decision-making characteristics of prescribers. There was a high non-response rate to the questionnaire with a number of those who did participate providing partial responses;

therefore, the actual response rate was between 26.7% and 30.9% for different elements of the questionnaire. The answers of non-responders may have demonstrated different results, and voluntary participation may have created a selection bias. Due to the need to link responses with prescribing error data, questionnaires were not anonymous which may have led respondents to give answers which they felt were expected (social desirability bias). As the questionnaire was administered to most respondents online there was no opportunity for clarification of any misunderstanding in the wording of questions.

Although a potential strength was that the questionnaire contained established validated tools, inclusion of the questions from the original 3-item version of the CRT may have given rise to skewed results due to pre-exposure.[383] Prior exposure to the CRT was not measured and psychiatrists may have a higher likelihood to have come across the questions before. Equally, the REI-40 captures self-reported rational and experiential ability and preference and therefore may not be an accurate representation of how participants think in a clinical setting.

7.4.4 Educational intervention

The intervention was undertaken in a single organisation and had a limited number of participants, which limits the generalisability of the results. The primary assessment method was the number of prescribing errors before and after the educational session, but the numbers for whom prescribing data were available both pre- and post-intervention were very low, making firm conclusions impossible. This was mainly due to this high turnover of junior medical staff, due to psychiatry rotations, such that some who attended the educational session had left the organisation by the second data collection period.

7.5 What the research adds

This study supports recent findings that prescribing errors appear to be more common in a mental health setting than early studies suggested.[147] Whilst previous studies investigating the prevalence of prescribing errors in a UK mental health setting have analysed error rates at some level by prescriber grade[101,147] and stage in the patient's journey,[147] this study has provided a more granular analysis by prescriber grade than previous studies. It has looked in detail at prescribing error rates in relation to level of experience and identified a relationship, albeit weak, between them. It has also identified the steps in the drug use process most prone to error in this setting and related that to prescriber grade and stage. In addition, those drugs most commonly involved in prescribing errors have been identified by BNF section and at individual

drug level, with perhaps surprisingly in a mental health setting, paracetamol the drug most commonly associated with error. The study has confirmed the findings of other studies and in other settings that junior doctors are responsible for a higher proportion of errors, but has also identified that, in this trust at least, this group of prescribers are not responsible for the high proportions of overall prescribing seen in other studies in acute hospitals.[18,19,189]

In probably the first qualitative study of the causes of prescribing errors in a mental health setting, a very similar pattern of factors was seen to contribute to errors, confirming that regardless of setting, prescribing errors are associated with multifactorial causes, which are unlikely to be solved by simple solutions. However, of note was the fact that by generally lagging behind acute trusts in terms of implementation of technological advances (ePMA, SCR), junior doctors joining a mental health trust on a psychiatry rotation are placed at a disadvantage, with an increased potential for errors.

Whilst few studies have administered decision-making tools to medical staff, this may have been the first to use such tools in psychiatry, and to link the responses to the occurrence of prescribing errors. No relationship was found between prescribing error rates and thinking dispositions as measured by the CRT, REI-40 or NCS, suggesting that accurate and appropriate prescribing involves more factors than can be captured by measurement of thinking disposition. Of interest however, was the fact that participants appeared to have lower rationality scores than those found in other groups of doctors, as measured by the REI-40 tool.

The final element of this study demonstrated that, whilst having an impact on self-reported understanding of decision making, a brief educational intervention on clinical decision making had no impact on reducing prescribing error rates.

7.6 Recommendations for future research

Future research which may complement the study described in this thesis includes:

- adapting the data collection method used to investigate the prescribing error rate in community-based mental health services, where there is generally little pharmacy infrastructure available to prevent errors reaching the patient.

- investigating the impact on prescribing errors on admission where staff have access to patients' past medication history via the summary care record.

- further work to identify the most effective methods for pharmacists to provide 'real-time' feedback to prescribers on their prescribing to promote on-going active learning.

- a larger study into the thinking dispositions of psychiatrists to identify whether there really is a difference in the rationality / experientiality profile of this group of professionals which would inform methods for influencing prescribers in the future.

- further investigations into multifactorial interventions to reduce prescribing errors.

7.7 Closing thoughts

In 2004, Edmondson argued that healthcare does not learn from errors as a result of two interrelated and powerful organisational issues. Firstly, voicing questions, concerns, and challenges that might intercept and prevent errors is often inhibited by interpersonal culture, and admission of error is discouraged. Secondly, the responses to failure are often workarounds and quick fixes, rather than systematic problem solving and root cause analysis. He emphasised that "an organisation learns when its teams learn" and that learning from failure requires substantial effort to create new beliefs and behaviour that support such learning.[445]

These views were expressed not long after the publication of key reports about patient safety in both the US[50] and the UK,[51,52] and the creation of the NPSA in the UK. The fact that more than half a million incident reports were submitted to the NRLS for the period October to December 2017, a five-fold increase on the number of reports during the same quarter in 2005,[446] hopefully reflects that in the intervening years improvements have been made in relation to these organisational issues. However, Edmondson's views about the role of leaders and team learning remain valuable, and feedback on prescribing errors is likely to be a key element in reducing their occurrence.

References

1. Commission for Healthcare Audit and Inspection. Talking about medicines. The management of medicines in trusts providing mental health services. London; 2007.
2. Care Quality Commission. Community Mental Health Survey. 2017.
3. Aitken M, Gorokhovich L. Advancing the responsible use of medicines: applying levers for change. IMS Institute for Healthcare Informatics; 2012.
4. World Health Organisation. Medication Without Harm. Geneva; 2017.
5. World Health Organisation. Medication Without Harm: WHO's Third Global Patient Safety Challenge [Internet]. [cited 2018 Aug 11]. Available from: http://www.who.int/patientsafety/medication-safety
6. Elliott RA, Camacho E, Campbell F, Jankovic D, Martyn St James M, Kaltenthaler E, et al. Prevalence and economic burden of medication errors in the NHS in England. Policy Research Unit in Economic Evaluation of Health & Care Interventions. Universities of Sheffield and York; 2018.
7. Department of Health & Social Care. The report of the short life working group on reducing medication-related harm. 2018.
8. Bhalla N, Duggan C, Dhillon S. The incidence and nature of drug-related admissions to hospital. Pharm J. 2003;270:583–6.
9. Howard R, Avery A, Howard P, Partridge M. Investigation into the reasons for preventable drug related admissions to a medical admissions unit: observational study. Qual Saf Health Care. 2003;12(4):280–5.
10. Pirmohamed M, James S, Meakin S, Green C, Scott AK, Walley TJ, et al. Adverse drug reactions as cause of admission to hospital: prospective analysis of 18 820 patients. BMJ. 2004;329(7456):15–9.
11. Cousins DH, Gerrett D, Warner B. A review of medication incidents reported to the National Reporting and Learning System in England and Wales over 6 years (2005 – 2010). Br J Clin Pharmacol. 2011;74(4):597–604.
12. Bates DW, Cullen DJ, Laird N, Petersen LA, Small SD, Servi D, et al. Incidence of adverse drug events and potential adverse drug events. Implications for prevention. JAMA. 1995;274(1):29–34.
13. Franklin BD, Reynolds M, Atef Shebl N, Burnett S, Jacklin A. Prescribing errors in hospital inpatients: a three-centre study of their prevalence, types and causes. Postgrad Med J. 2011;87(1033):739–45.
14. Dean B, Schachter M, Vincent C, Barber N. Prescribing errors in hospital inpatients: their incidence and clinical significance. Qual Saf Health Care. 2002;11(4):340–4.
15. Leape LL, Bates DW, Cullen DJ, Cooper J, Demonaco HJ, Gallivan T, et al. Systems analysis of adverse drug events. JAMA. 1995;274(1):35–43.
16. Lesar TS, Briceland L, Stein DS. Factors related to errors in medication prescribing. JAMA. 1997;277(4):312–7.
17. Lewis PJ, Dornan T, Taylor D, Tully MP, Wass V, Ashcroft DM. Prevalence, incidence and nature of prescribing errors in hospital inpatients: a systematic review. Drug Saf. 2009;32(5):379–89.
18. Dornan T, Ashcroft D, Heathfield H, Lewis P, Miles J, Taylor D, et al. An in depth investigation into causes of prescribing errors by foundation trainees in relation to their medical education. EQUIP study. General Medical Council; 2009.
19. Ashcroft DM, Lewis PJ, Tully MP, Farragher TM, Taylor D, Wass V, et al. Prevalence, nature, severity and risk factors for prescribing errors in hospital inpatients: prospective study in 20 UK hospitals. Drug Saf. 2015;38(9):833–43.
20. Lesar TS, Briceland LL, Delcoure K, Parmalee JC, Masta-Gornic V, Pohl H. Medication prescribing errors in a teaching hospital. JAMA. 1990;263(17):2329–34.

21. Ross S, Bond C, Rothnie H, Thomas S, Macleod MJ. What is the scale of prescribing errors committed by junior doctors? A systematic review. Br J Clin Pharmacol. 2009;67(6):629–40.
22. Schachter M. The epidemiology of medication errors: how many, how serious? Br J Clin Pharmacol. 2009;67(6):621–3.
23. Reason J. Human Error. Cambridge University Press; 1990.
24. Aronson JK. Medication errors: definitions and classification. Br J Clin Pharmacol. 2009;67(6):599–604.
25. Dean B, Barber N, Schachter M. What is a prescribing error? Qual Health Care. 2000;9(4):232–7.
26. Coombes ID, Stowasser DA, Coombes JA, Mitchell C. Why do interns make prescribing errors? A qualitative study. Med J Aust. 2008;188(2):89–94.
27. Dean B, Schachter M, Vincent C, Barber N. Causes of prescribing errors in hospital inpatients: a prospective study. Lancet. 2002;359(9315):1373–8.
28. Duncan EM, Francis JJ, Johnston M, Davey P, Maxwell S, McKay GA, et al. Learning curves, taking instructions, and patient safety: using a theoretical domains framework in an interview study to investigate prescribing errors among trainee doctors. Implement Sci. 2012;7(1):86.
29. Hallas J, Harvalid B, Gram L, Grodum E, Brosen K, Haghfelt T, et al. Drug related hospital admissions: the role of definitions and intensity of data collection, and the possibility of prevention. J Intern Med. 1990;228(2):83–90.
30. Barker KN, McConnell WE. The problems of detecting medication errors in hospitals. Am J Hosp Pharm. 1962;19:361–70.
31. Tesh DE, Beeley L, Clewett A, Walker G. Errors of drug prescribing. Br J Clin Pharmacol. 1975;2(5):403–9.
32. Betz R, Levy H. An interdisciplinary method of classifying and monitoring medication errors. Am J Hosp Pharm. 1985;42(8):1724–32.
33. Brennan TA, Leape LL, Laird NM, Hebert L, Localio AR, Lawthers AG, et al. Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. N Engl J Med. 1991;324(6):370–6.
34. Leape LL, Brennan TA, Laird N, Lawthers AG, Localio AR, Barnes BA, et al. The nature of adverse events in hospitalised patients. Results of the Harvard Medical Practice Study II. N Engl J Med. 1991;324(6):377–84.
35. Wilson RM, Runciman WB, Gibberd RW, Harrison BT, Newby L, Hamilton JD. The Quality in Australian Health Care Study. Med J Aust. 1995;163(9):458–71.
36. Thomas E, Studdert D, Burstin H, Orav E, Zeena T, Williams E, et al. Incidence and types of adverse events and negligent care in Utah and Colorado. Med Care. 2000;38(3):261–71.
37. Vincent C, Neale G, Woloshynowych M. Adverse events in British hospitals: preliminary retrospective record review. BMJ. 2001;322(7285):517–9.
38. Neale G, Woloshynowych M, Vincent C. Exploring the causes of adverse events in NHS hospital practice. J R Soc Med. 2001;94(7):322–30.
39. Bates DW, Leape LL, Petrycki S. Incidence and preventability of adverse drug events in hospitalized adults. J Gen Intern Med. 1993;8(6):289–91.
40. Bates DW, Boyle DL, Vander Vliet MB, Schneider J, Leape L. Relationship between medication errors and adverse drug events. J Gen Intern Med. 1995;10(4):199–205.
41. Bates DW, Spell N, Cullen DJ, Burdick E, Laird N, Petersen LA, et al. The costs of adverse drug events in hospitalized patients. JAMA. 1997;277(4):307–11.
42. Classen D, Pestotnik S, Evans R, Burke J. Computerized surveillance of adverse drug events in hospital patients. JAMA. 1991;266(20):2847–51.
43. Classen DC, Pestotnik SL, Evans RS, Lloyd JF, Burke JP. Adverse drug events in

hospitalized patients: excess length of stay, extra costs, and attributable mortality. JAMA. 1997;227(4):301–6.

44. Lesar TS, Lomaestro BM, Phol H. Medication-prescribing errors in a teaching hospital. A 9-year experience. Arch Intern Med. 1997;157(14):1569–76.
45. Lesar TS. Errors in the use of medication dosage equations. Arch Pediatr Adolesc Med. 1998;152(4):340–4.
46. Dean B, Allan EL, Barber ND, Barker KN. Comparison of medication errors in an American and British hospital. Am J Health Syst Pharm. 1995;52(22):2543–9.
47. Vincent C. Patient Safety. 2nd ed. Oxford: Wiley-Blackwell Publishing Ltd.; 2010.
48. Leape L, Berwick D. Safe health care: are we up to it? BMJ. 2000;320(7237):725–6.
49. Reason J. Human error: models and management. BMJ. 2000;320(7237):768–70.
50. Kohn LT, Corrigan JM, Donaldson MS, editors. To Err is Human: Building a Safer Health System. Washington DC; 1999.
51. Chief Medical Officer. An organisation with a memory. Report of an expert group on learning from adverse events in the NHS. London; 2000.
52. Department of Health. Building a safer NHS for patients. Implementing an organisation with a memory. London; 2001.
53. Smith J. Building a safer NHS for patients: Improving medication safety. London; 2004.
54. Pelaccia T, Tardif J, Triby E, Charlin B. An analysis of clinical reasoning through a recent and comprehensive approach: the dual-process theory. Med Educ Online. 2011;16:5890.
55. Maskrey N, Hutchinson A, Underhill J. Getting a better grip on research: the comfort of opinion. InnovAiT. 2009;2(11):679–86.
56. Harries C, Evans JSB, Dennis I, Dean J. A clinical judgement analysis of prescribing decisions in general practice. Trav Hum. 1996;59(1):87–109.
57. Croskerry P. Profiles in Patient Safety: Medication Errors in the Emergency Department. Acad Emerg Med. 2004;11(3):289–99.
58. Denig P, Witteman C, Schouten H. Scope and nature of prescribing decisions made by general practitioners. Qual Saf Health Care. 2002;11(2):137–43.
59. Richir MC, Tichelaar J, Geijteman EC, de Vries TP. Teaching clinical pharmacology and therapeutics with an emphasis on the therapeutic reasoning of undergraduate medical students. Eur J Clin Pharmacol. 2008;64(2):217–24.
60. Smith L, Gilhooly K. Regression versus fast and frugal models of decision-making: the case of prescribing for depression. Appl Cogn Psychol. 2006;20(2):265–74.
61. Denig P. Therapeutic decision making of physicians. Pharm Weekbl Sci. 1992;14(1):9–15.
62. Gilovich T, Griffin D. Heuristics and Biases: Then and Now. In: Gilovich T, Griffin D, Kahneman D, editors. Heuristics and Biases The Psychology of Intuitive Judgement. New York: Cambridge University Press; 2002.
63. Simon HA. Rational decision-making in business organizations (Nobel Memorial Lecture, 8 December 1978). Economic Sciences. 1978. p. 343–71.
64. Crowley R, Legowski E, Medvedeva O, Reitmeyer K, Tseytlin E, Castine M. Automated detection of heuristics and biases among pathologists in a computer-based system. Adv Health Sci Educ Theory Pract. 2013;18(3):343–63.
65. Wood TJ. Is it time to move beyond errors in clinical reasoning and discuss accuracy? Adv Health Sci Educ Theory Pract. 2014;19(3):403–7.
66. Croskerry P. Achieving quality in clinical decision making: cognitive strategies and detection of bias. Acad Emerg Med. 2002;9(11):1184–204.
67. Croskerry P. The importance of cognitive errors in diagnosis and strategies to

minimize them. Acad Med. 2003;78(8):775–80.

68. Graber M, Gordon R, Franklin N. Reducing diagnostic errors in medicine: what's the goal? Acad Med. 2002;77(10):981–92.

69. Bornstein B, Emler A. Rationality in medical decision making: a review of the literature on doctors' decision-making biases. J Eval Clin Pract. 2001;7(2):97–107.

70. Eva KW, Norman GR. Heuristics and biases - a biased perspective on clinical reasoning. Med Educ. 2005;39(9):870–2.

71. Norman GR, Eva KW. Diagnostic error and clinical reasoning. Med Educ. 2010;44(1):94–100.

72. Norman G. Dual processing and diagnostic errors. Adv Health Sci Educ Theory Pract. 2009;14(Suppl 1):37–49.

73. Norman GR, Monteiro SD, Sherbino J, Ilgen JS, Schmidt HG, Mamede S. The causes of errors in clinical reasoning: cognitive biases, knowledge deficits, and dual process thinking. Acad Med. 2017;92(1):23–30.

74. Lisby M, Nielsen L, Brock B, Mainz J. How are medication errors defined? A systematic literature review of definitions and characteristics. Int J Qual Health Care. 2010;22(6):507–18.

75. Yu K, Nation R, Dooley M. Multiplicity of medication safety terms, definitions and functional meanings: when is enough enough? Qual Saf Health Care. 2005;14(5):358–63.

76. National Coordinating Council for Medication Error Reporting and Prevention. About medication errors: What is a medication error [Internet]. 2014 [cited 2018 Jun 30]. Available from: http://www.nccmerp.org/about-medication-errors

77. Pintor-Marmol A, Baena MI, Fajardo PC, Sabater-Hernandez D, Saez-Benito L, Garcia-Cardenas MV, et al. Terms used in patient safety related to medication: a literature review. Pharmacoepidemiol Drug Saf. 2012;21(8):799–809.

78. American Society of Hospital Pharmacists. ASHP guidelines on preventing medication errors in hospitals. Am J Hosp Pharm. 1993;50(2):305–14.

79. Barker KN, Flynn EA, Pepper GA, Bates DW, Mikeal RL. Medication errors observed in 36 health care facilities. Arch Intern Med. 2002;162(16):1897–903.

80. Barker KN, Mikeal RL, Pearson RE, Illig NA, Morse ML. Medication errors in nursing homes and small hospitals. Am J Hosp Pharm. 1982;39(6):987–91.

81. Flynn EA, Barker KN, Pepper GA, Bates DW, Mikeal RL. Comparison of methods for detecting medication errors in 36 hospitals and skilled-nursing facilities. Am J Health Syst Pharm. 2002;59(5):436–46.

82. Allan EL, Barker KN. Fundamentals of medication error research. Am J Hosp Pharm. 1990;47(3):555–71.

83. Ferner RE, Aronson JK. Clarification of terminology in medication errors: definitions and classification. Drug Saf. 2006;29(11):1011–22.

84. Ferner R, Aronson J. Errors in prescribing, preparing, and giving medicines - definition, classification, and prevention. In: Aronson J, editor. Side Effects of Drugs Annual. Volume 22. Elsevier, Amsterdam; 1999. p. xxiii–xxxvi.

85. Aronson J. Medication errors: what they are, how they happen, and how to avoid them. Q J Med. 2009;102(8):513–21.

86. Lisby M, Nielsen L, Brock B, Mainz J. How should medication errors be defined? Development and test of a definition. Scand J Public Health. 2012;40(2):203–10.

87. Lisby M, Nielsen L, Mainz J. Errors in the medication process: frequency, type, and potential clinical consequences. Int J Qual Health Care. 2005;17(1):15–22.

88. Aronson JK, Ferner RE. Clarification of terminology in drug safety. Drug Saf. 2005;28(10):851–70.

89. Gandhi T, Seger D, Bates D. Identifying drug safety issues: from research to practice.

Int J Qual Health Care. 2000;12(1):69–76.

90. Morimoto T, Gandhi T, Seger A, Hsieh T, Bates D. Adverse drug events and medication errors: Detection and classification methods. Qual Saf Health Care. 2004;13(4):306–14.

91. Morimoto T, Sakuma M, Matsui K, Kuramoto N, Toshiro J, Murakami J, et al. Incidence of adverse drug events and medication errors in Japan: The JADE study. J Gen Intern Med. 2011;26(2):148–53.

92. World Health Organisation. Safety monitoring of medicinal products. Guidelines for setting up and running a pharmacovigilance centre. London: EQUUS; 2000.

93. Laurence D, Carpenter J, editors. A dictionary of pharmacology and allied topics. Amsterdam: Elsevier; 1998.

94. Edwards I, Aronson J. Adverse drug reactions: definitions, diagnosis, and management. Lancet. 2000;356(9237):1255–9.

95. Heinrick HW, Petersen D, Roos NR. Industrial accident prevention: a safety management approach. 5th ed. New York: McGraw-Hill; 1980.

96. Yousuf MI. Using experts' opinions through Delphi technique. Practical Assessment, Research & Evaluation. 2007;12(4).

97. McMillan SS, King M, Tully MP. How to use the nominal group and Delphi techniques. Int J Clin Pharm. 2016;38(3):655–62.

98. Robson C. Real World Research: a resource for social scientists and practitioner-researchers. 2nd ed. Oxford: Blackwell Publishing Ltd; 2002.

99. Stubbs J, Haw C, Cahill C. Auditing prescribing errors in a psychiatric hospital. Are pharmacists' interventions effective? Hosp Pharm. 2004;11(5):203–6.

100. Haw C, Stubbs J. Prescribing errors at a psychiatric hospital. Pharm Pract. 2003;13(2):64–6.

101. Stubbs J, Haw C, Taylor D. Prescription errors in psychiatry - a multi-centre study. J Psychopharmacol. 2006;20(4):553–61.

102. Ferner RE. The epidemiology of medication errors: the methodological difficulties. Br J Clin Pharmacol. 2009;67(6):614–20.

103. Kane-Gill SL, Devlin JW. Adverse drug event reporting in intensive care units: a survey of current practices. Ann Pharmacother. 2006;40(7–8):1267–73.

104. Avery T, Barber N, Franklin BD, Dhillon S. Investigating the prevalence and causes of prescribing errors in general practice : The PRACtICe Study (PRevalence And Causes of prescribing errors in general practiCe) A report for the GMC. 2012.

105. Franklin BD, McLeod M, Barber N. Comment on 'Prevalence , Incidence and Nature of Prescribing Errors in Hospital Inpatients : A Systematic Review' [letter]. Drug Saf. 2010;33(2):163–6.

106. Meyer-Massetti C, Cheng CM, Schwappach DL, Paulsen L, Ide B, Meier CR, et al. Systematic review of medication safety assessment methods. Am J Health Syst Pharm. 2011;68(3):227–39.

107. Westbrook JI, Li L, Lehnbom EC, Baysari MT, Braithwaite J, Burke R, et al. What are incident reports telling us? A comparative study at two Australian hospitals of medication errors identified at audit, detected by staff and reported to an incident system. Int J Qual Health Care. 2015;27(1):1–9.

108. Franklin B, O'Grady K, Donyai P, Jacklin A, Barber N. The impact of a closed-loop electronic prescribing and administration system on prescribing errors, administration errors and staff time: A before-and-after study. Qual Saf Health Care. 2007;16(4):279–84.

109. Dobrzanski S, Hammond I, Khan G, Holdsworth H. The nature of hospital prescribing errors. Br J Clin Gov. 2002;7(3):187–93.

110. Lewis PJ, Dornan T, Taylor D, Tully MP, Wass V, Ashcroft DM. Authors reply to

"Comment on 'Prevalence , Incidence and Nature of Prescribing Errors in Hospital Inpatients : A Systematic Review'" [letter]. Drug Saf. 2010;33(2):163–6.

111. Ryan C, Bond C, Ross S, Davey P, Francis J, Johnston M, et al. The perceived causes of prescribing errors made by junior doctors in Scottish hospitals [abstract]. Int J Pharm Pract. 2012;20(Suppl 1):15.

112. Ross S, Hamilton L, Ryan C, Bond C. Who makes prescribing decisions in hospital inpatients? An observational study. Postgrad Med J. 2012;88(1043):507–10.

113. Ross S, Ryan C, Duncan EM, Francis JJ, Johnston M, Ker JS, et al. Perceived causes of prescribing errors by junior doctors in hospital inpatients: a study from the PROTECT programme. BMJ Qual Saf. 2013;22(2):97–102.

114. Ryan C, Ross S, Davey P, Duncan EM, Fielding S, Francis JJ, et al. Junior doctors' perceptions of their self-efficacy in prescribing, their prescribing errors and the possible causes of errors. Br J Clin Pharmacol. 2013;76(6):980–7.

115. Grasso B, Rothschild J, Genest R, Bates D. What do we know about medication errors in inpatient psychiatry? Jt Comm J Qual Patient Saf. 2003;29(8):391–400.

116. Grasso BC. Medication errors in psychiatric care: incidence and reduction strategies. J Pharm Financ Econ Policy. 2006;15(4):73–108.

117. Maidment ID, Lelliott P, Paton C. Medication errors in mental healthcare: a systematic review. Qual Saf Health Care. 2006;15(6):409–13.

118. Maidment ID, Haw C, Stubbs J, Fox C, Katona C, Franklin BD. Medication errors in older people with mental health problems: a review. Int J Geriatr Psychiatry. 2008;23(6):564–73.

119. Procyshyn RM, Barr AM, Brickell T, Honer WG. Medication errors in psychiatry: a comprehensive review. CNS Drugs. 2010;24(7):595–609.

120. Alshehri GH, Keers RN, Ashcroft DM. Frequency and nature of medication errors and adverse drug events in mental health hospitals: a systematic review. Drug Saf. 2017;40(10):871–86.

121. Grasso BC, Genest R, Jordan CW, Bates DW. Use of chart and record reviews to detect medication errors in a state psychiatric hospital. Psychiatr Serv. 2003;54(5):677–81.

122. Bates D, Leape L, Cullen D, Laird N, Petersen L, Teich J, et al. Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. JAMA. 1998;280(15):1311–6.

123. Senst B, Achusim L, Genest R, Cosentino L, Ford C, Little J, et al. A practical approach to determining costs and frequency of adverse drug events in a health care network. Am J Health Syst Pharm. 2001;58(12):1126–32.

124. Maidment ID, Thorn A. A medication error reporting scheme: analysis of the first 12 months. Psychiatr Bull R Coll Psychiatr. 2005;29(8):298–301.

125. Ito H, Yamazumi S. Common types of medication errors on long-term psychiatric care units. Int J Qual Health Care. 2003;15(3):207–12.

126. Haw CM, Dickens G, Stubbs J. A review of medication administration errors reported in a large psychiatric hospital in the United Kingdom. Psychiatr Serv. 2005;56(12):1610–3.

127. Nirodi P, Mitchell A. The quality of psychotropic drug prescribing in patients in psychiatric units for the elderly. Aging Ment Health. 2002;6(2):191–6.

128. Paton C, Gill-Banham S. Prescribing errors in psychiatry. Psychiatr Bull R Coll Psychiatr. 2003;27(6):208–10.

129. Haw C, Stubbs J, Dickens G. An observational study of medication administration errors in old-age psychiatric inpatients. Int J Qual Health Care. 2007;19(4):210–6.

130. Rothschild JM, Mann K, Keohane CA, Williams DH, Foskett C, Rosen SL, et al. Medication safety in a psychiatric hospital. Gen Hosp Psychiatry. 2007;29(2):156–62.

131. Lefebvre C, Manheimer E, Glanville J, on behalf of the Cochrane Information Retrieval Methods Group. Searching for studies. In: Higgins JP, Green S, editors. Cochrane Handbook for Systematic Reviews of Interventions. 5.1.0. 2011.

132. Stupalski KA, Russell GE. Reported medication errors in community residences for individuals with mental retardation: a quality review. Ment Retard. 1999;37(2):139–46.

133. Grasso BC, Genest R, Yung K, Arnold C. Reducing errors in discharge medication lists by using personal digital assistants. Psychiatr Serv. 2002;53(10):1325–6.

134. Sawamura K, Ito H, Yamazumi S, Kurita H. Interception of potential adverse drug events in long-term psychiatric care units. Psychiatry Clin Neurosci. 2005;59(4):379–84.

135. Dickens G, Calvert J. Reducing medication administration errors in learning disability nursing. Nurse Prescribing. 2007;4(11):470–5.

136. Shawahna R, Rahman N-U. Prescribing errors in psychiatry department: an audit from a hospital in Lahore. J Pak Psychiatr Soc. 2008;5(1):31–3.

137. Sirithongthavorn S, Narkpongphun A, Kamduang N, Isarapongs P, Kanjanarat P. Common types of medication errors of outpatient service in pediatric psychiatry care [abstract]. Pharmacoepidemiol Drug Saf. 2009;18(Suppl 1):S245-6.

138. Jhanjee A, Bhatia M. Prescription errors - A cross-sectional study [abstract]. Asian J Psychiatr. 2011;4(Suppl 1):S72-3.

139. Keers R, Williams S. Investigating the quality and safety of discharge prescriptions in mental health hospitals: a prospective multicentre study [Abstract]. Int J Pharm Pract. 2015;23(Suppl S1):2.

140. Sahithi HK, Mohammad I, Manoranjani Reddy J, Nandha Kishore G, Ramesh M, Sebastian J. Assessment of medication errors in psychiatry practice in a tertiary care hospital. Int J Pharm Sci Res. 2015;6(1):226–32.

141. Scott H, Brown D, Herrera H. Prevalence and nature of prescribing errors in a mental health setting: analysis of preliminary data from a prospective study [Abstract]. Int J Pharm Pract. 2016;24(Suppl 3):8.

142. Ayani N, Sakuma M, Morimoto T, Kikuchi T, Watanabe K, Narumoto J, et al. The epidemiology of adverse drug events and medication errors among psychiatric inpatients in Japan: the JADE study. BMC Psychiatry. 2016;16(1):303.

143. Haw C, Cahill C. A computerized system for reporting medication events in psychiatry: the first two years of operation. J Psychiatr Ment Health Nurs. 2011;18(4):308–16.

144. Higuchi A, Higami Y, Takahama M, Yamakawa M, Makimoto K. Potential underreporting of medication errors in a psychiatric general hospital in Japan. Int J Nurs Pract. 2015;21(2):2–8.

145. Jayaram G, Doyle D, Steinwachs D, Samuels J. Identifying and reducing medication errors in psychiatry: creating a culture of safety through the use of an adverse event reporting mechanism. J Psychiatr Pract. 2011;17(2):81–9.

146. Jhanjee A, Bhatia M, Oberoi A, Srivastava S. Medication errors in psychiatric practice - a cross-sectional study. Delhi Psychiatry J. 2012;15(1):5–13.

147. Keers RN, Williams SD, Vattakatuchery JJ, Brown P, Miller J, Prescott L, et al. Prevalence, nature and predictors of prescribing errors in mental health hospitals: a prospective multicentre study. BMJ Open. 2014;4(9):e006084.

148. Keers R, Williams S, Vattakatuchery J, Brown P, Miller J, Prescott L, et al. Medication safety at the interface: evaluating risks associated with discharge prescriptions from mental health hospitals. J Clin Pharm Ther. 2015;40(6):645–54.

149. Soerensen A, Lisby M, Nielsen L, Poulsen B, Mainz J. The medication process in a psychiatric hospital: are errors a potential threat to patient safety? Risk Manag Healthc Policy. 2013;6:23–31.

150. Morcos S, Francis S-A, Duggan C. Where are the weakest links? A descriptive study

of discrepancies in prescribing between primary and secondary sectors of mental health service provision. Psychiatr Bull R Coll Psychiatr. 2002;26(10):371–4.

151. Murphy K, Coombes I, Moudgil V, Patterson S, Wheeler A. Clozapine and concomitant medications: assessing the completeness and accuracy of medication records for people prescribed clozapine under shared care arrangements. J Eval Clin Pract. 2017;23(6):1164–72.

152. Nelson L, Graham M, Schaefer M. Characterization of medication discrepancies occurring at the time of discharge from a state psychiatric inpatient facility [Abstract]. J Pharm Pract. 2010;23(2):153–4.

153. de Vries T, Henning R, Hogerzeil H, Fresle D. Guide to Good Prescribing. World Health Organisation; 1994.

154. Shawahna R, Masri D, Al-Gharabeh R, Deek R, Al-Thayba L, Halaweh M. Medication administration errors from a nursing viewpoint: a formal consensus of definition and scenarios using a Delphi technique. J Clin Nurs. 2016;25(3–4):412–23.

155. Franklin BD, Birch S, Savage I, Wong I, Woloshynowych M, Jacklin A, et al. Methodological variability in detecting prescribing errors and consequences for the evaluation of interventions. Pharmacoepidemiol Drug Saf. 2009;18(11):992–9.

156. Vincent C, Taylor-Adams S, Stanhope N. Framework for analysing risk and safety in clinical medicine. BMJ. 1998;316(7139):1154–7.

157. Reason J. Managing the risks of organizational accidents. Aldershot: Ashgate Publishing Ltd; 1997.

158. Vincent C, Burnett S, Carthey J. The measurement and monitoring of safety. The Health Foundation; 2013.

159. Vincent C, Taylor-Adams S, Chapman E, Hewett D, Prior S, Strange P, et al. How to investigate and analyse clinical incidents: clinical risk unit and association of litigation and risk management protocol. BMJ. 2000 Mar 18;320(7237):777–81.

160. Taylor-Adams S, Vincent C. Systems analysis of clinical incidents: The London protocol. London: Clinical Safety Research Unit; 2004.

161. Lawton R, McEachan RR, Giles SJ, Sirriyeh R, Watt IS, Wright J. Development of an evidence-based framework of factors contributing to patient safety incidents in hospital settings: a systematic review. BMJ Qual Saf. 2012;21(5):369–80.

162. World Health Organisation. Conceptual Framework for the International Classification for Patient Safety. Geneva; 2009.

163. Vincent C. The Essentials of Patient Safety. London; 2011.

164. Reason JT. Understanding adverse events: the human factor. In: Vincent C, editor. Clinical Risk Management: Enhancing Patient Safety. 2nd ed. London: BMJ Books; 2001.

165. Raban MZ, Westbrook JI. Are interventions to reduce interruptions and errors during medication administration effective?: a systematic review. BMJ Qual Saf. 2014;23(8):414–21.

166. National Patient Safety Agency. Introduction to human error theory [Internet]. [cited 2014 Jul 26]. Available from: https://report.npsa.nhs.uk/rcatoolkit/course/resources_main.htm

167. Puaar SJ, Franklin BD. Impact of an inpatient electronic prescribing system on prescribing error causation: a qualitative evaluation in an English hospital. BMJ Qual Saf. 2018;27(7):529–38.

168. The Shipman Inquiry [Internet]. [cited 2014 Oct 5]. Available from: http://webarchive.nationalarchives.gov.uk/20050202182438/http://the-shipman-inquiry.org.uk/home.asp

169. Ford R. Killer nurse Beverly Allitt to serve 30 years [Internet]. The Times. 2007 [cited 2014 Oct 5]. Available from: http://www.thetimes.co.uk/tto/news/uk/crime/article1873623.ece

170. Hamilton F. Nurse found guilty of killing two Stepping Hill patients with insulin [Internet]. The Times. 2015 [cited 2015 Jul 27]. Available from: http://www.thetimes.co.uk/tto/news/uk/crime/article4443811.ece

171. Toft B. External Inquiry into the adverse incident that occurred at Queen's Medical Centre, Nottingham, 4th January 2001. London: Department of Health; 2001.

172. Tully MP, Ashcroft DM, Dornan T, Lewis PJ, Taylor D, Wass V. The causes of and factors associated with prescribing errors in hospital inpatients: a systematic review. Drug Saf. 2009;32(10):819–36.

173. Buckley MS, Erstad BL, Kopp BJ, Theodorou AA, Priestley GR. Direct observation approach for detecting medication errors and adverse drug events in a pediatric intensive care unit. Pediatr Crit Care Med. 2007;8(2):145–52.

174. Kopp B, Erstad B, Allen M, Theodorou A, Priestley G. Medication errors and adverse drug events in an intensive care unit: Direct observation approach for detection. Crit Care Med. 2006;34(2):415–25.

175. Lederman R, Parkes C. Systems failure in hospitals - using Reason's model to predict problems in a prescribing information system. J Med Syst. 2005;29(1):33–43.

176. Patterson E, Cook R, Woods D, Render M. Examining the complexity behind a medication error: generic patterns in communication. IEEE Trans Syst Man Cybern A Syst Hum. 2004;34(6):749–56.

177. Wilson D, McArtney R, Newcombe R, McArtney R, Gracie J, Kirk C, et al. Medication errors in paediatric practice: insights from a continuous quality improvement approach. Eur J Pediatr. 1998;157(9):769–74.

178. Colpaert K, Claus B, Somers A, Vandewoude K, Robays H, Decruyenaere J. Impact of computerized physician order entry on medication prescription errors in the intensive care unit: A controlled cross-sectional trial. Crit Care. 2006;10(1):R21.

179. Fijn R, van den Bemt P, Chow M, de Blaey C, de Jong-van den Berg L, Brouwers J. Hospital prescribing errors: epidemiological assessment of predictors. Br J Clin Pharmacol. 2002;53(3):326–31.

180. Folli HL, Poole RL, Benitz WE, Russo JC. Medication error prevention by clinical pharmacists in two children's hospitals. Pediatrics. 1987;79(5):718–22.

181. Hendey GW, Barth BE, Soliz T. Overnight and postcall errors in medication orders. Acad Emerg Med. 2005;12(7):629–34.

182. Ho L, Brown G, Millin B. Characterization of errors detected during central order review. Can J Hosp Pharm. 1992;45(5):193–7.

183. Mandal K, Fraser S. The incidence of prescribing errors in an eye hospital. BMC Ophthalmol. 2005;5(4).

184. Vrca VB, Bećirević-Laćan M, Bozikov V, Birus M. Prescribing medication errors in hospitalised patients: a prospective study. Acta Pharm. 2005;55(2):157–67.

185. Ajemigbitse A, Omole M, Osi-Ogbu O, Erhun W. A qualitative study of causes of prescribing errors among junior medical doctors in a Nigeria in-patient setting. Ann Afr Med. 2013;12(4):223–31.

186. Fahrenkopf AM, Sectish TC, Barger LK, Sharek PJ, Lewin D, Chiang VW, et al. Rates of medication errors among depressed and burnt out residents: prospective cohort study. BMJ. 2008;336(7642):488–91.

187. Lewis PJ, Ashcroft DM, Dornan T, Taylor D, Wass V, Tully MP. Exploring the causes of junior doctors' prescribing mistakes: a qualitative study. Br J Clin Pharmacol. 2014;78(2):310–9.

188. Nichols P, Copeland T-S, Craib IA, Hopkins P, Bruce DG. Learning from error: identifying contributory causes of medication errors in an Australian hospital. Med J Aust. 2008;188(5):276–9.

189. Ryan C, Ross S, Davey P, Duncan EM, Francis JJ, Fielding S, et al. Prevalence and causes of prescribing errors: the PRescribing Outcomes for Trainee Doctors

Engaged in Clinical Training (PROTECT) study. PLoS One. 2014;9(1):e79802.

190. Slight S, Howard R, Ghaleb M, Barber N, Franklin B, Avery A. The causes of prescribing errors in English general practices: a qualitative study. Br J Gen Pract. 2013;63(615):e713-20.

191. Pennycook G, Fugelsang JA, Koehler DJ. What makes us think? A three-stage dual-process model of analytic engagement. Cogn Psychol. 2015;80:34–72.

192. Evans JSB. Dual-process theories of reasoning: Contemporary issues and developmental applications. Dev Rev. 2011;31(2–3):86–102.

193. Sloman SA. The empirical case for two systems of reasoning. Psychol Bull. 1996;119(1):3–22.

194. Evans JSB. In two minds: dual-process accounts of reasoning. Trends Cogn Sci. 2003;7(10):454–9.

195. Evans JSB. The heuristic-analytic theory of reasoning: Extension and evaluation. Psychon Bull Rev. 2006;13(3):378–95.

196. Evans JSB. Two minds rationality. Think Reason. 2014;20(2):129–46.

197. Mugg J. The dual-process turn: How recent defenses of dual-process theories of reasoning fail. Philos Psychol. 2015;29(2):300–9.

198. Stanovich KE. The comprehensive assessment of rational thinking. Educ Psychol. 2016;51(1):23–34.

199. Epstein S, Pacini R. Individual differences in intuitive-experiential and analytical-rational thinking styles. J Pers Soc Psychol. 1996;71(2):390–405.

200. Pacini R, Epstein S. The relation of rational and experiential information processing styles to personality, basic beliefs and the ratio-bias phenomenon. J Pers Soc Psychol. 1999;76(6):972–87.

201. Croskerry P, Singhal G, Mamede S. Cognitive debiasing 1: origins of bias and theory of debiasing. BMJ Qual Saf. 2013;22(Suppl 2):58–64.

202. Croskerry P, Norman G. Overconfidence in clinical decision making. Am J Med. 2008;121(5 Suppl):S24-9.

203. Croskerry P. A universal model of diagnostic reasoning. Acad Emerg Med. 2009;84(8):1022–8.

204. Croskerry P. Clinical cognition and diagnostic error: applications of a dual process model of reasoning. Adv Health Sci Educ Theory Pract. 2009;14(Suppl 1):27–35.

205. Evans JSB. Dual-processing accounts of reasoning, judgment, and social cognition. Annu Rev Psychol. 2008 Jan;59:255–78.

206. Kahneman D. Thinking, Fast and Slow. Penguin Group; 2011.

207. Hruska P, Hecker KG, Coderre S, McLaughlin K, Cortese F, Doig C, et al. Hemispheric activation differences in novice and expert clinicians during clinical decision making. Adv Health Sci Educ Theory Pract. 2016;21(5):921–33.

208. Hruska P, Krigolson O, Coderre S, McLaughlin K, Cortese F, Doig C, et al. Working memory, reasoning, and expertise in medicine - insights into their relationship using functional neuroimaging. Adv Health Sci Educ Theory Pract. 2016;21(5):935–52.

209. Melo M, Gusso GDF, Levites M, Amaro E, Massad E, Lotufo PA, et al. How doctors diagnose diseases and prescribe treatments: an fMRI study of diagnostic salience. Sci Rep. 2017;7:1304.

210. Croskerry P. Diagnostic Failure: A Cognitive and Affective Approach. In: Henriksen K, Battles J, Marks E, Lewin D, editors. Advances in Patient Safety: From Research to Implementation Volumes 1-4. Agency for Healthcare Research and Quality, Rockville, MD; 2005. p. 240–54.

211. Masicampo E, Baumeister RF. Toward a Physiology of Dual-Process Reasoning and Judgment. Psychol Sci. 2008;19(3):255–60.

212. Croskerry P. Cognitive forcing strategies in clinical decision making. Ann Emerg Med. 2003;41(1):110–20.

213. Croskerry P. The cognitive imperative: thinking about how we think. Acad Emerg Med. 2000;7(11):1223–31.

214. Croskerry P. Context is everything or how could I have been that stupid? Healthc Q. 2009;12(Special Issue 1):e171-76.

215. Norman GR, Brooks LR, Colle CL, Hatala RM. The benefit of diagnostic hypotheses in clinical reasoning: experimental study of an instructional intervention for forward and backward reasoning. Cogn Instr. 2000;17(4):433–8.

216. Groves M, O'Rourke P, Alexander H. The clinical reasoning characteristics of diagnostic experts. Med Teach. 2003;25(3):308–13.

217. Norman G, Young M, Brooks L. Non-analytical models of clinical reasoning: the role of experience. Med Educ. 2007;41(12):1140–5.

218. Norman G, Sherbino J, Dore K, Wood T, Young M, Gaissmaier W, et al. The etiology of diagnostic errors: a controlled trial of System 1 versus System 2 reasoning. Acad Med. 2014;89(2):277–84.

219. Bissessur SW, Geijteman EC, Al-Dulaimy M, Teunissen PW, Richir MC, Arnold AE, et al. Therapeutic reasoning: from hiatus to hypothetical model. J Eval Clin Pract. 2009;15(6):985–9.

220. McLellan L, Tully MP, Dornan T. How could undergraduate education prepare new graduates to be safer prescribers ? Br J Clin Pharmacol. 2012;74(4):605–13.

221. Brinkman DJ, Tichelaar J, van Agtmael MA, de Vries TP, Richir MC. Self-reported confidence in prescribing skills correlates poorly with assessed competence in fourth-year medical students. J Clin Pharmacol. 2015;55(7):825–30.

222. Brinkman D, Disselhorst G, Jansen B, Tichelaar J, van Agtmael M, de Vries T, et al. What should junior doctors know about the drugs they frequently prescribe? A Delphi study among physicians in the Netherlands. Basic Clin Pharmacol Toxicol. 2016;118(6):456–61.

223. Brinkman D, Tichelaar J, Schutte T, Benemei S, Böttiger Y, Chamontin B, et al. Essential competencies in prescribing: A first European cross-sectional study among 895 final-year medical students. Clin Pharmacol Ther. 2017;101(2):281–9.

224. Brinkman DJ, Tichelaar J, Graaf S, Otten RH, Richir MC, van Agtmael MA. Do final-year medical students have sufficient prescribing competencies? A systematic literature review. Br J Clin Pharmacol. 2018;84(4):615–35.

225. Cutrer WB, Sullivan WM, Fleming AE. Educational strategies for improving clinical reasoning. Curr Probl Pediatr Adolesc Heal Care. 2013;43(9):248–57.

226. Frederick S. Cognitive Reflection and Decision Making. J Econ Perspect. 2005;19(4):25–42.

227. Witteman C, van den Bercken J, Claes L, Godoy A. Assessing rational and intuitive thinking styles. Eur J Psychol Assess. 2009;25(1):39–47.

228. Sinayev A, Peters E. Cognitive reflection vs. calculation in decision making. Front Psychol. 2015;6:532.

229. Toplak ME, West RF, Stanovich KE. The Cognitive Reflection Test as a predictor of performance on heuristics-and-biases tasks. Mem Cogn. 2011;39(7):1275--89.

230. Sladek RM, Bond MJ, Huynh LT, Chew DP, Phillips PA. Thinking styles and doctors' knowledge and behaviours relating to acute coronary syndromes guidelines. Implement Sci. 2008;3:23.

231. Sladek RM, Bond MJ, Phillips PA. Why don't doctors wash their hands? A correlational study of thinking styles and hand hygiene. Am J Infect Control. 2008;36(6):399–406.

232. Calder LA, Forster AJ, Stiell IG, Carr LK, Brehaut JC, Perry JJ, et al. Experiential and rational decision making: a survey to determine how emergency physicians make

clinical decisions. Emerg Med J. 2012;29(10):811–6.

233. Djulbegovic B, Beckstead JW, Elqayam S, Reljic T, Hozo I, Kumar A, et al. Evaluation of physicians' cognitive styles. Med Decis Mak. 2014;34(5):627–37.

234. Djulbegovic M, Beckstead J, Elqayam S, Reljic T, Kumar A, Paidas C, et al. Thinking styles and regret in physicians. PLoS One. 2015;10(8):e0134038.

235. Jensen J, Bienkowski A, Travers A, Calder L, Walker M, Tavares W, et al. A survey to determine decision-making styles of working paramedics and student paramedics. Can J Emerg Med. 2016;18(3):213–22.

236. McLaughlin JE, Cox WC, Williams CR, Shepherd G. Rational and experiential decision-making preferences of third-year student pharmacists. Am J Pharm Educ. 2014;78(6):120.

237. Williams CR, Mclaughlin JE, Cox WC, Shepherd G. Relationship between Student Pharmacist Decision Making Preferences and Experiential Learning. Am J Pharm Educ. 2016;80(7):119.

238. Sladek RM, Bond MJ, Phillips PA. Do doctors, nurses and managers have different thinking styles? Aust Health Rev. 2010;34(3):375–80.

239. Cacioppo JT, Petty RE. The need for cognition. J Pers Soc Psychol. 1982;42(1):116–31.

240. Cacioppo JT, Petty RE. The efficient assessment of need for cognition. J Pers Assess. 1984;48(3):306–7.

241. Franklin BD, Vincent C, Schachter M, Barber N. The incidence of prescribing errors in hospital inpatients. An overview of the research methods. Drug Saf. 2005;28(10):891–900.

242. Gordon M, Bose-Haider B. A novel system of prescribing feedback to reduce errors: A pilot study. Int J Risk Saf Med. 2012;24(4):207–14.

243. Keers RN, Williams SD, Cooke J, Ashcroft DM. Prevalence and nature of medication administration errors in health care settings: a systematic review of direct observational evidence. Ann Pharmacother. 2013 Feb;47(2):237–56.

244. Kuo GM, Touchette DR, Marinac JS. Drug errors and related interventions reported by United States clinical pharmacists: the American College of Clinical Pharmacy Practice-Based Research Network medication error detection, amelioration and prevention study. Pharmacotherapy. 2013;33(3):253–65.

245. Franklin BD, O'Grady K, Paschalides C, Utley M, Gallivan S, Jacklin A, et al. Providing feedback to hospital doctors about prescribing errors; a pilot study. Pharm World Sci. 2007;29(3):213–20.

246. Avery A, Ghaleb M, Barber N, Franklin B, Armstrong S, Slight S, et al. Investigating the prevalence and causes of prescribing errors in general practice: The PRACtICe study [abstract]. Pharmacoepidemiol Drug Saf. 2012;21(Suppl 3):4.

247. Winder MB, Johnson JL, Planas LG, Crosby KM, Gildon BL, Oberst-Walsh LA. Pharmacist-led educational and error notification interventions on prescribing errors in family medicine clinic. J Am Pharm Assoc. 2015;55(3):238–45.

248. Sayers YM, Armstrong P, Hanley K. Prescribing errors in general practice: a prospective study. Eur J Gen Pr. 2009;15(2):81–3.

249. Mamede S, Schmidt HG, Penaforte JC. Effects of reflective practice on the accuracy of medical diagnoses. Med Educ. 2008;42(5):468–75.

250. Mamede S, Schmidt HG, Rikers R. Diagnostic errors and reflective practice in medicine. J Eval Clin Pract. 2007;13(1):138–45.

251. The Health Foundation. Evidence scan: Reducing prescribing errors. London; 2012.

252. Scott H. Medicines Management Annual Report 2012 - 13. South Essex Partnership University NHS Foundation Trust; 2013.

253. Dean BS, Barber ND. A validated, reliable method for scoring the severity of

medication errors. Am J Health Syst Pharm. 1999;56(1):57–62.

254. British Medical Association. Doctors' titles: explained. London; 2017.

255. Royal College of Psychiatrists. How to become a psychiatrist [Internet]. [cited 2018 Jul 8]. Available from: https://www.rcpsych.ac.uk/discoverpsychiatry/acareerinpsychiatry/choosepsychiatry/howtobecomeapsychiatrist.aspx

256. Donyai P, O'Grady K, Jacklin A, Barber N, Franklin BD. The effects of electronic prescribing on the quality of prescribing. Br J Clin Pharmacol. 2008;65(2):230–7.

257. Seden K, Kirkham J, Kennedy T, Lloyd M, James S, McManus A, et al. Cross-sectional study of prescribing errors in patients admitted to nine hospitals across North West England. BMJ Open. 2013;3(1):e002036.

258. Hansen CR, Bradley C, Sahm L. Factors influencing successful prescribing by intern doctors: a qualitative systematic review. Pharmacy. 2016;4(3):24.

259. Ghaleb M, Barber N, Franklin B, Wong I. The incidence and nature of prescribing and medication administration errors in paediatric inpatients. Arch Dis Child. 2010;95(2):113–8.

260. Barber N, Dean B, Schachter M, Vincent C. Prescribing errors in hospital inpatients - how can we reduce the risk? A pilot study. 2000.

261. Tully M, Parker D, Buchan I, McElduff P, Heathfield H, Rogers J, et al. Patient Safety Research Programme. Medication errors 2: pilot study. 2006.

262. Pharmaceutical Press, BMJ Group. BNF Online [Internet]. 2018 [cited 2018 Sep 3]. Available from: https://www.medicinescomplete.com/#/browse/bnf

263. Kollo A, Dean B. The development of a method to assess the severity of prescribing errors and the effect of related pharmacists' interventions [Abstract]. 6th Health Services Research & Pharmacy Practice Conference. Aberdeen; 2000.

264. Kollo AM. The development of a method to assess the severity of prescribing errors and the effect of pharmacists' interventions to prevent them. University of London; 1999.

265. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77–101.

266. Toplak ME, West RF, Stanovich KE. Assessing miserly information processing: An expansion of the Cognitive Reflection Test. Think Reason. 2014;20(2):147–68.

267. Cohen J. Statistical power analysis for behavioural sciences. 2nd ed. New Jersey: Erlbaum; 1988.

268. Peduzzi P, Concato J, Kemper E, Holford E, Feinstein A. A simulation study of the number of events per variable in logistic regression analysis. J Clin Epidemiol. 1996;49(12):1373–9.

269. National Prescribing Centre. Making Decisions Better. 2010.

270. Thomson CL, Maskrey N, Vlaev I. Making Decisions Better: an evaluation of an educational intervention. J Eval Clin Pract. 2017;23(2):251–6.

271. UK Health Departments. Governance Arrangements for Research Ethics Committees: a harmonised edition. Leeds; 2011.

272. National Institute for Health & Care Excellence. Drug allergy: diagnosis and management. 2014.

273. Bates K, Beddy D, Whirisky C, Murphy M, O'Mahony J, Mealy K. Determining the frequency of prescription errors in an Irish hospital. Ir J Med Sci. 2010;179(2):183–6.

274. Bobb A, Gleason K, Husch M, Feinglass J, Yarnold PR, Noskin GA. The epidemiology of prescribing errors: the potential impact of computerized prescriber order entry. Arch Intern Med. 2004;164(7):785–92.

275. Tully M, Buchan I. Prescribing errors during hospital inpatient care: factors influencing identification by pharmacists. Pharm World Sci. 2009;31(6):682–8.

276. Warholak T, Queiruga C, Roush R, Phan H. Medication error identification rates by pharmacy, medical, and nursing students. Am J Pharm Educ. 2011;75(2):article 24.

277. Beex-Oosterhuis MM, de Vogel EM, van der Sijs H, Dieleman HG, van den Bemt PM. Detection and correct handling of prescribing errors in Dutch hospital pharmacies using test patients. Int J Clin Pharm. 2013;35(6):1188–202.

278. Reynolds M, Jheeta S, Benn J, Sanghera I, Jacklin A, Ingle D, et al. Improving feedback on junior doctors' prescribing errors: mixed-methods evaluation of a quality improvement project. BMJ Qual Saf. 2017;26(3):240–7.

279. Royal Pharmaceutical Society of Great Britain. Keeping patients safe when they transfer between care providers – getting the medicines right. London; 2012.

280. National Institute for Health and Clinical Excellence, National Patient Safety Agency. Technical patient safety solutions for medicines reconciliation on admission of adults to hospital. 2007.

281. Brownlie K, Schneider C, Culliford R, Fox C, Boukouvalas A, Willan C, et al. Medication reconciliation by a pharmacy technician in a mental health assessment unit. Int J Clin Pharm. 2013;36(2):303–9.

282. Scott H. Medicines Management Annual Report 2010 - 2011. South Essex Partnership University NHS Foundation Trust; 2011.

283. Basey AJ, Krska J, Kennedy TD, Mackridge AJ. Prescribing errors on admission to hospital and their potential impact: a mixed-methods study. BMJ Qual Saf. 2014;23(1):17–26.

284. Akbarov A, Kontopantelis E, Sperrin M, Stocks SJ, Williams R, Rodgers S, et al. Primary care medication safety surveillance with integrated primary and secondary care electronic health records: a cross-sectional study. Drug Saf. 2015;38(7):671–82.

285. Ferracini A, Rodrigues A, de Barros A, Derchain S, Mazzola P. Prescribing errors intercepted by pharmacist intervention in care of patients hospitalised with breast and gynaecological cancer at a Brazilian teaching hospital. Eur J Cancer Care. 2017;27(1):e12767.

286. Ferracini AC, de Souza CM, Rodrigues AT, Moriel P, Derchain SF, Mazzola PG. Prevalence, prevention, and severity of prescribing errors in different years of residency training at an oncology ward [Letter]. Am J Med Qual. 2018;33(1):109.

287. Patel R, Green W, Martinez MM, Shahzad MW, Larkin C. A study of Foundation Year doctors' prescribing in patients with kidney disease at a UK renal unit: a comparison with other prescribers regarding the frequency and type of errors. Eur J Hosp Pharm Sci Pract. 2015;22(5):291–7.

288. Dearden E, Mellanby E, Cameron H, Harden J. Which non-technical skills do junior doctors require to prescribe safely? A systematic review. Br J Clin Pharmacol. 2015;80(6):1303–14.

289. Harding S, Britten N, Bristow D. The performance of junior doctors in applying clinical pharmacology knowledge and prescribing skills to standardized clinical cases. Br J Clin Pharmacol. 2010;69(6):598–606.

290. Hilmer S, Seale J, Le Couteur D, Crampton R, Liddle C. Do medical courses adequately prepare interns for safe and effective prescribing in New South Wales public hospitals? Intern Med J. 2009;39(7):428–34.

291. Brinkman D, Tichelaar J, Bissell L, Christiaens T, Likic R, Maciulaitis R, et al. Pharmacology and therapeutics education in EU needs harmonisation and modernisation: a cross-sectional survey among 185 medical schools in 27 countries. Clin Pharmacol Ther. 2017;102(5):815–22.

292. Heaton A, Webb DJ, Maxwell SR. Undergraduate preparation for prescribing: the views of 2413 UK medical students and recent graduates. Br J Clin Pharmacol. 2008;66(1):128–34.

293. James H, Tayem YI, Al Khaja K, Veeramuthu S, Sequeira RP. Prescription writing in small groups as a clinical pharmacology educational intervention: perceptions of

preclerkship medical students. J Clin Pharmacol. 2016;56(8):1028–34.

294. Geoghegan SE, Clarke E, Byrne D, Power D, Moneley D, Strawbridge J, et al. Preparedness of newly qualified doctors in Ireland for prescribing in clinical practice. Br J Clin Pharmacol. 2017;83(3):1826–34.

295. Hansen C, Walsh E, Bradley C, Sahm L. Teaching prescribing: just what the doctor ordered? a thematic analysis of the views of newly qualified doctors. Pharmacy. 2017;5(2):32.

296. Pearson SA, Rolfe I, Smith T. Factors influencing prescribing: An intern's perspective. Med Educ. 2002;36(8):781–7.

297. Maxwell SR, Coleman JJ, Bollington L, Taylor C, Webb DJ. Prescribing Safety Assessment 2016: Delivery of a national prescribing assessment to 7,343 UK final-year medical students. Br J Clin Pharmacol. 2017;83(10):2249–58.

298. Charlin B, Tardif J, Boshuizen H. Scripts and medical diagnostic knowledge: theory and applications for clinical reasoning instruction and research. Acad Med. 2000;75(2):182–90.

299. Schmidt H, Norman G, Boshuizen H. A cognitive perspective on medical expertise: theory and implications. Acad Med. 1990;65(10):611–21.

300. Ericsson KA, Krampe RT, Tesch-Römer C. The role of deliberate practice in the acquisition of expert performance. Psychol Rev. 1993;100(3):363–406.

301. Ericsson KA. Deliberate practice and the acquisition and maintenance of expert performance in medicine and related domains. Acad Med. 2004;79(Suppl 10):S70–81.

302. Gladwell M. Outliers. New York City: Little, Brown & Company; 2008.

303. Pretz JE. Intuition versus analysis: strategy and experience in complex everyday problem solving. Mem Cogn. 2008;36(3):554–66.

304. Cousins D, Hatoum H. The development of a computerised quality assurance system for clinical pharmacy. Int J Pharm Pract. 1991;1(2):86–9.

305. Lewis PJ, Tully MP. Uncomfortable prescribing decisions in hospitals: the impact of teamwork. J R Soc Med. 2009;102(11):481–8.

306. Onatade R, Sawieres S, Veck A, Smith L, Gore S, Al-Azeib S. The incidence and severity of errors in pharmacist-written discharge medication orders. Int J Clin Pharm. 2017;39(4):722–8.

307. Franklin BD. Reliability of prescribing for hospital inpatients. How safe are clinical systems? London: The Health Foundation; 2011. p. 43–68.

308. Thomas S, McDowell S, Hodson J, Nwulu U, Howard R, Avery A, et al. Developing consensus on hospital prescribing indicators of potential harms amenable to decision support. Br J Clin Pharmacol. 2013;76(5):797–809.

309. Fox A, Pontefract S, Brown D, Portlock J, Coleman J. Developing consensus on hospital prescribing indicators of potential harm for infants and children. Br J Clin Pharmacol. 2016;82(2):451–60.

310. Taylor DM, Barnes TR, Young AH. The Maudsley Prescribing Guidelines in Psychiatry. 13th ed. Wiley Blackwell; 2018.

311. Davies S. Annual Report of the Chief Medical Officer 2013. Public Mental Health Priorities: Investing in the Evidence. London; 2014.

312. Working Group for Improving the Phsycial Health of People with SMI. Improving the physical health of adults with severe mental illness: essential actions (OP100). Royal College of Psychiatrists; 2016.

313. The Mental Health Taskforce. The five year forward view for mental health. 2016.

314. HM Government. No Health Without Mental Health: A cross-government mental health outcomes strategy for people of all ages. Department of Health. 2011.

315. Khan I, Arsanious M. Does the perception of severity of medical error differ between

varying levels of clinical seniority? Adv Med Educ Pract. 2018;9:443–52.

316. Bourne R, Shulman R, Tomlin M, Mills G, Borthwick M, Berry W. Reliability of clinical impact grading by health professionals of common prescribing errors and optimisations in critical care patients. Int J Qual Health Care. 2017;29(2):250–5.

317. Franklin B, Reynolds M. A comparative study of prescribing errors in three NHS organisations [abstract]. Int J Pharm Pract. 2010;18(Suppl S2):80–1.

318. Barber N, Franklin BD, Cornford T, Klecun E, Savage I. Safer, faster, better? Evaluating electronic prescribing: report to the Patient Safety Research Programme. 2006.

319. Garfield S, Reynolds M, Dermont L, Franklin BD. Measuring the severity of prescribing errors: a systematic review. Drug Saf. 2013;36(12):1151–7.

320. Patient Safety Observatory. Safety in doses: medication safety incidents in the NHS. 2007.

321. King WJ, Paice N, Rangrej J, Forestell GJ, Swartz R. The effect of computerized physician order entry on medication errors and adverse drug events in pediatric inpatients. Pediatrics. 2003;112(3 Pt 1):506–9.

322. Hartwig S, Denger S, Schneider P. Severity-indexed, incident report-based medication error-reporting program. Am J Hosp Pharm. 1991;48(12):2611–6.

323. Dean B. Learning from prescribing errors. Qual Saf Health Care. 2002;11(3):258–60.

324. Abdel-Qader DH, Harper L, Cantrill JA, Tully MP. Pharmacists interventions in prescribing errors at hospital discharge: an observational study in the context of an electronic prescribing system in a UK teaching hospital. Drug Saf. 2010;33(11):1027–44.

325. Kaushal R, Bates D, Landrigan C, McKenna K, Clapp M, Federico F, et al. Medication errors and adverse drug events in pediatric inpatients. JAMA. 2001;285(16):2114–20.

326. Leape L, Cullen D, Clapp M, Burdick E, Demonaco H, Erickson J, et al. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. JAMA. 1999;282(3):267–70.

327. Vira T, Colquhoun M, Etchells E. Reconcilable differences: correcting medication errors at hospital admission and discharge. Qual Saf Health Care. 2006;15(2):122–6.

328. National Coordinating Council for Medication Error Reporting and Prevention. Taxonomy of Medication Errors. 1998.

329. Forrey RA, Pedersen CA, Schneider PJ. Interrater agreement with a standard scheme for classifying medication errors. Am J Health Syst Pharm. 2007;64(2):175–81.

330. Mann K, Rothschild J, Keohane C, Chu J, Bates D. Adverse drug events and medication errors in psychiatry: Methodological issues regarding identification and classification. World J Biol Psychiatry. 2008;9(1):24–33.

331. Orquin JL, Kurzban R. A meta-analysis of blood glucose effects on human decision making. Psychol Bull. 2016;142(5):546–67.

332. Kahneman D. A perspective on judgement and choice. Mapping bounded rationality. Am Psychol. 2003;58(9):697–720.

333. El-Sharkawy AM, Bragg D, Watson P, Neal K, Sahota O, Maughan RJ, et al. Hydration amongst nurses and doctors on-call (the HANDS on prospective cohort study). Clin Nutr. 2016;35(4):935–42.

334. Ishak WW, Lederer S, Mandili C, Nikravesh R, Seligman L, Vasa M, et al. Burnout During Residency Training: A Literature Review. J Grad Med Educ. 2009;1(2):236–42.

335. National training surveys 2018 : Initial findings report. General Medical Council; 2018.

336. Braun SE, Auerbach SM, Rybarczyk B, Lee B, Call S. Mindfulness, burnout, and

effects on performance evaluations in internal medicine residents. Adv Med Educ Pract. 2017;8:591–7.

337. Smith F, Goldacre MJ, Lambert TW. Adverse effects on health and wellbeing of working as a doctor: views of the UK medical graduates of 1974 and 1977 surveyed in 2014. J R Soc Med. 2017;110(5):198–207.

338. Tyssen R, Vaglum P, Gronvold NT, Ekeberg O. The Impact of Job Stress and Working Condition on Mental Health Problems Among Junior House Officers. A Nationwide Norwegian Prospective Cohort Study. Med Educ. 2000;34(5):374–80.

339. Abdulghani HM, Irshad M, Al Zunitan MA, Al Sulihem AA, Al Dehaim MA, Al Esefir WA, et al. Prevalence of stress in junior doctors during their internship training: a cross-sectional study of three Saudi medical colleges' hospitals. Neuropsychiatr Dis Treat. 2014;10:1879–86.

340. Røvik JO, Tyssen R, Hem E, Gude T, Ekeberg O, Moum T, et al. Job stress in young physicians with an emphasis on the work-home interface: a nine-year, nationwide and longitudinal study of its course and predictors. Ind Health. 2007;45(5):662–71.

341. Margittai Z, Nave G, Strombach T, van Wingerden M, Schwabe L, Kalenscher T. Exogenous cortisol causes a shift from deliberative to intuitive thinking. Psychoneuroendocrinology. 2016;64:131–5.

342. Maxwell S, Walley T. Teaching safe and effective prescribing in UK medical schools: a core curriculum for tomorrow. Br J Clin Pharmacol. 2003;55(6):496–503.

343. Baker E, Roberts AP, Wilde K, Walton H, Suri S, Rull G, et al. Development of a core drug list towards improving prescribing education and reducing errors in the UK. Br J Clin Pharmacol. 2011;71(2):190–8.

344. Audi S, Burrage DR, Lonsdale DO, Pontefract S, Coleman JJ, Hitchings AW, et al. The "top 100" drugs and classes in England An updated "starter formulary" for trainee prescribers. Br J Clin Pharmacol. 2018;84(11):2562–71.

345. Maxwell SRJ, Cameron IT, Webb DJ. Prescribing safety: ensuring that new graduates are prepared. Lancet. 2015;385(9968):579–81.

346. Illing JC, Morrow GM, Rothwell nee Kergon CR, Burford BC, Baldauf BK, Davies CL, et al. Perceptions of UK medical graduates' preparedness for practice: a multi-centre qualitative study reflecting the importance of learning on the job. BMC Med Educ. 2013;13(34).

347. Sikkens JJ, Gerritse SL, Peters EJG, Kramer MHH, van Agtmael MA. The 'morning dip' in antimicrobial appropriateness: circumstances determining appropriateness of antimicrobial prescribing. J Antimicrob Chemother. 2018;73(6):1714–20.

348. British Medical Association. The state of pre and post-graduate medical recruitment in England. 2017.

349. Health Education England. National Psychiatry Recruitment - Fill Rates & Competition Rates [Internet]. 2017 [cited 2018 Aug 4]. Available from: https://www.nwpgmd.nhs.uk/national_Psychiatry_Recruitment_Comp_Ratios_Fill_Rates

350. Health Education England. Stepping Forward to 2020/21: The Mental Health Workforce Plan for England. 2017.

351. Rimmer A. NHS needs culture shift regarding sleeping at work. BMJ. 2016;354:i3982.

352. Greig P, Snow R. Fatigue and risk: are train drivers safer than doctors? BMJ. 2017;359:j5107.

353. Sexton J, Thomas E, Helmreich R. Error, stress, and teamwork in medicine and aviation: cross sectional surveys. BMJ. 2000 Mar 18;320(7237):745–9.

354. Anderson C, Sullivan JP, Flynn-Evans EE, Cade BE, Czeisler CA, Lockley SW. Deterioration of Neurobehavioral Performance in Resident Physicians During Repeated Exposure to Extended Duration Work Shifts. Sleep. 2012;35(8):1137–46.

355. Benson M, Grimes I, Gopal D, Reichelderfer M, Soni A, Benson H, et al. Influence of

Previous Night Call and Sleep Deprivation on Screening Colonoscopy Quality. Am J Gastroenterol. 2014;109(8):1133–7.

356. Ayas NT, Barger LK, Cade BE, Hashimoto DM, Rosner B, Cronin JW, et al. Extended Work Duration and the Risk of Self-reported Percutaneous Injuries in Interns. JAMA. 2006;296(9):1055–62.

357. Westbrook JI, Raban M, Walter SR, Douglas H. Task errors by emergency physicians are associated with interruptions, multitasking, fatigue and working memory capacity: a prospective, direct observation study. BMJ Qual Saf. 2018;27(8):655–63.

358. Mountain SA, Quon BS, Dodek P, Sharpe R, Ayas NT. The impact of housestaff fatigue on occupational and patient safety. Lung. 2007;185(4):203–9.

359. Sexton JB, Schwartz SP, Chadwick WA, Rehder KJ, Bae J, Bokovoy J, et al. The associations between work–life balance behaviours, teamwork climate and safety climate: cross-sectional survey introducing the work–life climate scale, psychometric properties, benchmarking data and future directions. BMJ Qual Saf. 2017;26(8):632–40.

360. NHS Staff Survey 2017 [Internet]. 2017 [cited 2018 Jul 29]. Available from: http://www.nhsstaffsurveys.com

361. Raban MZ, Walter SR, Douglas HE, Strumpman D, Mackenzie J, Westbrook JI. Measuring the relationship between interruptions, multitasking and prescribing errors in an emergency department: a study protocol. BMJ Open. 2015;5(10):e009076.

362. Foroughi CK, Werner NE, Nelson ET, Boehm-Davis DA. Do interruptions affect quality of work? Hum Factors. 2014;56(7):1262–71.

363. Westbrook JI, Coiera E, Dunsmuir WTM, Brown BM, Kelk N, Paoloni R, et al. The impact of interruptions on clinical task completion. Qual Saf Health Care. 2010;19(4):284–9.

364. Weigl M, Müller A, Holland S, Wedel S, Woloshynowych M. Work conditions, mental workload and patient care quality: a multisource study in the emergency department. BMJ Qual Saf. 2016;25(7):499–508.

365. NHS Digital. Summary Care Record (SCR) [Internet]. [cited 2018 Aug 4]. Available from: https://digital.nhs.uk/services/summary-care-records-scr#summary

366. National Patient Safety Agency. Design for patient safety. A guide to the design of dispensed medicines. 2007.

367. Royal Pharmaceutical Society. Medicines, Ethics and Practice. 42nd ed. London; 2018.

368. Schmidt HG, van Gog T, Ce Schuit S, Van den Berge K, LA Van Daele P, Bueving H, et al. Do patients' disruptive behaviours influence the accuracy of a doctor's diagnosis? A randomised experiment. BMJ Qual Saf. 2016;26(1):19–23.

369. Mamede S, Van Gog T, Schuit SC, Van den Berge K, Van Daele P LA, Bueving H, et al. Why patients' disruptive behaviours impair diagnostic reasoning: a randomised experiment. BMJ Qual Saf. 2016;26(1):13–8.

370. Croskerry P, Abbass AA, Wu AW. How doctors feel: affective issues in patients' safety. Lancet. 2008;372(9645):1205–6.

371. Tallentire V, Hale R, Dewhurst N, Maxwell S. The contribution of prescription chart design and familiarity to prescribing error: a prospective, randomised, cross-over study. BMJ Qual Saf. 2013;22(10):864–70.

372. Aronson J. A prescription for better prescribing. Br J Clin Pharmacol. 2006;61(5):487–91.

373. Millar JA, Silla RC, Lee GE, Berwick A. The national inpatient medication chart: Critical audit of design and performance at a tertiary hospital. Med J Aust. 2008;188(2):95–9.

374. Coombes I, Stowasser D, Reid C, Mitchell C. Impact of a standard medication chart

on prescribing errors: A before-and-after audit. Qual Saf Health Care. 2009;18(6):478–85.

375. Atik A. Adherence to the Australian National Inpatient Medication Chart: The efficacy of a uniform national drug chart on improving prescription error. J Eval Clin Pract. 2013;19(5):769–72.

376. Keogh B. Standards for the design of hospital in-patient prescription charts. 2011.

377. NHS England. Safer Hospitals Safer Wards. Achieving an integrated digital care record. 2013.

378. National Information Board. Personalised health and care 2020: using data and technology to transform outcomes for patients and citizens. A framework for action. 2014.

379. Ahmed Z, Garfield S, Jani Y, Dean Franklin B. Impact of electronic prescribing on patient safety in hospitals: implications for the UK. Clin Pharm. 2016;8(5):144–51.

380. McLeod M, Ahmed Z, Barber N, Franklin BD. A national survey of inpatient medication systems in English NHS hospitals. BMC Health Serv Res. BMC Health Services Research; 2014;14(1):93.

381. Ahmed Z, McLeod MC, Barber N, Jacklin A, Franklin BD. The use and functionality of electronic prescribing systems in English acute NHS trusts: A cross-sectional survey. PLoS One. 2013;8(11).

382. Chew KS, Durning SJ, van Merriënboer JJ. Teaching metacognition in clinical decision-making using a novel mnemonic checklist: an exploratory study. Singapore Med J. 2016;57(12):694–700.

383. Haigh M. Has the standard Cognitive Reflection Test become a victim of its own success? Adv Cogn Psychol. 2016;12(3):145–9.

384. Thomson KS, Oppenheimer DM. Investigating an alternate form of the cognitive reflection test. Judgm Decis Mak. 2016;11(1):99–113.

385. Stieger S, Reips U-D. A limitation of the Cognitive Reflection Test: familiarity. PeerJ. 2016;4:e2395.

386. Primi C, Morsanyi K, Chiesi F, Donati MA, Hamilton J. The Development and Testing of a New Version of the Cognitive Reflection Test Applying Item Response Theory (IRT). J Behav Decis Mak. 2016;29(5):453–69.

387. Liberali JM, Reyna VF, Furlan S, Stein LM, Pardo ST. Individual Differences in Numeracy and Cognitive Reflection , with Implications for Biases and Fallacies in Probability Judgment. J Behav Decis Mak. 2012;25(4):361–81.

388. Pennycook G, Ross RM. Commentary: Cognitive reflection vs. calculation in decision making. Front Psychol. 2016;7:9.

389. Hoover JD, Healy AF. Algebraic reasoning and bat-and-ball problem variants: solving isomorphic algebra first facilitates problem solving later. Psychon Bull Rev. 2017;24(6):1922–8.

390. Pennycook G, Fugelsang JA, Koehler DJ. Everyday Consequences of Analytic Thinking. Curr Dir Psychol Sci. 2015;24(6):425–32.

391. Barz DL, Achimaș-Cadariu A. Development of a skills-based instrument to measure scientific reasoning in medicine across different levels of expertise. Journal of Baltic Science Education. 2017;16(3):289–99.

392. Kinnear J, Wilson N. Assessing the association between thinking dispositions and clinical error. Postgrad Med J. 2018;94(1107):3–6.

393. Pineros DB, Doctor JN, Friedberg MW, Meeker D, Linder JA. Cognitive reflection and antibiotic prescribing for acute respiratory infections. Fam Pract. 2016;33(3):309–11.

394. Travers E, Rolison JJ, Feeney A. The time course of conflict on the Cognitive Reflection Test. Cognition. 2016;150:109–18.

395. Mata A, Ferreira MB, Voss A, Kollei T. Seeing the conflict: an attentional account of

reasoning errors. Psychon Bull Rev. 2017;24(6):1980–6.

396. Fitzgerald CJ, Lueke AK. Mindfulness increases analytical thought and decreases just world beliefs. Curr Res Soc Psychol. 2017;24(8):80–5.

397. Stupple EJ, Pitchford M, Ball LJ, Hunt TE, Steel R. Slower is not always better: Response-time evidence clarifies the limited role of miserly information processing in the Cognitive Reflection Test. PLoS One. 2017;12(11):e0186404.

398. Sladek RM, Bond MJ, Phillips PA. Age and gender differences in preferences for rational and experiential thinking. Pers Individ Dif. 2010;49(8):907–11.

399. Bhugra D, Easter A, Mallaris Y, Gupta S. Clinical decision making in psychiatry by psychiatrists. Acta Psychiatr Scand. 2011;124(5):403–11.

400. Bloch S. The art of psychiatry. World Psychiatry. 2005;4(3):130–4.

401. Bhugra D. Decision-making in psychiatry: what can we learn? Acta Psychiatr Scand. 2008;118(1):1–3.

402. Bhugra D, Malliaris Y, Gupta S. How shrinks think: decision making in psychiatry. Australas Psychiatry. 2010;18(5):391–3.

403. Phillips WJ, Fletcher JM, Marks AD, Hine DW. Thinking styles and decision making: a meta-analysis. Psychol Bull. 2016;142(3):260–90.

404. Sladek RM, Phillips PA, Bond MJ. Implementation science: a role for parallel dual processing models of reasoning? Implement Sci. 2006;1:12.

405. Sadowski CJ. An examination of the short Need for Cognition Scale. J Psychol. 1993;127(4):451–4.

406. Bruinsma J, Crutzen R. A longitudinal study on the stability of the need for cognition. Pers Individ Dif. 2018;127:151–61.

407. Cacioppo JT, Petty RE, Feinstein JA, Jarvis WBG. Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. Psychol Bull. 1996;119(2):197–253.

408. West R, Toplak M, Stanovich K. Heuristics and biases as measures of critical thinking. Associations with cognitive ability and thinking disposition. J Educ Psychol. 2008;100(4):930–41.

409. Levin IP, Huneke ME, Jasper J. Information processing at successive stages of decision making: Need for cognition and inclusion-exclusion effects. Organ Behav Hum Decis Process. 2000;82(2):171–93.

410. Ruscio J. The role of complex thought in clinical prediction: Social accountability and the need for cognition. J Consult Clin Psychol. 2000;68(1):145–54.

411. Curseu PL. Need for cognition and rationality in decision making. Stud Psychol. 2006;48(2):141–56.

412. Dunphy BC, Cantwell R, Bourke S, Fleming M, Smith B, Joseph K, et al. Cognitive elements in clinical decision-making: toward a cognitive model for medical education and understanding clinical reasoning. Adv Health Sci Educ Theory Pract. 2010;15(2):229–50.

413. Bhatti A. Cognitive bias in clinical practice – nurturing healthy skepticism among medical students. Adv Med Educ Pract. 2018;9:235–7.

414. Harendza S, Krenz I, Klinge A, Wendt U, Janneck M. Implementation of a clinical reasoning course in the internal medicine trimester of the final year of undergraduate medical training and its effect on students' case presentation and differential diagnostic skills. GMS J Med Educ. 2017;34(5):Doc66.

415. McGregor CA, Paton C, Thomson C, Chandratilake M, Scott H. Preparing medical students for clinical decision making: a pilot study exploring how students make decisions and the perceived impact of a clinical decision making teaching intervention. Med Teach. 2012;34(7):e508-17.

416. General Medical Council. Tomorrow's Doctors. London: General Medical Council;

2009.

417. Rencic J, Trowbridge RL, Fagan M, Szauter K, Durning S. Clinical Reasoning Education at US Medical Schools: Results from a National Survey of Internal Medicine Clerkship Directors. J Gen Intern Med. 2017;32(11):1242–6.

418. Reilly JB, Ogdie AR, Von Feldt JM, Myers JS. Teaching about how doctors think: A longitudinal curriculum in cognitive bias and diagnostic error for residents. BMJ Qual Saf. 2013;22(12):1044–50.

419. Houchens N, Harrod M, Fowler KE, Moody S, Saint S. How Exemplary Inpatient Teaching Physicians Foster Clinical Reasoning. Am J Med. 2017;130(9):1113.e1-1113.e8.

420. Jenkins MM, Youngstrom EA. A randomized controlled trial of cognitive debiasing improves assessment and treatment selection for pediatric bipolar disorder. Consult Clin Psychol. 2016;84(4):323–33.

421. Barber N, Rawlins M, Franklin B. Reducing prescribing error: competence, control, and culture. Qual Saf Health Care. 2003;12(Suppl 1):i29-32.

422. Brennan N, Mattick K. A systematic review of educational interventions to change behaviour of prescribers in hospital settings, with a particular emphasis on new prescribers. Br J Clin Pharmacol. 2012;75(2):359–72.

423. Kamarudin G, Penm J, Chaar B, Moles R. Educational interventions to improve prescribing competency: a systematic review. BMJ Open. 2013;3(8):e003291.

424. Bos JM, van den Bemt PMLA, de Smet PA, Kramers C. The effect of prescriber education on medication-related patient harm in the hospital: a systematic review. Br J Clin Pharmacol. 2017;83(5):953–61.

425. Tully M. Prescribing errors in hospital practice. Br J Clin Pharmacol. 2012;74(4):668–75.

426. Gray J. Changing physician prescribing behaviour. Can J Clin Pharmacol. 2006;13(1):e81-4.

427. Cantillon P, Sargeant J. Giving feedback in clinical settings. BMJ. 2008;337:a1961.

428. Williams D, Phipps L, Ashcroft M. Understanding the attitudes of hospital pharmacists to reporting medication incidents: A qualitative study. Res Social Adm Pharm. 2013;9(1):80–9.

429. Lloyd M, Watmough S, O'Brien S, Furlong N, Hardy K. Exploring the impact of pharmacist-led feedback on prescribing behaviour: A qualitative study. Res Social Adm Pharm. 2017;14(6):545–54.

430. Ferguson J, Keyworth C, Tully MP. 'If no-one stops me, I'll make the mistake again': Changing prescribing behaviours through feedback; A Perceptual Control Theory perspective'. Res Social Adm Pharm. 2018;14(3):241–7.

431. Bertels J, Almoudaris A, Cortoos P, Jacklin A, Franklin B. Feedback on prescribing errors to junior doctors: exploring views, problems and preferred methods. Int J Clin Pharm. 2013;35(3):332–8.

432. Lloyd M, Watmough S, O'Brien S, Furlong N, Hardy K. Exploring attitudes and opinions of pharmacists toward delivering prescribing error feedback: a qualitative case study using focus group interviews. Res Social Adm Pharm. 2016;12(3):461–74.

433. Lloyd M, Watmough S, O'Brien S, Furlong N, Hardy K. Exploring the impact of feedback on prescribing error rates: a pilot study. Int J Clin Pharm. 2017;39(5):1013–7.

434. McLellan L, Dornan T, Newton P, Williams SD, Lewis P, Steinke D, et al. Pharmacist-led feedback workshops increase appropriate prescribing of antimicrobials. J Antimicrob Chemother. 2016;71(5):1415–25.

435. Chaturvedi S, Sinha P, Chandra PS, Desai G. Improving quality of prescriptions with clinical audit. Indian J Med Sci. 2008;62(11):461–4.

436. Ungvari G, Chow L, Chiu H, Ng F, Leung T. Modifying psychotropic drug prescription

patterns: a follow-up survey. Psychiatry Clin Neurosci. 1997;51(5):309–14.

437. Thompson A, Sullivan S, Barley M, Strange S, Moore L, Rogers P, et al. The DEBIT trial: An intervention to reduce antipsychotic polypharmacy prescribing in adult psychiatry wards - a cluster randomized controlled trial. Psychol Med. 2008;38(5):705–15.

438. Thompson A, Sullivan S, Barley M, Moore L, Rogers P, Sipos A, et al. Effectiveness of a cognitive behavioural workbook for changing beliefs about antipsychotic polypharmacy: analysis from a cluster randomized controlled trial. J Eval Clin Pract. 2010;16(3):520–8.

439. Prajapati AR, Johnston E, Ugochukwu U, Solomka B. Prescribing quality improvement: reducing high-dose antipsychotic use. Prog Neurol Psychiatry. 2017;21(3):18–21.

440. Mace S, Taylor D. Reducing the rates of prescribing high-dose antipsychotics and polypharmacy on psychiatric inpatient and intensive care units: Results of a 6-year quality improvement programme. Ther Adv Psychopharmacol. 2015;5(1):4–12.

441. Hazra M, Uchida H, Sproule B, Remington G, Suzuki T, Mamo DC. Impact of feedback from pharmacists in reducing antipsychotic polypharmacy in schizophrenia. Psychiatry Clin Neurosci. 2011;65(7):676–8.

442. Baandrup L, Allerup P, Lublin H, Nordentoft M, Peacock L, Glenthoj B. Evaluation of a multifaceted intervention to limit excessive antipsychotic co-prescribing in schizophrenia out-patients. Acta Psychiatr Scand. 2010;122(5):367–74.

443. Seidling HM, Stützle M, Hoppe-Tichy T, Allenet B, Bedouch P, Bonnabry P, et al. Best practice strategies to safeguard drug prescribing and drug administration: an anthology of expert views and opinions. Int J Clin Pharm. 2016;38(2):362–73.

444. McCartney C, Sadasivam S, Shaw F, Henry A. Foundation doctor - pharmacist buddy scheme: Evaluation of a sucessful programme [Abstract]. Guild of Healthcare Pharmacists and United Kingdom Clinical Pharmacy Association 11th Joint National Conference. 2015. p. 31.

445. Edmondson A. Learning from failure in health care: frequent opportunities, pervasive barriers. Qual Saf Health Care. 2004;13(suppl 2):ii3-9.

446. NHS Improvement. NRLS national patient safety incident reports. 2018.

447. Abbasinazari M, Hajhossein A, Eshraghi A, Sahraei Z. Detection and management of medication errors in internal wards of a teaching hospital by clinical pharmacists. Acta Med Iran. 2013;51(7):482–6.

448. Ben-Yehuda A, Bitton Y, Sharon P, Rotfeld E, Armon T, Muszkat M. Risk factors for prescribing and transcribing medication errors among elderly patients during acute hospitalization: a cohort, case-control study. Drugs Aging. 2011;28(6):491–501.

449. Dutton K, Hedger N, Wills S, Brown D, Davies P. Prevent medication errors on admission. Clin Gov. 2003;8(2):128–38.

450. Jani Y, Barber N, Wong I. Paediatric dosing errors before and after electronic prescribing. Qual Saf Health Care. 2010;19(4):337–41.

451. Montesi G, Lechi A. Prevention of medication errors: detection and audit. Br J Clin Pharmacol. 2009;67(6):651–5.

452. National Coordinating Council for Medication Error Reporting and Prevention. Index for Categorizing Medication Errors Algorithm. 2001.

453. National Coordinating Council for Medication Error Reporting and Prevention. Index for Categorizing Medication Errors. 2001.

Appendices

Appendix 1: Summary of primary research into prescribing errors in mental health settings

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Ayani N, Sakuma M, Morimoto T, Kikuchi T, Watanabe K, Narumoto J, et al. The epidemiology of adverse drug events and medication errors among psychiatric inpatients in Japan: the JADE study. BMC Psychiatry 2016;16(1):303.[142]	To estimate the incidence and nature of ADEs and medication errors among psychiatric inpatients in Japan.	• 438 psychiatric inpatient beds in one psychiatric hospital and one tertiary care teaching hospital, Japan • Retrospective cohort study of psychiatric inpatients admitted and discharged from 1 April 2010 to 31 March 2011 Outcome measured: • number of ADEs • medication errors	Definition: • Not reported Subclass of medication errors studied: • Ordering • Monitoring	Denominator: • 1000 patient days Rate of error: • All errors: 398 o 39% of patients o 17.5 per 1000 patient days o 88.8 per 100 admissions Distribution of errors: • Ordering 134/398 (34%) • Monitoring 155/398 (39%) Distribution of medications involved: • Not reported	Distribution of severity: • Not reported Method of severity rating: • Not reported
Grasso BC, Genest R, Yung K *et al.* Reducing errors in discharge medication by using personal digital assistants. Psychiatr Serv. 2002; 53(10):1325-6[133]	To examine whether the number of errors in discharge medication lists at a psychiatric hospital would decrease when the practice of transcribing the lists by hand from physicians' discharge orders was replaced by the use of personal digital assistants (PDAs) to create and directly print out such lists.	• 103 bedded state psychiatric hospital, Maine, USA • Civil and forensic patients admitted • Retrospective comparison of hand-transcribed and PDA discharge medication lists o Hand-transcribed data collected 1 June to 30 September 2000 o PDA-generated data collected 1 April to 31 July 2001 Outcomes measured: • Rate of errors found in discharge medication lists	Definition: • Erroneous exclusion of a currently used medication; erroneous addition of a new drug; incorrect or incomplete dosage, quantity to be dispensed, or frequency of administration; illegibility; and inclusion of usages that are prone to misinterpretation. Subclass of medication errors studied: • Transcription	Denominator: • Number of discharge medication lists Rate of error: • Hand-transcribed: 20/110 (18%) • PDA-generated: 7/90 (8%) Distribution of errors: • Not reported Distribution of medications involved: • Not reported	Distribution of severity: • Not reported Method of severity rating: • Not reported

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Grasso BC, Genest R, Jordan CW *et al*. Use of chart and record reviews to detect medication errors in a state psychiatric hospital. Psychiatr Serv. 2003; 54(5): 677-81[121]	To compare the effectiveness of using a review team and the usual self-reporting method for detecting different types of medication errors in a state psychiatric hospital	• 103 bedded state psychiatric hospital, Maine, USA • Civil and forensic patients admitted • Retrospective chart review of entire hospitalisation of a random selection of 31/95 patients discharged from 1 June to 15 October 2001 • Prospective clinician self-reporting of medication errors via incident reporting system Outcomes measured: • Rate of medication errors • Severity of error	Definition: • NCC MERP definition Subclass of medication errors studied: • Prescribing • Transcription • Dispensing • Administration	Denominator: • Error per 1000 patient days Rate of error: • Prescribing: 165 • Transcription: 344 Distribution of errors: • Prescribing: 239/2,194 (11%) • Transcription: 498/2,194 (23%) Distribution of medications involved: • Not reported Comment: The review team detected a total of 2,194 medication errors compared with only 9 self-reported incidents for the same patient group (a ratio of 244:1)	Distribution of severity (<u>all error types</u>): • Low risk of harm: 19% • Moderate risk of harm: 23% • High risk of harm: 58% Method of severity rating: • Rated by review team with a random sample of 15 records checked by the medical director on two occasions for consistency
Haw C, Stubbs J. Prescribing errors in a psychiatric hospital. Pharm Pract. 2003; 13(2): 64-6[100]	To determine the nature, frequency and potential severity of prescribing errors detected by pharmacists working in a psychiatric hospital	• 400 bedded private psychiatric tertiary referral centre, Northampton, UK • Adolescent, brain injured, elderly, forensic and learning disabilities • Prospective recording of prescribing errors on a data entry form by pharmacists during January 2002 Outcomes measured: • Rate of prescribing errors • Severity of error	Definition: • Dean *et al* definition[25] Subclass of medication errors studied: • Prescribing	Denominator: • Number of medication orders checked recorded on four sample days Rate of error: • Overall 50/2,274 (2.2%) • Psychotropic 34/1,180 (2.9%) • Non-psychotropics 16/1,094 (1.5%) Distribution of errors: • Prescription writing (clerical): 272/311 (87.5%) • Decision making: 39/311 (12.5%) Distribution of medications involved: • Psychotropics: 124/311 (39.8%) • Non-psychotropics: 187/311 (60.1%)	Distribution of severity (all error types): • Clinically insignificant: 173/311 (56%) • Minimal clinical significance: 111/311 (36%) • Potentially serious (could cause harm): 27/311 (9%) • Potentially life-threatening: nil Method of severity rating: • Rated independently by review team on scale above. Median used if no agreement Comment: Potentially serious errors were more likely to be made by junior than consultant psychiatrists

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Haw C, Cahill C. A computerized system for reporting medication events in psychiatry: the first two years of operation. J Psychiatr Ment Health Nurs. 2011; 18(4):308-16[143]	To describe the first 2 years of operation of an electronic system for reporting medication events in psychiatry	• 570 bedded private psychiatric tertiary referral centre, Northampton, Essex & Birmingham, UK • Forensic & rehabilitation, older adults, adolescents and acquired brain injury • Descriptive analysis of medication events reported via the electronic system between 1 March 2008 and 28 February 2010 Outcomes measured: • Number of incidents reported • Severity of error	Definition: • Dean *et al* definition[25] Subclasses of medication errors studied: • Prescribing • Dispensing • Administration	Denominator: • Not reported Rate of error: • Prescribing: 30 Distribution of errors: • Prescribing: 30/446 (6.7%) Distribution of medications involved (all error types): • Psychotropics: 276/377 (73.2%) • Non-psychotropics: 133/377 (35.3%)	Distribution of severity (all error types): • Insignificant: 88/446 (19.7%) • Minor: 330/446 (74.0%) • Moderate: 24/446 (5.4%) • Serious: 4/446 (0.9%) • Life-threatening: nil Method of severity rating: • Rated independently by review team with inter-rater reliability checked for 20 errors
Higuchi A, Higami Y, Takahama M, Yamakawa M, Makimoto K. Potential underreporting of medication errors in a psychiatric general hospital in Japan. Int J Nurs Pract. 2015;21(2):2–8.[144]	To explore a pattern of underreporting by comparing medication errors among 17 wards in a psychiatric general hospital	• 948 bedded psychiatric general hospital, Osaka, Japan • Acute care, dementia care, psychiatric long-term care, psychiatric general • Quantitative analysis of prospectively collected incidence reports in the fiscal year of 2010 Outcomes measured: • Number of incidents reported • Number of incidents reported by ward • Severity of incidents	Definition: • Not reported Subclasses of medication errors studied: • Prescribing • Dispensing • Administration	Denominator: • 1000 patient-days Rate of error: • Prescribing: 2.6% of all medication incidents reported online (17 incidents) Distribution of errors: • Not reported Distribution of medications involved: • Not reported	Distribution of severity (all error types): • Intercepted near miss: 12.3% • Non-intercepted near miss: 61.6% • Minor: 24% • Moderate: not recorded (assume nil) • Serious: nil • Serious/life-threatening: nil Method of severity rating: • Self-rated by incident reporter Comment: Majority of reported incidents related to administration (94%). Main perspective of study was differences in reporting rates between individual wards.

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Ito H, Yamazumi S. Common types of medication errors on long-term psychiatric care units. Int J Qual Health Care. 2003; 15(3): 207-12[125] Also reported as Sawamura K, Ito H, Yamazumi S, *et al*. Interception of potential adverse drug events in long-term psychiatric care units. Psychiatry Clin Neurosci. 2005; 59(4): 379–84.[134]	To identify the most frequent types of medication errors in long-term psychiatric care hospitals	• 85 long-stay units in 44 private psychiatric hospitals, Japan • Analysis of incident reports between 1 October and 30 November 2000 Outcomes measured: • Types of potential adverse drug events • Severity of error	Definition: • Any event that could be harmful to patients on participating units, whether the incident was intercepted or not Subclasses of medication errors studied: • Prescribing • Dispensing • Administration	Denominator: • Error per 1000 patient days Rate of error: • All errors: 221 (0.79 per 1000 patient days) • Prescribing: nil Distribution of errors: • Not reported Distribution of medications involved: • Not reported	Distribution of severity (<u>all error types</u>): • Clinically insignificant: 125/221 (56.6%) • Potentially significant: 33/221 (14.9%) • Potentially serious: 63/221 (28.5%) Method of severity rating: • Self-rated by incident reporter Comment: All reported errors appear to relate to administration
Jayaram G, Doyle D, Steinwachs D, *et al*. Identifying and reducing medication errors in psychiatry: creating a culture of safety through the use of an adverse event reporting mechanism. J Psychiatr Pract. 2011; 17(2): 81–9[145]	To investigate medication errors on inpatient psychiatric units	• 88-bed psychiatric division of an academic, inner-city hospital, Baltimore, US • Incident report analysis for years 2003, 2005 and 2007 Outcomes measured: • Number of incidents reported	Definition: • Not reported Subclasses of medication errors studied: • Prescribing • Transcription • Preparation • Administration • Monitoring	Denominator: • Error per 100 patient days Rate of error (all error types): • 2003: 27.9 • 2005: 5.5 • 2007: 3.4 Distribution of errors: • Prescribing o 2003: 12/494 (2.4%) o 2005: 5/133 (3.8%) o 2007: 15/100 (15.0%) • Transcription o 2003: 249/494 (50.4%) o 2005: 39/133 (29.3%) o 2007: 17/100 (17.0%) Distribution of medications involved: • Not reported	Distribution of severity: • Not Reported

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Jhanjee A, Bhatia M, Oberoi A, Srivastava S. Medication errors in psychiatric practice - a cross-sectional study. Delhi Psychiatry J 2012;15(1):5–13.[146]	To identify and quantify various types of medication errors in psychiatric prescriptions	• psychiatry outpatient department of tertiary hospital, Delhi, India • Cross-sectional study of psychiatric outpatient prescriptions between 1 March 2009 and 1 November 2011 Outcomes measured: • Frequency of errors • Nature of errors	Definition: • Dean *et al* definition[25] • WHO guidelines for prescription writing[153] Subclasses of medication errors studied: • Prescribing	Denominator: • Not reported Rate of error: • Not reported Distribution of errors: • error categories reported as absolute numbers Distribution of medications involved: • Not reported	Distribution of severity: • Not reported Method of severity rating: • Not reported
Keers RN, Williams SD, Vattakatuchery JJ, et al. Prevalence, nature and predictors of prescribing errors in mental health hospitals: a prospective multicentre study. BMJ Open. 2014;4(9):e006084.[147]	To determine the prevalence, nature and predictors of prescribing errors in three mental health hospitals	• Inpatient units in three NHS mental health hospitals in the North West of England • Prospective recording of prescribing errors in newly written or omitted medication orders screened on 10 data collection days between January and April 2013 Outcomes measured: • Frequency of errors • Nature of errors • Potential severity of errors • Predictors of errors	Definition: • Dean *et al* definition[25] Subclasses of medication errors studied: • Prescribing	Denominator: • Number of newly written or omitted medication orders screened Rate of error: • 281/4,427 (6.3%) items affected (288 total errors) Distribution of errors: • by prescribing stage o On admission 92/863 (10.7%) o During stay 100/1530 (6.5%) o Rewritten 46/1273 (3.6% o Leave 11/247 (4.5%) o Discharge 32/495 (6.5%) • by prescriber o FY1 11/216 (5.1%) o FY2 26/536 (4.9%) o Specialty trainee 159/2336 (6.8%) o Staff grade 30/465 (6.5%) o Consultant 34/586 (5.8%) o Pharmacist 0/10 (0%) o Nurse prescriber 0/12 (0%) o Unknown prescriber 21/266 (7.9%) Distribution of medications involved: • Not reported	Distribution of severity: • Minor: 126/288 (43.8%) • Significant: 142/288 (49.3%) • Serious: 19/288 (6.6%) • Life-threatening: 1/288 (0.3%) Method of severity rating: • Validation undertaken by a multidisciplinary panel

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Keers R, Williams S, Vattakatuchery J, Brown P, Miller J, Prescott L, et al. Medication safety at the interface: evaluating risks associated with discharge prescriptions from mental health hospitals. J Clin Pharm Ther 2015;40(6):645–54.[139]	To determine the prevalence, nature and predictors of prescribing errors affecting discharge prescriptions in three mental health hospitals	• Inpatient units in three NHS mental health hospitals in the North West of England • Prospective recording of prescribing errors in newly written or omitted medication orders screened during 6 weeks between February and March 2014 Outcomes measured: • prescription writing errors • clerical errors • inadequate communication	Definition: • Dean *et al* definition[25] Subclasses of medication errors studied: • Prescribing	Denominator: • Number of newly written or omitted medication orders screened in discharge prescriptions Rate of error: • 222/259 (81%) discharges affected by at least one error Distribution of errors: • discharge prescriptions: 54/259 (20.8%) • medication orders 74/1,456 (5.1%) • clerical errors: 197/274 (71.9%) • communication issues: 44/64 (68.8%) Distribution of medications involved: • CNS: 36/74 (48.65%) • Respiratory: 21/74 (28.4%) • Cardiovascular: 6/74 (8.1%) • Endocrine: 4/74 (5.4%) • Others: 7/74 (9.5%)	Distribution of severity (prescribing errors): • Clinically relevant: 54/74 (52.9%) • Serious: 4/74 (5.4%) Method of severity rating: • Validation undertaken by a multidisciplinary panel
Maidment ID, Thorn A. A medication error reporting scheme: analysis of the first 12 months. Psychiatr Bull R Coll Psychiatr. 2005; 29(8): 298-301[124]	To analyse all mediation incidents reported in the first year of a new medication error reporting system	• Single NHS and Social Care Trust, Kent, UK • Patient population not specified • Incident report analysis • April 2003 to March 2004 Outcomes measured: • Type of error • Site of error	Definition: • Not reported Subclasses of medication errors studied: • Prescribing • Dispensing • Administration	Denominator: • Error per month Rate of error (all error types): • 5.5 per month Distribution of errors: • Prescribing: 2/66 (3.0%) Distribution of medications involved: • Not reported	Distribution of severity (all error types): • Low: 40/66 (60.6% • Moderate: 23/66 (34.8%) • High: 3/66 (4.5%) • Life-threatening: nil Method of severity rating: • Rated by single rater using Likert scale of 1-5 Comment: Moderate and severe incidents occurred disproportionately on older adult in-patient wards

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Nirodi P, Mitchell AJ. The quality of psychotropic drug prescribing in patients in psychiatric units for the elderly. Aging Ment Health. 2002; 6(2): 191-6[127]	To examine the quality of drug prescribing by medical staff for elderly patients hospitalised with dementia in comparison with functional psychiatric illness	• Two psychiatric inpatient units for the elderly (≥ 65 years), Yorkshire, UK o Unit A - medium size hospital with catchment population of 50,000 o Unit B - regional psychiatric hospital with catchment population of 110,080 • Retrospective review of prescription charts for the duration of index admission for a representative sample of 112 patients Outcomes measured: • Number of prescription records containing errors	Definition • Six measures of prescribing quality (psychotropics only) Subclasses of medication errors studied: • Prescribing	Denominator: • Patient episode Rate of error: • 92/112 (82%) patient records contained an error Distribution of errors (dementia *vs.* functionally ill): • Illegibility 19.9% *vs.* 11.0% • Frequency of administration missing: 36.5% *vs.* 22.5% • Dose missing: 25.2% *vs.* 5.8% Distribution of medications involved: • Not reported	Distribution of severity: • Not reported Comment: Prescribing quality was inferior for patients with a diagnosis of dementia compared to those with functional illness.
Paton C, Gill-Banham S. Prescribing errors in psychiatry. Psychiatr Bull R Coll Psychiatr. 2003; 27(6): 208-10[128]	To describe prescribing errors within psychiatry by analysing interventions made by pharmacists	• Twelve mental health trusts, UK • Prospective recording by psychiatric pharmacists of the details of prescribing errors during May 2002 Outcomes measured: • Nature of prescribing errors • Action taken by the pharmacist	Definition: • Not reported Subclasses of medication errors studied: • Prescribing	Denominator: • Not reported Rate of error (all error types): • 557 interventions reported Distribution of errors: • Prescription writing (clerical): 155/557 (27.8%) • Decision making: 335/557 (60.1%) • Other: 67/557 (12.0%) Distribution of medications involved: • Psychotropics: 377/557 (67.7%) • Non-psychotropics: 180/557 (32.3%)	Distribution of severity: • Potentially serious outcome: 63/557 (11.3%) Method of severity rating: • Not reported Comment: Action taken by pharmacists: • Contacted prescriber directly: 338/557 (60.6%) • Left note on prescription chart/ward diary: 180/557 (32.3%) • Spoke to nursing staff: 95/557 (17.1%) • Wrote in clinical notes: 5/557 (0.9%)

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Rothschild JM, Mann K, Keohane CA *et al*. Medication safety in a psychiatric hospital. Gen Hosp Psychiatry. 2007; 29(2): 156-62[130]	To assess the epidemiology of medication errors and adverse drug events in a psychiatric hospital.	• 172-bed academic psychiatric hospital, New England, USA • Dissociative disorders and trauma, schizophrenia and bipolar, geriatric, acute psychiatric, dementia • Acute inpatient satellite unit off campus • Prospective data collection using healthcare record review, staff reports and pharmacy intervention reports between 1 September 2004 and 28 February 2005 Outcomes measured: • Types of medication errors • Adverse drug events	Definition: • Bates *et al* definition[12] Subclasses of medication errors studied: • Prescribing • Transcription • Administration	Denominator: • 1000 patient days • 100 admissions Rate of error (all error types): • 10.6 per 1000 patient days • 10.8 per 100 admissions Rate of error (prescribing): • 7.2 per 1000 patient days • 7.4 per 100 admissions Distribution of errors: • Prescribing: 138/203 (67.9%) • Transcription: 40/203 (19.7%) Distribution of medications involved: • Psychotropics: 141/203 (69.5%) o Antipsychotics: 51/203 (26.1%) o Mood stabilisers: 49/203 (24.1%) o Antidepressants: 18/203 (8.9%) o Anxiolytics/sedatives: 18/203 (8.9%) • Non-psychotropics: 62/203 (30.5%)	Distribution of severity (all error types): • Significant: 103/203 (50.7%) • Serious: 91/203 (44.8%) • Life-threatening: 9/203 (4.4%) Method of severity rating: • Rated by physician raters using 4-point Likert scale. Disagreements resolved by discussion
Sahithi HK, Mohammad I, Manoranjani Reddy J, Nandha Kishore G, Ramesh M, Sebastian J. Assessment of medication errors in psychiatry practice in a tertiary care hospital. Int J Pharm Sci Res 2015;6(1):226–32.[140]	To determine the incidence, causes, patterns, outcomes and predictors of medication errors in psychiatric practice	• 1,200-bed psychiatry department, tertiary hospital, Mysore district, India • Prospective data collection from November 2012 to April 2013. • Patients aged 18 years and over (inpatients and outpatients) receiving at least one psychotropic agent Outcomes measured: • Number of medication errors • Types of medication errors	Definition: • NCC MERP definition Subclasses of medication errors studied: • Prescribing • Administration • Dispensing	Denominator: • Patients Rate of error (all error types): • 215 errors in 166 patients; 1.3 errors per patient • Prescribing: 72 errors in 59 patients Rate of error (prescribing): • Not reported Distribution of errors: • Prescribing: 72/215 (33.5%) Distribution of medications involved: • Not reported	Distribution of severity: • Not reported

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Sawamura K, Ito H, Yamazumi S, *et al*. Interception of potential adverse drug events in long-term psychiatric care units. Psychiatry Clin Neurosci. 2005; 59(4): 379–84.[134] Also reported as Ito H, Yamazumi S. Common types of medication errors on long-term psychiatric care units. Int J Qual Health Care. 2003; 15(3): 207-12[125]	To identify the most frequent types of medication errors in long-term psychiatric care hospitals	• 85 long-stay units in 44 private psychiatric hospitals, Japan • Analysis of incident reports between 1 October and 30 November 2000 Outcomes measured: • Types of potential adverse drug events • Severity of error	Definition: • Any event that could be harmful to patients on participating units, whether the incident was intercepted or not Subclasses of medication errors studied: • Prescribing • Dispensing • Administration	Denominator: • Error per 1000 patient days Rate of error: • All errors: 221 (0.79 per 1000 patient days) • Prescribing: nil Distribution of errors: • Not reported Distribution of medications involved: • Not reported	Distribution of severity (<u>all error types</u>): • Clinically insignificant: 125/221 (56.6%) • Potentially significant: 33/221 (14.9%) • Potentially serious: 63/221 (28.5%) Method of severity rating: • Self-rated by incident reporter Comment: All reported errors appear to relate to administration
Shawahna R, Rahman N-U. Prescribing errors in psychiatry department: an audit from a hospital in Lahore. J Pak Psychiatr Soc 2008;5(1):31–3.[136]	To investigate the incidence of prescribing errors in a psychiatry ward, and the types of errors encountered	• 15 randomly selected inpatient cases from a psychiatry department, Lahore, Pakistan • Prospective review over a period of 15 days from 1 September 2006 Outcomes measured: • Number of prescribing errors • Percentage of prescribing errors • Types of prescribing errors	Definition: • Not reported Subclasses of medication errors studied: • Prescribing	Denominator: • Number of medications prescribed Rate of error: • 33/84 (39.28%) Distribution of errors: • Not reported Distribution of medications involved: • Not reported	Distribution of severity: • Not reported
Sirithongthavorn S, Narkpongphun A, Kamduang N, Isarapongs P, Kanjanarat P. Common types of medication errors of outpatient service in pediatric psychiatry care [abstract]. Pharmacoepidemiol Drug Saf 2009;18(Suppl 1):S245-6.[137]	To identify incidence and types of medication errors related to paediatric psychiatry outpatient services	• Outpatient unit of a tertiary psychiatric care hospital for children, Thailand • Prospective review of every prescription, January to December 2007	Definition: • Not reported Subclasses of medication errors studied: • Prescribing • Pre-prescribing • Dispensing	Denominator: • Number of medications prescribed Rate of error: • All errors: 2.42% • Prescribing: 180/7,444 Distribution of errors: • Not reported Distribution of medications involved: • Not reported	Distribution of severity: • Not reported

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Soerensen AL, Lisby M, Neilsen LP *et al.* The medication process in a psychiatric hospital: are errors a potential threat to patient safety? Risk Manage Healthc Policy. 2013; 6: 23-31[149]	To investigate the frequency, type and potential severity of errors in several stages of the medication process in an inpatient psychiatric setting	• Three psychiatric wards, university hospital, Denmark • Prospective data collection using direct observation, unannounced visits and chart review between January and April 2010 Outcomes measured: • Frequency of errors	Definition: • A planned action which failed to achieve the desired consequences (including deviation from guidelines) Subclasses of medication errors studied: • Prescribing • Dispensing (≡ decanting by nurses) • Administration • Discharge summaries	Denominator: • Opportunity for error Rate of error (all error types): • 189 errors in 1,082 opportunities for error (17.5%) Rate of error: • Prescribing: 10/267 (3.7%) • Discharge summaries: 19/84 (22.6%) Distribution of errors: • Prescribing: 10/189 (5.3%) • Discharge summaries: 19/189 (10.1%) Distribution of medications involved (prescribing; only with potential to be serious/fatal): • Antipsychotics: 3/6 (50%) • Analgesics: 2/6 (33.3%) • Anxiolytic/sedative: 1/6 (16.7%)	Distribution of severity: • Potentially non-significant: nil • Potentially significant: 4/10 (40%) • Potentially serious: 4/10 (40%) • Potentially fatal: 2/10 (20%) Method of severity rating: • Rated independently by two clinical pharmacologists using a four-point scale. More severe category used if disagreement between raters. Inter-rater agreement of 1.0 for prescribing.
Stubbs J, Haw C, Cahill C. Auditing prescribing errors in a psychiatric hospital. Are pharmacists' interventions effective? Hosp Pharm. 2004; 11(5): 203-6[99]	To determine the nature and severity of prescribing detected by pharmacists in a psychiatric hospital. To assess the effectiveness of pharmacy interventions for correcting these errors	• 550 bedded private psychiatric tertiary referral centre, Northampton, UK • Adolescent, brain injured, elderly, forensic, learning disabilities, general psychiatry • Prospective recording of prescribing errors on a data entry form by pharmacists during March 2003 Outcomes measured: • Rate of prescribing errors • Severity of error • Nature and effectiveness of pharmacists' interventions	Definition: • Dean *et al* definition[25] Subclass of medication errors studied: • Prescribing	Denominator: • Not recorded Rate of error: • 211 errors reported Distribution of errors: • Prescription writing (clerical): 161/211 (76.3%) • Decision making: 50/211 (23.7%) Distribution of medications involved: • Psychotropics: 111/211 (52.6%) o Antipsychotics: 61/211 (28.9%) o Hypnotic/anxiolytics: 18/211 (8.5%) • Non-psychotropics: 100/211 (47.4%) o GI medications: 21/211 (10.0%) o Topical medications: 16/211 (7.6%)	Distribution of severity (all error types): • Clinically insignificant: 173/311 (56%) • Minimal clinical significance: 111/311 (36%) • Definitely clinically significant: 27/311 (9%) • Potentially life-threatening: nil Method of severity rating: • Rated independently by review team. Median used if no agreement Comment: 136/211 (64.8%) of cases, the drug involved was administered before error detected. 183/198 (92.4%) of interventions were accepted.

Reference	Objective(s)	Design and details of study	Definition of error and type studied	Number and rate of error	Severity of errors and method of rating severity
Stubbs J, Haw C, Taylor D. Prescription errors in psychiatry - a multi-centre study. J Psychopharmacol. 2006; 20(4): 553-61[101]	To examine and compare the nature, frequency and potential severity of prescribing errors across a range of UK mental health units. To determine if higher relative pharmacy staffing levels were associated with higher prescribing error detection rates.	• 8 NHS trusts and 1 private psychiatric hospital, England and Wales • Prospective recording of prescribing errors detected by pharmacists as part of their routine work, over 1 week (5 working days) in June 2004 Outcomes measured: • Rate of errors • Type of error • Severity of error • Comparative detection rates	Definition: • Dean *et al* definition[25] • Errors relating to the whole prescription chart were excluded from analysis Subclasses of medication errors studied: • Prescribing	Denominator: • Number of medication orders checked Rate of error: • Overall 523/22,036 (2.4%) • Psychotropics: 289/11,688 (2.5%) • Non-psychotropics: 212/10,368 (2.0%) Distribution of errors: • Prescription writing (clerical): 405/523 (77.4%) • Decision making: 118/523 (22.6%) Distribution of medications involved: • Psychotropics: 289/523 (55.3%) o Antipsychotics: 89/523 (17.0%) o Hypnotic/anxiolytics: 69/523 (13.2%) • Non-psychotropics: 212/523 (40.5%) o GI medications: 35/523 (6.7%) o Analgesics: 31/523 (5.9%)	Distribution of severity: • Doubtful or negligible importance: 250/523 (47.85) • Minor importance: 240/523 (45.9%) • Serious effect or relapse: 17/523 (3.3%) • Potentially fatal: 5/523 (1.0%) Method of severity rating: • Rated by mutual agreement of authors. Most severe errors independently rated by panel of psychopharmacologists. Comment: Fourfold variation in error detection between sites (range 1.2 - 4.5%) but no correlation with time taken to check one medication order (used as measure of pharmacy workload relative to staffing levels)

Appendix 2: Biases and Failed Heuristics

Ambiguity bias	The display of preference for known or certain probabilities over uncertain probabilities regardless of the actual benefits.
Anchoring bias	The tendency to be unduly persuaded by features encountered early in the presentation of illness, thereby committing to a premature diagnosis.
Availability bias	The tendency to overestimate the prevalence of an event which has recently been encountered or read about
Bandwagon effect	An accelerating diffusion through a group of a pattern of behaviour, the probability of any individual adopting it increasing with the proportion who have already done so.
Bounded rationality	A restrictive 'keyhole' view of the problem being confronted
Confirmation bias	Attention is directed disproportionally towards observations that appear to confirm a hypothesis instead of seeking evidence that might disprove it.
Conjunction fallacy	The likelihood of two or more independent instances occurring is overestimated through mistakenly linking them in a cause-effect relationship
Hindsight bias	Exaggerating what may have been anticipated in foresight and overestimating what was known at the time the case was first encountered
Impact bias	Failure to anticipate the ability to adapt to new states. The tendency to overestimate the long-term impact of both positive and negative events.
Omission bias	The tendency to prefer the consequences of inaction (omission) rather than commit to doing something that changes the patient's course.
Outcome bias	The tendency to judge the quality of a decision in terms of its outcome
Prevalence bias	The tendency to misjudge the true base rate of a disease
Representativeness bias	Mistaken belief that circumstantial factors are representative of an event that the observer is anxious not to miss
Search satisficing	Calling off the search for further information having found the first result

Appendix 3: Database Searches

1. EMBASE, MEDLINE, PsycINFO, CINAHL; (((medication AND error) OR (prescribing AND error)) AND (mental health OR psychiatr*)).ti,ab [Limit to: Publication Year 2000-2014]; 329 results.

2. EMBASE, MEDLINE, PsycINFO, CINAHL; ((prescribing AND error) AND thinking).ti,ab [Limit to: Publication Year 2000-2014]; 0 results.

3. EMBASE, MEDLINE, PsycINFO, CINAHL; (((medication AND error) OR (prescribing AND error)) AND psychology).ti,ab [Limit to: Publication Year 2000-2014]; 21 results.

4. EMBASE, MEDLINE, PsycINFO, CINAHL; (pathophysiology AND (medication OR prescribing) AND error).ti,ab [Limit to: Publication Year 2000-2014]; 49 results.

5. EMBASE, MEDLINE, PsycINFO, CINAHL; ("dual process" AND (health OR medicine OR prescribing)).ti,ab [Limit to: Publication Year 2000-2014]; 125 results.

6. EMBASE, MEDLINE, PsycINFO, CINAHL; ("cognitive psychology" AND (health OR medicine OR prescribing) AND error).ti,ab [Limit to: Publication Year 2000-2014]; 42 results.

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5. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2000-2002]; 242 results.

7. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2003-2005]; 438 results.

9. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2006-2007]; 350 results.

12. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2008-2008]; 203 results.

14. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2009-2009]; 309 results.

16. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2010-2010]; 312 results.

18. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2011-2011]; 399 results.

21. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2012-2012]; 392 results.

23. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2013-2013]; 358 results.

25. EMBASE, MEDLINE, PsycINFO, CINAHL; (((prescribing OR prescription) AND error)).ti,ab [Limit to: Publication Year 2014-2014]; 34 results.

Appendix 4: Options appraisal of potential methods

Decision Required	Detail	Options	Advantages	Disadvantages	Notes	Use	Refs
Prevalence and types of prescribing errors (inpatients only)							
Study population	Wards	All	• Gives greater chance of finding errors improving statistical rigour • Full range of sub-specialties • Can be reduced later if necessary	• Involves greater number of data collectors so consistency may be lower • Larger sample size necessary to retain statistical power for sub-specialty analysis? • Some wards visited less frequently than others (needs to be taken into account in any bed-day calculations) • Would be impossible for researcher to be involved in data collection due to numbers and time requirements	Adult Assessment, OP Assessment, Adult Acute, Adult Rehabilitation, OP Continuing Care, Forensic, PICU, CAMHS	✓	
		Selection by geographic location	• Easier to collect data • Smaller number of data collectors involved so consistency may be higher • Will take longer to obtain number required for sample size	• Reduces range of sub-specialties involved so results less generalisable	Rochford (OP Assessment, Adult Acute, CAMHS) Brockfield (Low & medium secure) Basildon MHU (Adult & OP Assessment, PICU, Adult Acute)	✗	
		Selection by sub-specialty	• Easier to collect data • Smaller number of data collectors involved so consistency may be higher • Will take longer to obtain number required sample size • Some ward types visited daily, so data will be faster to collect	• Geographically dispersed • Less generalisable		✗	
Data items	Medication orders containing errors (numerator)	All	• Faster to collect required sample size • More work for ward pharmacists	• Difficult to ensure errors not double counted	Approach used by Bobb, Lesar, Ryan	✗	16,20,189,274
		Newly prescribed items (not previously screened by pharmacist)	• Easy to ensure errors not double counted • Workload remains manageable for ward pharmacists	• Will take longer to achieve required sample size	Approach used by Tully, Franklin, Ghaleb (implied), Stubbs (implied), Dean	✓	13,101,245,259 ,275,307
	Definition	Dean et al[25]	• Widely used	• Criticised by Ferner & Aronson	"definition is not the same as classification"; development of "case law"[104] Used by Avery, Dean, Franklin, Haw, Ghaleb	✓	13,22,85,89, 140,245

Decision Required	Detail	Options	Advantages	Disadvantages	Notes	Use	Refs
Data items	Denominator	Number/proportion of new medication orders in which a prescribing error found	• Measure of risk associated with prescribing act[318] • Less extra information for ward pharmacists to record • Effectively acting as a random sample		Approach used by Tully, Franklin, Dean 2% random sample used by Avery	✓	13,104,245,275,307
		Number/proportion of all medication orders in which a prescribing error found	• Measure of risk associated with prescribing act[318]	Obtain denominator - retrospectively estimate number of orders written during study period • Resource intensive • Time consuming • Some notes will be missing	Dean used 1 in 5 sample to estimate total numbers[14]	✗	14,189,260,318
				Obtain denominator - record all medication orders • Prohibitively time consuming	Used by Franklin (one 28-bedded ward; 2 x 4 weeks)	✗	155,260
				Obtain denominator - from pharmacy system • Not possible in UK because of use of ward stock whereas all IPD in US	Used by Lesar but different health system	✗	16,20
		Number of medication errors per patient day	• Measure of risk to individual patients[318] • Bed day data should be available for each ward	Obtain denominator - record all medication orders • Prohibitively time consuming	Used by Franklin (one 28-bedded ward; 2 x 4 weeks)	✗	155,260
	Errors per order	One prescribing error per order allowed		• Understates number of errors	Approach used by Barber, Dean	✗	14,260,318
		Multiple prescribing errors per order allowed	• Better reflection of actual situation		Approach used by Avery, Ghaleb, Haw, Seden, Stubbs, Dean, Franklin	✓	84,85,89,243,245,292
Data collection	Sample size				Aim to collect >200 errors. Will probably need about 10,000 items screened overall		
	Sampling period	Continuous until X number of items/ errors reached	• Required numbers will be achieved sooner	• Open ended which makes planning difficult • Risk of data collection fatigue which may lead to data not being rigorously collected	Approach used by Seden (min 400 items x 9 sites)	✗	257
		Defined time period (X weeks)	• Easier to plan dependent steps in the project	• Need to make sure that sample size accurately calculated at outset to ensure statistical power achieved	Approach used by Barber (4 weeks), Franklin, Dean (2 weeks), Ghaleb (2 weeks per ward x 11 wards i.e. 22 weeks), Haw, Stubbs (1 month), Stubbs (5 days)	✗	12,84–86,243,246,292

Decision Required	Detail	Options	Advantages	Disadvantages	Notes	Use	Refs
Data collection	Sampling period	Census days/weeks	• Intermittent data collection days reduces data collection fatigue • Easier to adjust process as get clearer picture of the number of errors being detected	• Need to ensure all weekdays included • Data collectors may forget details if too widely spaced • As irregular data collectors may forget to collect data • Need to make sure that sample size accurately calculated at outset to ensure statistical power achieved • May miss wards not visited weekly	Approach used by Tully (38 randomly selected days over 18 months), Franklin (1 day per fortnight, alternating Mondays & Wednesdays), Ryan (1 week each month), Seden (1 day per week, but different)	✓	174,231,244, 261
	Method	Drug chart review	• Part of routine clinical pharmacy activities • Ward pharmacist has access to information that is not in health care record	• Likely to identify 'trivial' deviations which would never be harmful[102] • Identifies fewer prescribing errors than retrospective review • May be deficiencies in documenting errors by ward pharmacists (especially for minor errors which they rectify) • Differences in clinical knowledge • Differences in diligence at finding and documenting errors	Approach used by Ajemigbitsi, Abbasinazari, Barber, Ben-Yehuda, Bobb, Colpaert, Dean, Donyai, Dornan, Dutton, Franklin, Haw, Jani, Kuo, Paton, Ross, Ryan, Stubbs, Tully	✓	13,18,99–102,104,113,128,178,185,189,244,245,256,260,274,275,307,447–450
		Medical record review	• Identifies more prescribing errors than drug chart review • More likely to identify omissions	• Far more time consuming (ten times longer per patient) • Unlikely to identify all errors as some items will have been changed/ceased for other reasons than error and where chart amended following intervention may not be obvious	Approach used by Grasso (31 patients), Leape & Rothschild (both real time)	✗	15,121,130,155
		Spontaneous reporting	• DATIX system already in place	• Dependent on voluntary reporting by staff • Poor quality data completion when do report • Huge degree of under-reporting	Not suitable for research purposes	✗	155
		Solicited reporting		• Dependent on recall of staff • Unlikely to identify more than a proportion of actual errors • Resource intensive	Approach used by Bates (twice daily), Leape (at least daily), Rothschild	✗	12,15,130
		Trigger tools		• Low identification rate for prescribing errors • Many false positives • Trigger tools do not exist for the error types being investigated	Not suitable for research purposes	✗	155

Decision Required	Detail	Options	Advantages	Disadvantages	Notes	Use	Refs
Data collection	Data collector	Ward pharmacist	• Part of routine clinical practice on wards • Familiar with patients • Familiar with prescribers • Has access to healthcare record • Able to collect larger quantities of data than a single researcher	• Adds to workload of ward pharmacists • Number that fail to be identified is unknown • Pharmacists will need training (1:1 ward based training suggested by Barber[260]) • Researcher will need to review all reported incidence against inclusion criteria • Differences in ability of ward pharmacists to detect errors • Differences in diligence of ward pharmacists at recording • Errors may be missed	Franklin identified 9 minutes per ward per day to collect the data	✓	87,140,227, 231,246,338
		Researcher	• Not adding to workload of ward pharmacists • Has access to healthcare record	• Less likely to detect errors (not clinical pharmacist) • Not familiar with patients • Not familiar with prescribers • Quantity of data able to collect will be limited		✗	
		Researcher shadowing ward pharmacist	• Part of routine clinical practice on wards • Familiar with patients • Familiar with prescribers • Has access to healthcare record	• Quantity of data able to collect will be limited • Researcher may be distraction to ward pharmacist resulting in normal work of lower quality • If ward pharmacists work at normal rate difficult for researcher to capture necessary information	Approach used by Ghaleb (5 data collectors shadowing 10 pharmacists)	✗	259
Data analysis	Classification of error type	Components of prescribing process	• Based on stages of the drug use process	• Developed for categorising clinical pharmacist interventions • May be difficult to decide which stage a prescribing error occurs in	Used by Tully, Franklin, Dean, Cousins, Suggested not appropriate by Barber	✓	14,155,260,261 ,275,304
		Clinical consequences	• May lead to concentration only on errors causing ADEs	• Number of errors which have actually caused harm to patient likely to be very small		✗	
		Psychological cause of error	• Links to Reason's model and therefore later sections of project	• Unless collecting information from prescribers based on assumption	Used by Leape (termed proximal cause), Lesar	✗	15,16
		Type of discrepancy	• Lisby - developed by consensus from error types identified in review of 203 studies		Used by Avery, Lisby, Grasso, Lesar, Ryan, Seden, Dornan, Franklin, Bobb	✓	17,19,71,89, 106,174,243, 260,292
		Dean et al scenarios[25]	• Should be relatively easy to identify categories	• "definition is not the same as classification" - considered inappropriate for this purpose by originator	Used by Haw & Stubbs (with extra MH scenarios)	✗	25,99–101
		WHO classification	• Should be internationally recognised	• Not widely used		✗	162

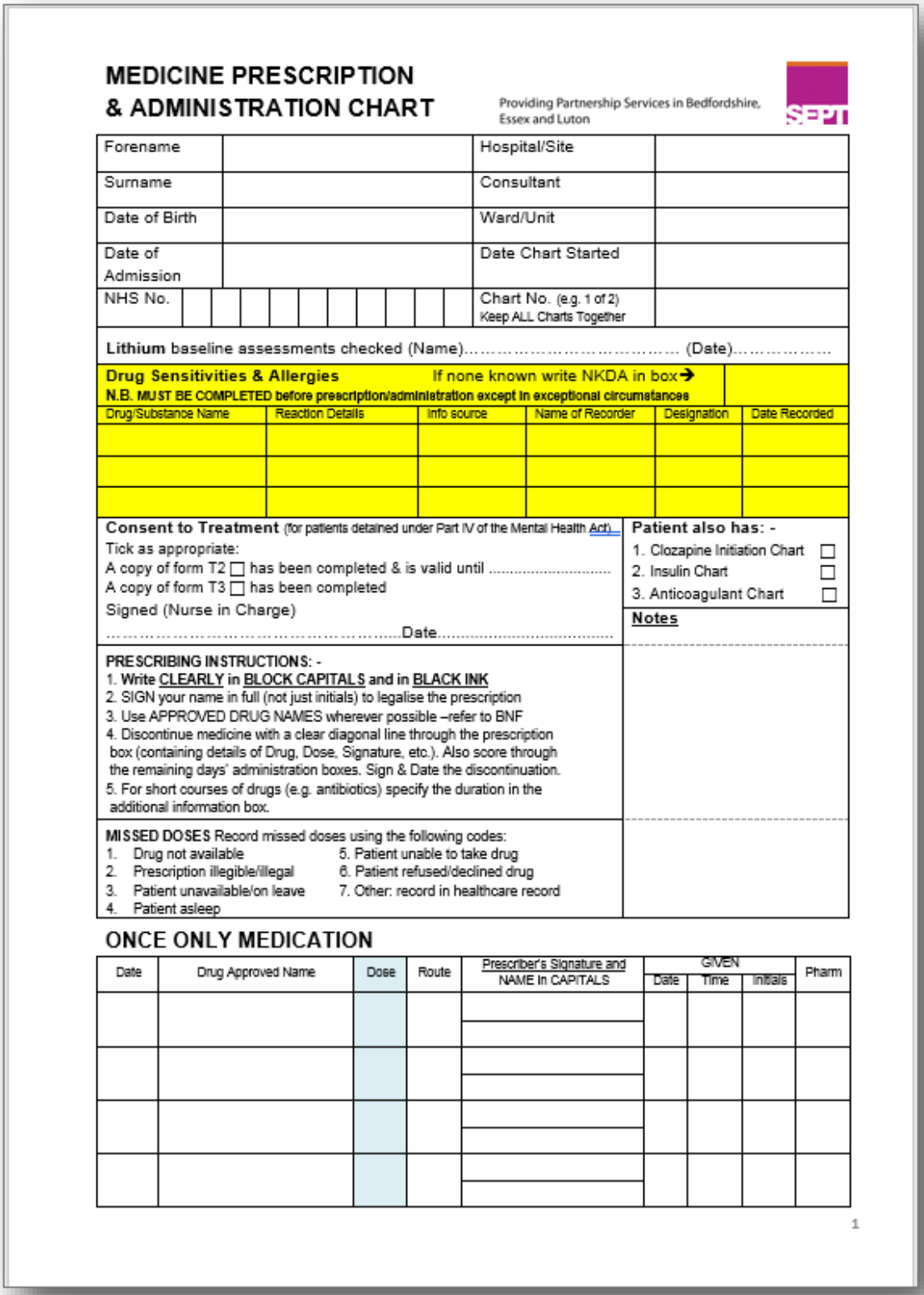
Decision Required	Detail	Options	Advantages	Disadvantages	Notes	Use	Refs
Data analysis	Classification of error origin (decision making vs prescription writing)	Ward pharmacist to assess		• Researcher would need to validate at least a sample so duplicating work • Extra work for ward pharmacist • Less familiar with concept	Used by Dean	✗	14
		Researcher to assess	• Reduces workload for ward pharmacists • Task only undertaken once			✓	
	Severity scale	NCC MERP index[452,453]	• Widely used in publications	• Developed to assess actual rather than potential harm • Includes 'not an error' category so mixed system • System not widely used in the UK	Assessing severity increases clinical relevance of findings Rothschild used as well as 4-point severity scale	✗	115,174,260, 303
		NCC MERP index as adapted by Forrey[329]	• Established validity • Good interrater agreement when used • Widely used in publications	• System not widely used in the UK		✗	319,329
		Dean & Barber tool[253]	• Established validity and reliability for administration errors • Established reliability for prescribing errors • Relationship between potential and actual harm established • Tested on a large sample • Continuous scale potentially permits more powerful statistical analysis • Uses visual analogue scale which is simple to use and familiar to most	• Designed and validated for medication administration errors • Requires four reviewers to achieve acceptable reliability • Including pharmacy, nursing and medical panel members suggested to facilitate ownership[253] • Resource intensive • May be more time consuming to use	Adapted by Kollo for prescribing errors[263] Used by Avery (grouped to minimise workload), Franklin (1 in 5 sample) Professional discipline of each judge less relevant than expected[253] Score > 7.0 considered to be 'serious'[13] Score <3 considered 'minor'; 3-7 'moderate', >7 'severe'[104]	✓	13,104,253,263 ,307,319
	Severity assessment	By data collector	• Collected at time error identified • Has knowledge of other medicines being taken by patient • Has knowledge of co-morbidity of patient • Has access to lab results and healthcare record	• Does not require panel of experts who may need to evaluate a large number of errors • May be difficult to get consistency between data collectors		✗	
		By data collector with sample assessed by panel of 'experts'	• Collected at time error identified • Has knowledge of other medicines being taken by patient • Has knowledge of co-morbidity of patient • Has access to lab results and healthcare record	• Needs at least two reviewers of each of two professions to be achieve acceptable reliability[263]	Approach used by Franklin (1 in 5 sample) 20% sample	✓	13
		By panel of 'experts'	• True to the validated method developed by Dean & Barber and adapted by Kollo (as using that tool)	• Needs at least two reviewers of each of two professions to be achieve acceptable reliability[263] • Resource intensive and time consuming	Approach used by Franklin, Haw, Lesar	✗	19,51,85,93, 239,249,292

Decision Required	Detail	Options	Advantages	Disadvantages	Notes	Use	Refs
Causes of prescribing errors							
Study population	Prescribers (including NMPs)	All prescribers who have made errors	• Comprehensive population	• Probably prohibitively large numbers involved • Will reach saturation anyway		✗	
		Sample of prescribers who have made non-serious and serious errors	• More manageable number of interviews to undertake • Less resource intensive	• Need to establish process for choosing non-serious errors to follow up (balanced numbers?)		✓	
		All prescribers who have made serious errors	• More manageable number of interviews to undertake • Less resource intensive	• May result in small numbers of participants • May take much longer to reach saturation • May give biases results as issues involved in serious errors may be different from those in non-serious errors	Approach used by Barber, Dean	✗	27,260
Data collection	Semi-structured interview or questionnaire	Semi-structured interview	• Benefit of non-verbal feedback • Allows prompting and exploration of answers given	• Resource intensive • Time consuming • Outcomes may be influenced by experience of interviewer at qualitative interviewing	Used by Barber & Dean and Coombes to assess reasons for the error	✓	18,26,27,260
		Questionnaire	• Faster to administer • Could ask participants to complete and bring to interview? • Questions can act as a prompt	• Loss of non-verbal feedback • Limited to questions as written • Generally limited to closed questions • Questions may lead the interviewees answers	Used by Barber & Dean and Coombes to investigate potential contribution of factors to error production during semi-structured interview	✗	26,27,260
	Time limit on contacting prescribers	72 hours	• Short timescale aids recall of incident	• Likely to be difficult to achieve, especially taking weekends into account	Approach used by Coombes	✗	
		96 hours	• Short timescale aids recall of incident	• Likely to be difficult to achieve, especially taking weekends into account	Approach used by Barber, Dean, Ross	✓	27,113,260
		1 week	• More achievable	• Recall likely to be less		✗	
		>1 week		• Recall more likely to be impaired	Nichols interviewed up to 60 days post event (median 8 days)	✗	188
	Type of interview	Face to face	• Benefit of non-verbal feedback	• More travel time involved for researcher		✓	
		Telephone	• Less resource intensive for researcher • May be more attractive to some participants	• Loss of non-verbal feedback	Ideally face to face but may be necessary	✓	

Decision Required	Detail	Options	Advantages	Disadvantages	Notes	Use	Refs
Data collection	Sample	Until saturation	• No new themes emerging		Approach used by Barber, Dean (44 required)	✓	27,260
		Purposive			Approach used by Dornan, Lewis (68 interviews), Duncan (22 interviews)	✗	18,28,187
		Convenience	• Prescriber who made the error		Approach used by Franklin (15 interviews), Nichols (26 interviews), Ross & Ryan (40 interviews)	✗	13,113,188,189 ,307
Data analysis	Classification	Reason's model of accident causation[23,49] adapted for healthcare[156,159] (London Protocol[160])	• Commonly used in this context • Makes easier to link findings to previous research		Approach used by Barber, Dean, Dornan, Franklin, Lewis, Ross, Ryan, Coombes, Nichols (although not stated)	✓	12,17,172–174,246,292, 25,27,28,56,98, 141,144,145
		Theoretical domain framework			Approach used by Duncan	✗	28
Decision making characteristics (Administering CRT[226] and REI[200] to determine thinking style (~10 minutes))							
Data collection	Paper based or electronic survey	Paper based	• Enables coding so that can match any that do not identify themselves	• May be less likely to be returned		✗	
		Electronic survey	• May be more likely to get responses • SurveyMonkey includes tracking options	• Needs specialist software (e.g. Qualtrics, SurveyMonkey)		✓	
	Timing	Before error data collection	• Easier to match respondents to errors as detected	• May alert prescribers to study and bias results			
		After error data collection					
	Who to administer to	All prescribers	• Easier to administer • Need to be able to compare results for those who have made errors during the study with those who have not	• Could not be anonymous sample as need to match scores to whether errors have been made • May get poor response rate as asking to identify themselves	Need to establish which NMPs prescribe for inpatients	✓	
		Prescribers who have made errors			Need data for those for whom errors have not be made as well	✗	

Appendix 5: Prescription and Medicines Administration Chart

Front cover



MEDICINE PRESCRIPTION & ADMINISTRATION CHART

Providing Partnership Services in Bedfordshire, Essex and Luton

SEPT

Forename		Hospital/Site	
Surname		Consultant	
Date of Birth		Ward/Unit	
Date of Admission		Date Chart Started	
NHS No.		Chart No. (e.g. 1 of 2) Keep ALL Charts Together	

Lithium baseline assessments checked (Name)…… (Date)……

Drug Sensitivities & Allergies If none known write NKDA in box →

N.B. MUST BE COMPLETED before prescription/administration except in exceptional circumstances

Drug/Substance Name	Reaction Details	Info source	Name of Recorder	Designation	Date Recorded

Consent to Treatment (for patients detained under Part IV of the Mental Health Act)

Tick as appropriate:

A copy of form T2 ☐ has been completed & is valid until ……

A copy of form T3 ☐ has been completed

Signed (Nurse in Charge)

……Date……

Patient also has: -

1. Clozapine Initiation Chart ☐
2. Insulin Chart ☐
3. Anticoagulant Chart ☐

Notes

PRESCRIBING INSTRUCTIONS: -

1. **Write CLEARLY in BLOCK CAPITALS and in BLACK INK**
2. SIGN your name in full (not just initials) to legalise the prescription
3. Use APPROVED DRUG NAMES wherever possible –refer to BNF
4. Discontinue medicine with a clear diagonal line through the prescription box (containing details of Drug, Dose, Signature, etc.). Also score through the remaining days' administration boxes. Sign & Date the discontinuation.
5. For short courses of drugs (e.g. antibiotics) specify the duration in the additional information box.

MISSED DOSES Record missed doses using the following codes:

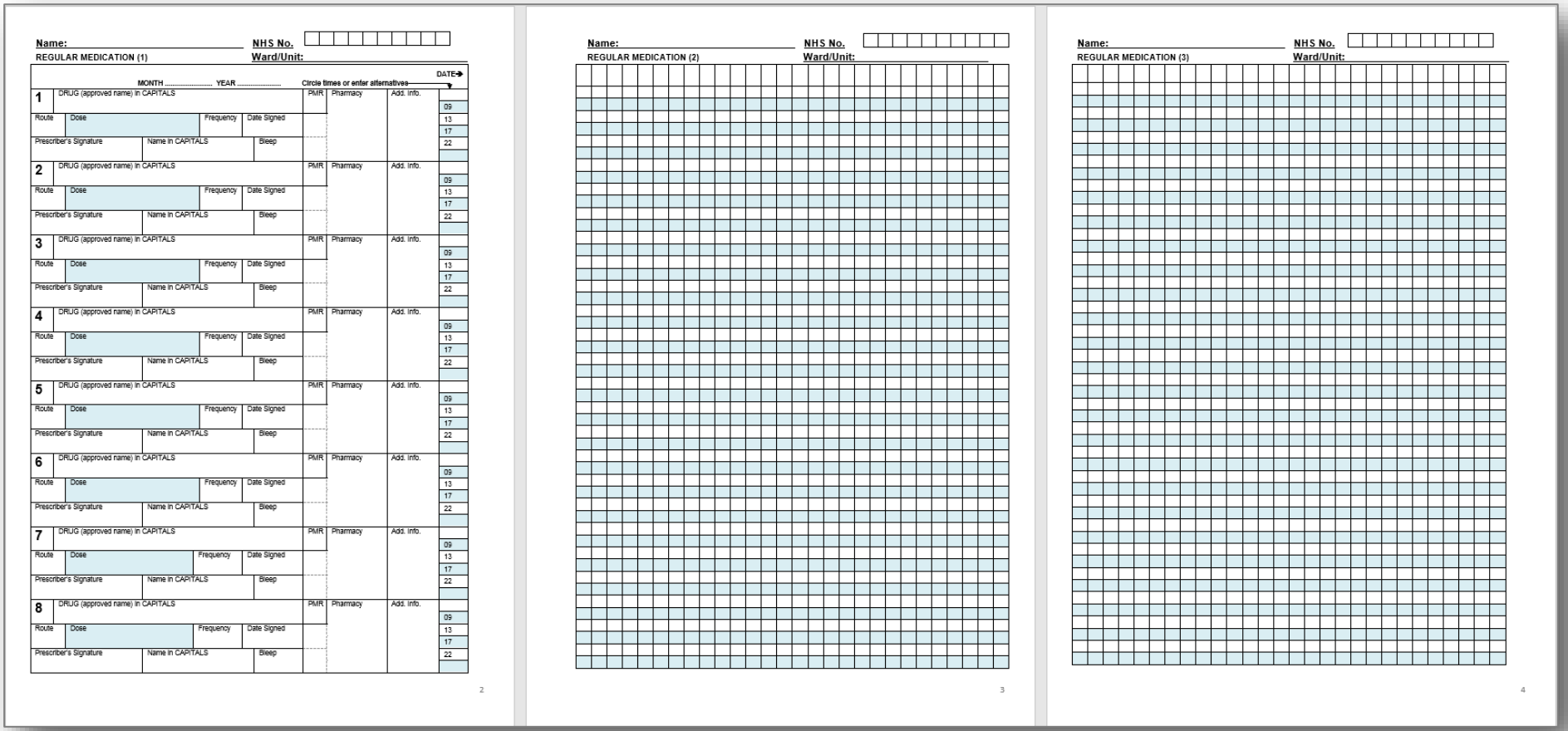
1. Drug not available
2. Prescription illegible/illegal
3. Patient unavailable/on leave
4. Patient asleep
5. Patient unable to take drug
6. Patient refused/declined drug
7. Other: record in healthcare record

ONCE ONLY MEDICATION

Date	Drug Approved Name	Dose	Route	Prescriber's Signature and NAME in CAPITALS	GIVEN Date	GIVEN Time	GIVEN Initials	Pharm

1

Inside section fully open



Name: NHS No.
REGULAR MEDICATION (1) Ward/Unit:

MONTH ..... YEAR ..... Circle times or enter alternatives DATE→

1	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				
2	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				
3	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				
4	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				
5	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				
6	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				
7	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				
8	DRUG (approved name) in CAPITALS			PMR	Pharmacy	Add. Info.	09 13 17 22
	Route	Dose	Frequency / Date Signed				
	Prescriber's Signature	Name in CAPITALS	Bleep				

2

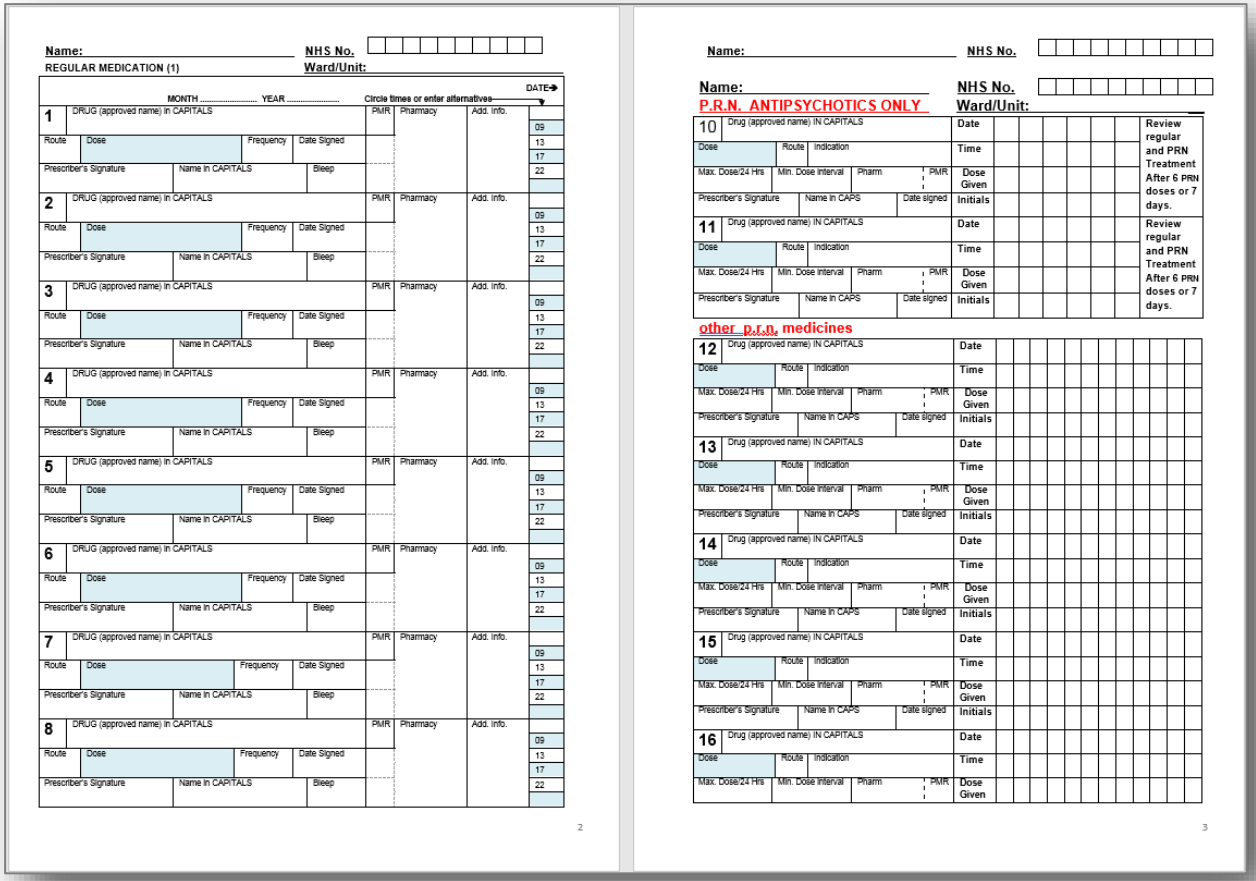
Name: NHS No.
REGULAR MEDICATION (2) Ward/Unit:

3

Name: NHS No.
REGULAR MEDICATION (3) Ward/Unit:

4

Inside with right page closed to reveal ‘as required’ section



Name: NHS No.

REGULAR MEDICATION (1) Ward/Unit:

MONTH ..... YEAR ..... Circle times or enter alternatives DATE→

	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
1	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				
2	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				
3	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				
4	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				
5	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				
6	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				
7	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				
8	DRUG (approved name) in CAPITALS	PMR	Pharmacy	Add. Info.	09 13 17 22
	Route / Dose / Frequency / Date Signed; Prescriber's Signature / Name in CAPITALS / Bleep				

2

Name: NHS No.

Name: NHS No.

P.R.N. ANTIPSYCHOTICS ONLY Ward/Unit:

10	Drug (approved name) IN CAPITALS	Date	Review regular and PRN Treatment After 6 PRN doses or 7 days.
	Dose / Route / Indication	Time	
	Max. Dose/24 Hrs / Min. Dose Interval / Pharm / PMR	Dose Given	
	Prescriber's Signature / Name in CAPS / Date signed	Initials	
11	Drug (approved name) IN CAPITALS	Date	Review regular and PRN Treatment After 6 PRN doses or 7 days.
	Dose / Route / Indication	Time	
	Max. Dose/24 Hrs / Min. Dose Interval / Pharm / PMR	Dose Given	
	Prescriber's Signature / Name in CAPS / Date signed	Initials	

other p.r.n. medicines

12	Drug (approved name) IN CAPITALS	Date	
	Dose / Route / Indication	Time	
	Max. Dose/24 Hrs / Min. Dose Interval / Pharm / PMR	Dose Given	
	Prescriber's Signature / Name in CAPS / Date signed	Initials	
13	Drug (approved name) IN CAPITALS	Date	
	Dose / Route / Indication	Time	
	Max. Dose/24 Hrs / Min. Dose Interval / Pharm / PMR	Dose Given	
	Prescriber's Signature / Name in CAPS / Date signed	Initials	
14	Drug (approved name) IN CAPITALS	Date	
	Dose / Route / Indication	Time	
	Max. Dose/24 Hrs / Min. Dose Interval / Pharm / PMR	Dose Given	
	Prescriber's Signature / Name in CAPS / Date signed	Initials	
15	Drug (approved name) IN CAPITALS	Date	
	Dose / Route / Indication	Time	
	Max. Dose/24 Hrs / Min. Dose Interval / Pharm / PMR	Dose Given	
	Prescriber's Signature / Name in CAPS / Date signed	Initials	
16	Drug (approved name) IN CAPITALS	Date	
	Dose / Route / Indication	Time	
	Max. Dose/24 Hrs / Min. Dose Interval / Pharm / PMR	Dose Given	

3

Back cover when closed

Prescriptions for Home Leave (NOT FOR DISCHARGE)
(For discharges a DISCHARGE NOTE MUST be written)

Name: _____ **NHS No.** | | | | | | | | | | |

Ward/Unit: _____ **Card of**

NB. Controlled Drugs must be written on a separate line, and the TOTAL QUANTITY must be written in WORDS and FIGURES (e.g. 21mg, twenty one mg) – this is a legal requirement (If unsure, ask a pharmacist)

Date	Regular Drugs Required State "All" or use index numbers	PRN Drugs Required Use index numbers, And state quantities.	Duration	Prescriber's Signature & Name in CAPITALS	Pharmacy
Example 01/02/03	Example All	Example 12 (4 doses) 14 (2 doses)	Example 5/7	Sign Example Bob Smith CAPS Example BOB SMITH	
				Sign CAPS	
				Sign CAPS	
				Sign CAPS	
				Sign CAPS	
				Sign CAPS	
				Sign CAPS	
				Sign CAPS	
				Sign CAPS	
				Sign CAPS	

6

Appendix 6: Information booklet for clinical pharmacists

Information for Pharmacists Collecting Prescribing Error Data

On each of the study days, ward pharmacists are asked to record the number of new previously unscreened, unendorsed medication orders seen in drug charts or leave/discharge prescriptions, PLUS details of any prescribing errors identified in these medication orders.

All 'regular' and 'when required (PRN)' medication orders should be included. This includes newly written inpatient charts or leave/discharge prescriptions and items on newly rewritten/transcribed charts.

The number of previously unscreened, unendorsed medication orders needs to be recorded for EVERY patient, even if no errors are identified for that patient. This is because we are considering errors per prescribed item, not per patient.

The study has been reviewed by the University of Portsmouth Science Faculty Ethics Committee, and the SEPT Research Governance Group and received a favourable opinion from both.

What is a prescribing error?

We are using the following definition of a prescribing error:

> *"A prescribing error occurs when, as a result of a prescribing decision or prescription writing process, there is an unintentional, significant*
> *(1) reduction in the probability of treatment being timely and effective or*
> *(2) increase in the risk of harm when compared with generally accepted practice"*

Notes:

1. All prescribing errors that meet the definition above should be included, regardless of their severity. So even if you correct a 'minor' error by endorsing the chart (and not contacting the doctor), for example adding the strength of an inhaler, include it as a prescribing error.

2. More than one error can be recorded per prescription item. For example, dose and frequency may both be wrong.
3. Inclusion of the word **significant** in the definition above is intended to differentiate between prescribing errors and minor deviations from optimal therapy. For example, prescribing phenytoin 300mg once daily may be more convenient for the patient than 100mg three times daily, but the latter is not a prescribing error if it is appropriate for the patient.
4. Prescribing errors can originate from the **prescribing decision** (for example, not taking into account the patient's renal function when deciding on the dose to prescribe) or the **prescription writing process** (for example, accidentally transposing the doses of two drugs written at the same time).
5. Even if the prescriber does not change an erroneous prescription following your intervention, it is still a prescribing error if it meets the definition above and should be included.

Which prescriptions to include?

Only include new items on the drug chart, i.e. medicines that are being seen for the first time by a pharmacist on the data collection days, even if they were written some days ago.

Prescribing errors in all types of medication orders should be included - regular, when required, once only, leave and discharge medication. Also include errors that have occurred when a drug chart has been rewritten.

What to record about the error

Please provide sufficient detail about the nature of the prescribing error so that someone else would be able to understand the error. It is essential to record the name of the drug, the dose and frequency, as well as a brief description of what the error was. If it was an error because of another drug the patient was already prescribed, (i.e. duplication, interaction) or because of the patient's clinical condition, (i.e. contra-indications, allergy, co-morbidity) please give brief details.

Please indicate whether you made a pharmacy intervention as a result of finding the error and if so of what type. This may include resolving it yourself by annotating the chart.

What counts as a prescribing error?

Below are listed some examples of what should and should not be considered prescribing errors. The list is not exhaustive so if you are unsure include the error. For the purposes of the study the following **should be** included as prescribing errors:

Scenario	Decision Making Error	Prescription Writing Error
Choice of drug		
Prescribing a drug for a patient who has a documented clinically significant allergy	✓	
Prescribing a drug for a patient for whom, as a result of a co-existing clinical condition, that drug is contraindicated	✓	
Prescribing a drug for which there is no indication for that patient	✓	
Not taking into account a potentially serious drug interaction	✓	
Continuing a drug in the event of a clinically significant adverse drug reaction	✓	
Prescribing a drug for a detained patient without the necessary MHA authorisation to treatment form (T2/T3)	✓	
Prescribing a drug without carrying out the necessary monitoring (e.g. clozapine, lithium)	✓	
Not prescribing a drug for a clinical condition for which medication is indicated	✓	
Failure to communicate essential information		
Writing "milligrams" when "micrograms" was intended		✓
Prescribing "one tablet" of a drug that is available in more than one strength		✓
Omission of the route of administration for a drug that can be given by more than one route		✓
Writing a medication order for a drug, dose or route that was not that intended		✓
Writing an incomplete, illegible or ambiguous medication order that would require clarification before administration, including using non-standard abbreviations and major misspelling of the drug name		✓
Omission of the prescriber's signature		✓
Prescribing a drug without first registering the patient with the drug company (e.g. clozapine)	✓	
Prescribing a dose regimen (dose / frequency) that is not recommended for the formulation prescribed	✓	
Prescribing a dose that cannot readily be administered using the dosage forms available		✓
Prescribing a drug that should be given at specific times (including in relation to meals) without specifying this information on the prescription		✓

Scenario	Decision Making Error	Prescription Writing Error
Transcription errors		
Transcribing a medication order incorrectly when rewriting a patient's drug chart		✓
Writing a prescription for leave or discharge medication that unintentionally deviates from the medication prescribed on the inpatient drug chart		✓
On admission, writing a medication order that unintentionally deviates from the patient's pre-admission prescription. This includes unintentional omission of medication		✓
Continuing a GP's prescribing error when writing a patient's drug chart on admission		✓
Dosing errors		
Prescribing a drug with a narrow therapeutic index in a dose predicted to give serum levels significantly above or below the desire therapeutic range	✓	
Prescribing a drug in a dose above or below that appropriate for the patient's clinical condition (both condition being treated and renal/hepatic function)	✓	
Not altering the dose following steady state serum levels significantly outside the therapeutic range	✓	
Prescribing two drugs for the same indication when only one of the drugs is necessary	✓	
Prescribing a drug that has already been prescribed on the current drug chart (or components thereof have)	✓	
Omission of a maximum dose for 'when required' drug		✓
Errors in the calculation of drug doses	✓	
Prescribing a dose above the maximum dose recommended in the BNF or SPC	✓	
Continuing a prescription for a longer duration than necessary	✓	

Scenarios in italics may be errors depending on the circumstances

For the purposes of the study the following **should not** be included as prescribing errors:

Scenario
Prescribing by brand name
Prescribing a drug that is not in the Trust formulary
Prescribing a drug contrary to Trust or national guidelines
Prescribing for an indication that is not in a drug's product license
Minor misspellings of a drug name
Prescribing a drug without informing the patient of its uses and potential side effects
Prescribing a drug for which there is no evidence of efficacy, because the patient wishes it
Prescribing a child a drug that has no product license for use in children

There is more information in Appendix 1 to help you identify potential prescribing errors.

Guidance on completing the data collection forms

Form A - Ward Level Information (see Appendix 3)

1. Patient number

Assign consecutive numbers to each patient as you review their drug chart - this is so that you can keep track of who you have included.

2. Prescriber

Enter the full name of the prescriber of any new medication orders that you have checked for this patient *on the data collection day*.

If more than one prescriber has written these items include them on separate lines, but use the same patient number so that it is clear that they are for the same patient.

If it is impossible to tell who the prescriber is because their name is illegible write N/K (not known).

3. Number of previously unscreened, unendorsed items checked

This refers to the number of new medication orders that you have checked for this patient *on the data collection day*.

When the patient is newly admitted, this will refer to all prescribed drugs.

When the patient has had one or more additional drug added during their stay, this will refer to only that / those drug(s).

When the chart has been rewritten, this will refer to all the rewritten drugs that you check to make sure that they are rewritten correctly.

When a leave or discharge prescription has been written, this will refer to all the drugs on the TTO.

If none of these apply, and you have not screened any drugs for this patient *on the data collection day*, then write 0 or score through the line.

Record separately the number of drugs that are regular or PRN items within the two categories psychotropic and non-psychotropic drugs.

4. Prescribing stage

On admission (A) refers to errors identified in medication orders that were written immediately following a patient's admission. This includes errors resulting from medication history taking or identified during medicines reconciliation and could include omissions.

Prescribing during stay (S) refers to errors identified in medication orders written at any other stage of the patient's hospital stay.

Rewriting drug chart (R) refers to errors that occur when the patient's chart is rewritten during the patient's hospital stay. It could include inadvertent omissions.

Leave (L) refers to errors identified in prescriptions written for a period of leave. It could include inadvertent omissions.

Discharge (D) refers to errors identified in a discharge prescription and could include inadvertent omissions.

If new medication orders relate to more than one prescribing stage please record them on separate lines.

5. Number of new drugs with prescribing errors

This refers to the number of errors that you have found amongst the new items you have checked for this patient *on the data collection day*.

Record separately the number of drugs that are regular or PRN items, by prescriber if there was more than one.

If a medication order includes more than one error, please record them both, but indicate that they were in the same medication order.

For each error found complete Form B.

Form B - Patient Level Information (see Appendix 4)

1. Patient Number

Use the patient number that you assigned to this patient on Form A.

2. Grade of Prescriber

If you are unsure about the grade of the prescriber who has made the error tick 'Not known' and it will be added later.

Enter the name of the prescriber in the box provided below. If it is impossible to work this out from the chart indicate this in the 'details illegible' box.

3. Pharmacy intervention

Indicate here if you made an intervention (i.e. contacted a non-pharmacy member of the healthcare team, or wrote in the patient's healthcare record) in an attempt to rectify the error. This includes annotating the chart with information that is missing such as the strength of an inhaler, but would not include adding the generic drug name, 'with food' etc.

This is to gain an indication of the workload involved in resolving prescribing errors.

4. Details of the error

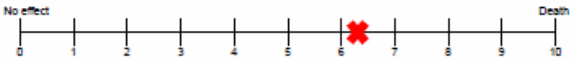
Provide sufficient detail about the error to enable someone else to understand it. This is because the severity and categorisation of a sample of anonymous errors will be verified by the research team. Also details of some of the errors will be used at a later stage of the project to try and identify causes and contributory factors in discussion with prescribers.

The details of the drug, dose, route and frequency are essential, as well as a brief description of why it was a prescribing error. If prescribing this item was an error because of co-morbidity or other drugs prescribed for the patient, include what these are. Please indicate in the grid what type of error you believe has occurred.

If any doses have been given or omitted (if the error is a drug omission) before you identified it please detail how many.

5. Assessing the clinical significance of the error

Please rate the prescribing error in terms of ***potential*** clinical significance if the error had remained undetected, using the 0-10 scale. Zero should be given to a case which will have no effects on the patient, and ten to a case that would result in death.



Mark the scale clearly by placing a cross on, or between, the numbers.

There are examples in Appendix 2 to help guide you in deciding what the potential clinical significance may be but this will be influenced by the specific circumstances of the patient, their drug regimen, their condition and co-existing morbidities. You will need to use your professional judgement based on your knowledge of the circumstances. Make sure that any relevant information that influences your decision is included in the details of the error.

6. Actual harm

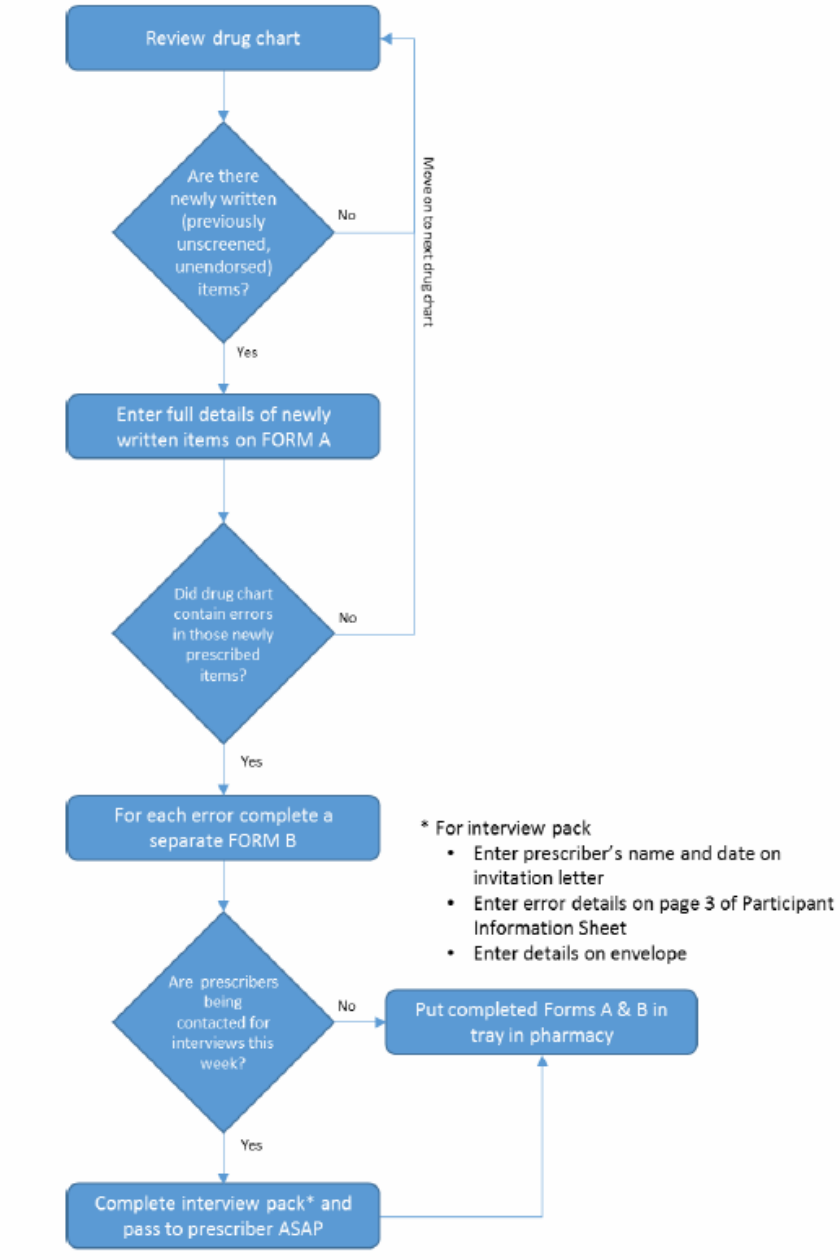
If doses of the erroneous medication order were administered to the patient, or missed by the patient if the error was an omitted medicine, indicate the number of doses given / omitted.

If as a result of the error the patient experienced actual harm, please provide details. This might include experiencing a side effect, adverse effect, or need for intervention.

Information for Prescribers

During certain periods of the study, prescribers who have made an error need to be sent correspondence inviting them to participate in a face to face interview with the researcher. Only during those periods, for each Form B complete the details about the error at the end of the 'Participant Information Sheet' and send, along with a copy of the Invitation to Interview Letter and Consent Form to the prescriber.

Process for data collection



Appendix 1 - More detail on potential prescribing errors

Unintentional omission of a drug on admission, rewrite or leave/discharge

Pharmacists need to ensure that this was an unintentional omission and not the discontinuation of a drug for therapeutic reasons.

Premature discontinuation of a drug

This is the early discontinuation of a drug, where there are hospital guidelines as to how long treatment should be prescribed, and it is not being stopped because of lack of efficacy or side effects.

A drug is not prescribed for a clinical condition for which one is indicated

Any situation in which a drugs is not prescribed for a clinical condition for which a drug is indicated. This would include the erroneous omission of drugs from an inpatient chart or discharge prescription. It could include where there are hospital guidelines for the treatment of a condition (such as alcohol withdrawal) and a drug has not be prescribed (such as thiamine).

Continuation of a drug for a longer duration than necessary

Continuation of a prescribed drug for a longer duration than necessary, where that is of clinical significance to the patient. This could include ongoing prescribing of an antimicrobial after the infection has cleared or for longer than the recommended period with increased risk of side effect and/or development of resistance.

No indication for the drug prescribed

Prescribing a drug without a corresponding indication. This would include where drugs are prescribed in 'reflex' mode, without considering whether a set of guidelines apply to a patient.

Duplication of therapy

Prescription of two or more drugs with the same therapeutic action when only one of the drugs is necessary, or prescription of the same drug more than once. This would include the unintentional prescribing of two benzodiazepines or co-proxamol and

paracetamol, but would not include the use of two antihypertensives in order to obtain adequate blood pressure control. If you need to get one drug stopped, it is probably an error.

Prescription of a drug to which the patient has a clinical contra-indication

Prescription of a drug that is contra-indicated due to a pre-existing medical condition such as diabetes, severe renal impairment or liver disease. This also includes significant cautions where you consider it necessary to recommend a treatment alternation.

Continuing a drug in the event of a clinically significant adverse drug reaction

Continuing a drug that is causing a clinically significant adverse drug reaction without taking steps to either discontinue the drug, reduce the dose or prescribe symptomatic relief.

This include prescribing a drug where a side effect has previously occurred and the drug should not be started again.

Prescription of a drug that was not that intended

Any situation in which the drug prescribed was not that desired. This includes errors in medication history taking and transcription errors when rewriting drug charts or discharge prescriptions, as well as inappropriate clinical decisions.

Failure to specify the maximum dose

Failure to specify the maximum dose for a drug prescribed to be given as required. The decision as to whether each incidence of, for example, paracetamol prescribing is recorded needs to be made by the pharmacists' interpretation as to whether this is "an increase in the risk of harm, when compared to generally accepted practice" for that patient.

Failure to take into account a drug interaction

The prescription of a drug at a dose that is not appropriate because of a concurrent drug interaction.

Not altering the dose following steady-state serum levels significantly outside the therapeutic range

Steady state serum levels exist for the patient which indicate that a dosage change should be made, but no action has been taken on the results.

Total daily dose correct but divided into doses incorrectly

Any situation in which the total daily dose is correct, but it has been divided into an incorrect number of daily doses *and* that matters clinically, e.g. thiamine 100mg BD instead of 50mg QDS. Differences that are not clinically relevant are not included, e.g. phenytoin 100mg TDS instead of 300mg nocte.

Overdose

Any situation in which the patient is prescribed a dose of a drug which is too high *for them*. This does not have to be over the BNF maximum to count as an error.

Underdose

Any situation in which the patient is prescribed a dose of a drug which is too low *for them*. This does not have to be below the BNF minimum to count as an error.

Wrong route

Prescription of a route that is inappropriate for the drug prescribed or for the drug in those circumstances, e.g. oral antimicrobial in septicaemia.

Wrong formulation

Prescription of the wrong formulation or the drug and dose regimen prescribed. This includes failure to specify that a product should be a modified release formulation.

Administration times incorrect or not specified

Any situation in which the prescribed administration times are incorrect or not specified in sufficient detail. This includes the prescription of a drug such as an antibiotic or inhaled steroid to be given when required when it should be given regularly, and the failure to specify the conditions under which a drug prescribed to be given when

required should be given. This can also be the selection of the wrong times, e.g. prescribing an oral hypoglycaemic to be given at bedtime instead of with the evening meal. It will also include where the times are omitted completely.

Start date incorrect or not specified

Includes failure to specify the start date or the inclusion of a wrong start date.

Product or formulation not specified

Any situation in which the product, device or formulation is not specified in sufficient detail for a supply to be made. This includes failure to specify the formulation intended and the prescription of illegible or otherwise ambiguous medication orders, where you would be concerned as to patient benefit or safety if the prescription was left unendorsed.

Strength or dose not specified

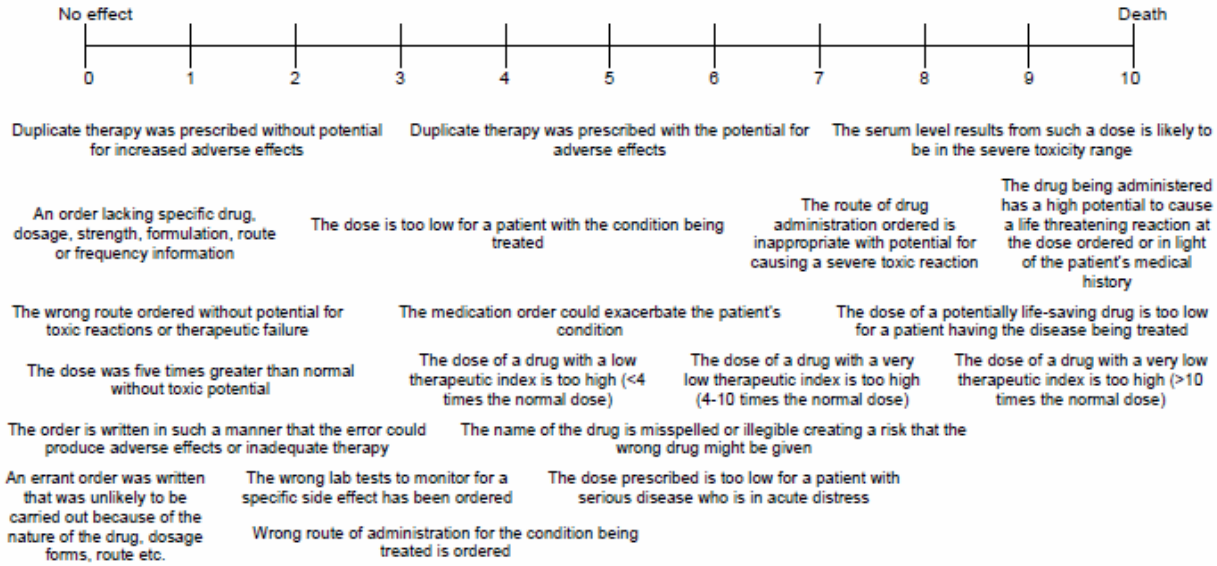
Any situation in which the strength or dose of a preparation is not specified in sufficient detail for the appropriate product to be supplied.

Route not specified

Failure to state the route of administration for a drug that can be given by more than one route.

Appendix 2: Clinical significance - examples

The potential clinical significance for a particular prescribing error will be influenced by the medicine involved, other medicine the patient is also prescribed and the patient's clinical condition.



Appendix 3: Example Form A - Ward Level Information

On each data collection day, please return the day's completed forms A & B to the tray in pharmacy in a labelled envelope

University of Portsmouth

SEPT

Prescribing Error Data Collection

Form A - Ward Level Information

Pharmacist Name:	Joe Bloggs	Date:	21/09/2013
Ward:	Petunia Ward		

Patient No.	Prescriber (please print clearly)	No. of previously unscreened, unendorsed items checked				Prescribing Stage A = Admission, S = During Stay, R = Rewriting, L = Leave, D = Discharge	No. of new drugs with prescribing error(s) (complete form B)	
		Psychotropic Drugs		Non-psychotropic drugs				
		Regular	PRN	Regular	PRN		Regular	PRN
1	Dr A Smith	1	0	0	0	S	0	0
2	Dr B Jones	0	1	0	0	S	0	0
2	N/K	0	0	2	0	S	0	0
3								
4	Dr A Smith	4	2	0	2	R	0	0
5	Dr C Patel	1	3	0	0	A	0	0
6	Dr D Braun	0	0	0	1	S	0	0
7	Dr A Smith	1	2	3	1	R	1	0
8	Dr C Patel	4	3	2	2	D	0	0
9								
10	Dr D Braun	0	0	2	0	R	0	0
11	Dr B Jones	0	1	5	3	R	0	1

Form A v6 (08 February 2015)

Appendix 4: Example Forms B - Patient Level Information

University of Portsmouth

Prescribing Error Data Collection

Form B - Patient Level Information

For all errors identified on Form A, please provide further details below (use one sheet for each error).

Pharmacist Name:	Joe Bloggs	Date:	21/09/2015
Ward:	Petunia Ward	Patient No.: (from form A)	7

Grade of Prescriber				Pharmacy Intervention	
Foundation year 1 (FY1)	☐	Foundation year 2 (FY2)	☐	Contacted prescriber	☑
Specialist trainee (StR 1-8)	☑	Staff grade	☐	Alerted nursing staff	☐
Consultant	☐	Pharmacist	☐	Left note to resolve	☐
Nurse	☐	Not Known	☐	Resolved by self	☐
Other (please specify)			☐	Other (please specify)	☐

Name of Prescriber *(please print clearly)*	Dr A Smith	Details illegible	

Name of drug & formulation	Dose	Route	Freq.	Regular/ PRN	Details of error (Include details of co-morbidities and other drugs being taken if relevant to the error)
Eg. Diuretics	*20mg*	*PO*	*TDS*	*Regular*	*Patient already taking Lithium. Potentially serious risk of Lithium toxicity*
Flucloxacillin	500mg	PO	TDS	Reg	Should be prescribed 6 hourly

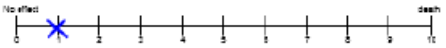
Type of error

Allergy information missing ☐	Duplication of drug(s) ☐	Omission of route of administration ☐	Wrong dosing interval ☑
Allergy to prescribed drug ☐	Illegible handwriting ☐	Omission of signature ☐	Wrong drug ☐
Ambiguous drug name ☐	Omission of date ☐	Omission of strength/unit ☐	Wrong formulation ☐
Calculation error ☐	Omission of dose ☐	Omission of treatment time ☐	Wrong duration of treatment ☐
Decimal place error ☐	Omission of dosing interval ☐	PRN without maximum dose limit ☐	Wrong route of administration ☐
Drug-disease interaction ☐	Omission of drug ☐	PRN without minimum dose interval ☐	Wrong strength/unit ☐
Drug-drug interaction ☐	Omission of formulation ☐	Wrong concentration ☐	Wrong transcription ☐
Drug-lab test interaction ☐	Omission of indication for PRN ☐	Wrong dose ☐	Other ☐

Number of doses administered / ~~omitted~~ before error detected 5

Assessment of potential clinical significance

Please mark the scale clearly by placing a cross on, or between, the numbers.



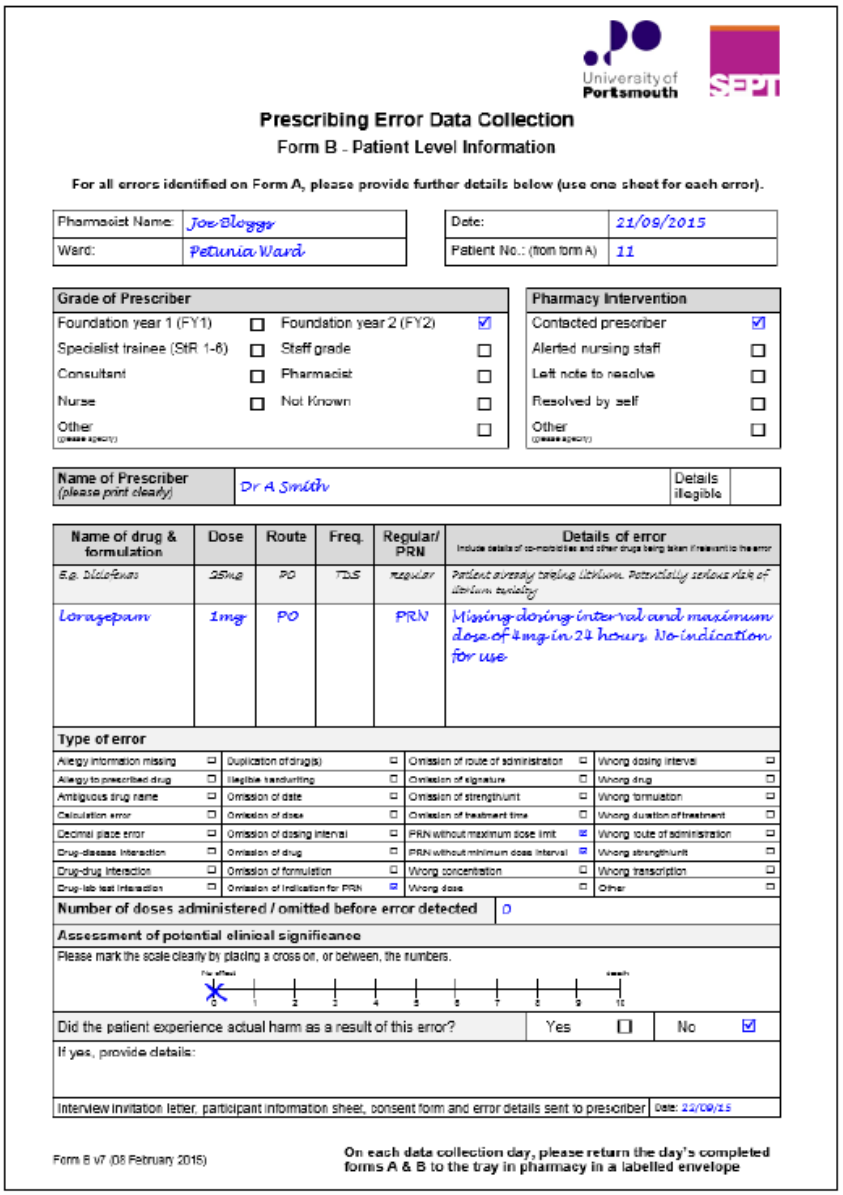
Did the patient experience actual harm as a result of this error?	Yes ☐	No ☑

If yes, provide details:

Interview invitation letter, participant information sheet, consent form and error details sent to prescriber — Date: 22/09/15

Form B v7 (08 February 2015)

On each data collection day, please return the day's completed forms A & B to the tray in pharmacy in a labelled envelope



University of Portsmouth

SEPT

Prescribing Error Data Collection

Form B - Patient Level Information

For all errors identified on Form A, please provide further details below (use one sheet for each error).

Pharmacist Name:	Joe Bloggs	Date:	21/09/2015
Ward:	Petunia Ward	Patient No.: (from form A)	11

Grade of Prescriber				Pharmacy Intervention	
Foundation year 1 (FY1)	☐	Foundation year 2 (FY2)	☑	Contacted prescriber	☑
Specialist trainee (StR 1-6)	☐	Staff grade	☐	Alerted nursing staff	☐
Consultant	☐	Pharmacist	☐	Left note to resolve	☐
Nurse	☐	Not Known	☐	Resolved by self	☐
Other (please specify)	☐			Other (please specify)	☐

Name of Prescriber *(please print clearly)*	Dr A Smith	Details illegible	

Name of drug & formulation	Dose	Route	Freq.	Regular/ PRN	Details of error (include details of co-morbidities and other drugs being taken if relevant to the error)
E.g. Diclofenac	25mg	PO	TDS	regular	Patient already taking lithium. Potentially serious risk of lithium toxicity
Lorazepam	1mg	PO		PRN	Missing dosing interval and maximum dose of 4mg in 24 hours. No indication for use

Type of error

Allergy information missing ☐	Duplication of drug(s) ☐	Omission of route of administration ☐	Wrong dosing interval ☐
Allergy to prescribed drug ☐	Illegible handwriting ☐	Omission of signature ☐	Wrong drug ☐
Ambiguous drug name ☐	Omission of date ☐	Omission of strength/unit ☐	Wrong formulation ☐
Calculation error ☐	Omission of dose ☐	Omission of treatment time ☐	Wrong duration of treatment ☐
Decimal place error ☐	Omission of dosing interval ☐	PRN without maximum dose limit ☑	Wrong route of administration ☐
Drug-disease interaction ☐	Omission of drug ☐	PRN without minimum dose interval ☑	Wrong strength/unit ☐
Drug-drug interaction ☐	Omission of formulation ☐	Wrong concentration ☐	Wrong transcription ☐
Drug-lab test interaction ☐	Omission of indication for PRN ☑	Wrong dose ☐	Other ☐

Number of doses administered / omitted before error detected	0

Assessment of potential clinical significance

Please mark the scale clearly by placing a cross on, or between, the numbers.

Did the patient experience actual harm as a result of this error?	Yes ☐	No ☑

If yes, provide details:

Interview invitation letter, participant information sheet, consent form and error details sent to prescriber	Date: 22/09/15

Form B v7 (08 February 2015)

On each data collection day, please return the day's completed forms A & B to the tray in pharmacy in a labelled envelope

Appendix 7: Participant consent form (Pharmacists)

School of Pharmacy & Biomedical Sciences
University of Portsmouth
St Michael's Building
White Swan Road
Portsmouth
PO14 3HZ
Email: hilary.scott@myport.ac.uk

Participant Consent Form

"Investigating the role of the decision making process and human factors in prescribing errors within an inpatient mental health setting"

Data collection by pharmacists

		Please initial box
1	I confirm that I have read and understand the 'information for pharmacists collecting prescribing error data' dated 12 July 2015 (version 7) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
2	I understand that my participation in collecting data for this project is voluntary and that I am free not to contribute data on any of the identified data collection days, without giving any reasons.	☐
3	I understand that data collected during the study may be looked at by individuals from the University of Portsmouth, and may be included in the study's final report and any resulting publications and presentations. I give permission for these individuals to have access to this information in an anonymised format.	☐
4	I understand that the results of this study may be published and / or presented at meetings. I give permission for data, which does not identify me nor the patients it relates to, to be disseminated in this way.	☐
5	I agree to take part in the above study by collecting data on prescribing errors.	☐

Name of participant: _____ Date: _____ Signature: _____

Name of researcher: _____ Date: _____ Signature: _____

When: completed: one for participant; one (signed) for researcher's file

Appendix 8: Prescribing error data collection form (Ward level)

On each data collection day, please return the day's completed forms A & B to the tray in pharmacy in a labelled envelope

University of Portsmouth

SEPT

Prescribing Error Data Collection

Form A - Ward Level Information

Pharmacist Name:	
Ward:	

Date:	

Patient No.	Prescriber (please print clearly)	No. of previously unscreened, unendorsed items checked				Prescribing Stage A = Admission, B = During Stay, R = Rewriting, L = Leave, D = Discharge	No. of new drugs with prescribing error(s) (complete form B)	
		Psychotropic Drugs		Non-psychotropic drugs				
		Regular	PRN	Regular	PRN		Regular	PRN

Form A v7 (12 July 2015)

Appendix 9: Prescribing error data collection form (Patient level)

On each data collection day, please return the day's completed forms A & B to the tray in pharmacy in a labelled envelope

University of Portsmouth

Prescribing Error Data Collection

Form B - Patient Level Information

For all errors identified on Form A, please provide further details below (use one sheet for each error).

Pharmacist Name:		Date:	
Ward:		Patient No.: (from form A)	

Grade of Prescriber			
Foundation year 1 (FY1)	☐	Foundation year 2 (FY2)	☐
Specialist trainee (StR 1-6)	☐	Staff grade	☐
Consultant	☐	Pharmacist	☐
Nurse	☐	Not Known	☐
Other (please specify)			☐

Pharmacy Intervention	
Contacted prescriber	☐
Alerted nursing staff	☐
Left note to resolve	☐
Resolved by self	☐
Other (please specify)	☐

Name of Prescriber *(please print clearly)*		Details illegible	

Name of drug & formulation	Dose	Route	Freq.	Regular/ PRN	Details of error (Include details of co-morbidities and other drugs being taken if relevant to the error)
E.g. Diclofenac	*25mg*	*PO*	*TDS*	*regular*	*Patient already taking lithium. Potentially serious risk of lithium toxicity*

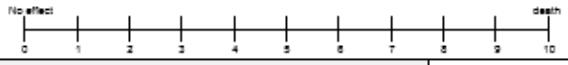
Type of error

Allergy information missing ☐	Duplication of drug(s) ☐	Omission of route of administration ☐	Wrong dosing interval ☐
Allergy to prescribed drug ☐	Illegible handwriting ☐	Omission of signature ☐	Wrong drug ☐
Ambiguous drug name ☐	Omission of date ☐	Omission of strength/unit ☐	Wrong formulation ☐
Calculation error ☐	Omission of dose ☐	Omission of treatment time ☐	Wrong duration of treatment ☐
Decimal place error ☐	Omission of dosing interval ☐	PRN without maximum dose limit ☐	Wrong route of administration ☐
Drug-disease interaction ☐	Omission of drug ☐	PRN without minimum dose interval ☐	Wrong strength/unit ☐
Drug-drug interaction ☐	Omission of formulation ☐	Wrong concentration ☐	Wrong transcription ☐
Drug-lab test interaction ☐	Omission of indication for PRN ☐	Wrong dose ☐	Other ☐

Number of doses administered / omitted before error detected

Assessment of potential clinical significance

Please mark the scale clearly by placing a cross on, or between, the numbers.



Did the patient experience actual harm as a result of this error?	Yes ☐	No ☐

If yes, provide details:

Interview invitation letter, participant information sheet, consent form and error details sent to prescriber	Date:

Form B v8 (12 July 2015)

University of Portsmouth

SEPT

Prescribing Error Data Collection

Form C - Assessment of Severity

Reviewer Name:		Date:	

	Name of drug	Dose	Route	Freq	Regular/ PRN?	Details of error	Assessment of potential clinical significance *Please mark the scale clearly by placing a cross on, or between, the numbers*
E.g. Diclofenac		25mg	PO	TDS	Regular	Patient already taking lithium. Potentially serious risk of lithium toxicity	No effect 0 1 2 3 4 5 6 7 8 9 10 death
5.13C	50:50 White soft paraffin	Apply	TOP	TDS	PRN	No indication provided for use.	No effect 0 1 2 3 4 5 6 7 8 9 10 death
10.18D	Adcal®	-	PO	BD	Regular	No strength or formulation stated on admission prescription.	No effect 0 1 2 3 4 5 6 7 8 9 10 death
10.18E	Adcal® Calcium carbonate 1.5g	-	PO	BD	Regular	Prior to admission, patient was taking Calcium carbonate 1.25g / colecalciferol 200 units (Calcichew D3®)	No effect 0 1 2 3 4 5 6 7 8 9 10 death
1.11C	Adcal-D3®	1.5g/ 10mcg	PO	BD	Regular	Discharge prescription was unsigned by prescriber.	No effect 0 1 2 3 4 5 6 7 8 9 10 death
2.14A	Adcal-D3®	T	PO	BD	Regular	No strength or formulation stated on prescription. Patient was previously prescribed chewable tablets.	No effect 0 1 2 3 4 5 6 7 8 9 10 death
4.04A	Adcal-D3®	T	PO	OD	Regular	Previously prescribed BD.	No effect 0 1 2 3 4 5 6 7 8 9 10 death
4.38A	Adcal-D3®	1 tablet	PO	OD	Regular	Frequency stated as OD but two administration times circled.	No effect 0 1 2 3 4 5 6 7 8 9 10 death

1

Form C v2 (24 August 2014)

Appendix 11: Causes of prescribing error interview invitation letter

Date:

School of Pharmacy & Biomedical Sciences
University of Portsmouth
St Michael's Building
White Swan Road
Portsmouth
PO14 3HZ

Email: hilary.scott@myport.ac.uk
Mobile: 07983 577234

Dear

"Investigating the role of the decision making process and human factors in prescribing errors within an inpatient mental health setting"

I am writing to ask if you would be willing to participate in an interview to explore the reasons why prescribing errors occur. This is part of my PhD research project supported by the University of Portsmouth.

Previous research on medication errors, and prescribing errors in particular, has concentrated on the secondary care sector. At the moment it is not clear how often prescribing errors occur and what are the underlying causes in a mental health setting. Very little has been published looking at these issues in mental health, where the frequency, nature and causes of prescribing error may be quite different from in acute care.

I am interested in investigating the prevalence and causes of prescribing errors in mental health.

The study has been reviewed and received a favourable opinion from the University of Portsmouth Science Faculty Research Ethics Committee (Ref No 2015-015) and the SEPT Research Governance Group.

Enclosed is an information sheet which explains what the interview will involve. Please read the information sheet. If you are willing to be interviewed please contact me by email or phone as soon as possible, returning the enclosed consent form, so that we can arrange a mutually convenient date and time.

Yours sincerely

Hilary Scott BSc, MPhil, MBA, MRPharmS
Researcher

Appendix 12: Participant information sheet (Interviews)

School of Pharmacy & Biomedical Sciences
University of Portsmouth
St Michael's Building
White Swan Road
Portsmouth PO14 3HZ
Email: hilary.scott@myport.ac.uk
Mobile: 07983 577234

Participant Information Sheet
(Interviews)

"Investigating the role of the decision making process and human factors in prescribing errors within an inpatient mental health setting"

Invitation to take part

You are being invited to take part in the above study; however, before you decide to take part, it is important to understand why the research is being done and what it would involve for you. This information sheet provides you with a brief explanation about the study and what the study will cover. Please take the time to read the information provided and feel free to contact me with any questions you may have.

Thank you for taking the time to read this leaflet.

What is the purpose of the study?

The main aim of this study is to identify the prevalence, nature and causes of prescribing errors in a mental health setting, as most of the current research evidence relates to secondary care. I am looking at both clinically important errors and those that you might perceive to be small "silly" errors. The study is being undertaken as part of a PhD award.

Why have you been invited to participate?

I would like to include you in my study because you prescribe for SEPT inpatients in Essex mental health and learning disability services where the study is being undertaken. The first part of the study involves the detection of prescription errors by ward pharmacists as part of their routine clinical pharmacy work. I would like to talk to prescribers who have made potential prescribing errors (either minor or more serious) to gain a better understanding of the underlying issues which may contribute to errors. Details of a potential error are enclosed.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you are still free to withdraw at any time, and without giving a reason.

What will happen if I decide to take part?

I would like you to take part in a 30 - 60 minute interview to explore the causes of the potential prescribing error which you have made. The interview will be conducted at a venue of your choice, for example, consulting room, office, or wherever is most convenient for you. I would like to make an audio-recording of the interview, so that it is not necessary to take detailed notes. You can ask me to stop the interview at any time if you no longer wish to participate, or can decline to answer specific questions.

Recordings and notes will be stored on password-protected computers with access only to those involved in the research. Any patient/staff member identified during the interview will be anonymised in the transcript.

What are the possible disadvantages and risks of taking part?

The interview will focus on the causes of prescribing errors. I understand that this is a potentially sensitive topic. However, I will take care to conduct the interview in a sensitive manner and no blame will be attributed to you. If the error that we discuss resulted in significant patient harm, or was potentially the result of a serious breach of practice, I will ask you whether the error was reported via DATIX, and encourage you to do so if not.

What are the possible benefits of taking part?

Participating in the study will help me gain a better understanding of the causes of prescribing errors in mental health, and whether they differ from those in other settings. In turn, this may help in the development of strategies for preventing or reducing errors in the future.

Will my participation in the study remain confidential?

All information which is collected during the course of the research will remain confidential and no participants will be named in the report. Any verbatim quotes from interviewees will not be attributed to named individuals.

If you participate it is possible that some of the data collected will be viewed by authorised persons within the University to check that the study is being carried out correctly. All will have a duty of confidentiality to you as a research participant and the data that they see will be anonymised.

What will happen if I don't want to carry on with the interview?

Your participation is voluntary and you are free to withdraw at any time during the interview, without giving a reason. If you decide to do so you can ask for your data not to be used in the study.

What will happen to the results of the research study?

The results will form the basis of my PhD thesis. The findings may also be presented at conferences or published in journals. It is intended to share the results with prescribers via the SEPT academic programme. Any outputs which are disseminated will have been anonymised in such a way that they cannot be attributed to the original source. No participants will be named in this process and verbatim quotes will not be attributed to named individuals.

Who is organising and funding this research?

The research is supported by the University of Portsmouth, and will be subject to its supervision and insurance.

Who has reviewed the study?

Research at the University of Portsmouth is reviewed by an independent Research Ethics Committee to protect your interests. Research undertaken at SEPT is reviewed by the Research Governance Group. This study has been reviewed and given a favourable opinion by both committees (University Ref No 2015-015).

What if there is a problem?

If you have a concern about any aspect of this study, you should speak to the researcher or their supervisor, who will do their best to answer your questions. If you remain unhappy or wish to complain formally, you can do this by contacting the Head of Department, Dr Steph Arkle (023 9284 3594; stephen.arkle@port.ac.uk) or the University Complaints Officer (023 9284 3642; complaintsadvice@port.ac.uk).

Contact for further information

If you wish to ask any questions about this study before deciding to take part, please contact one of the following people, who will be pleased to help you.

Researcher: Hilary Scott, School of Pharmacy & Biomedical Sciences, University of Portsmouth. Tel: 07983 577234, e-mail: hilary.scott@myport.ac.uk

Supervisor: Prof David Brown, School of Pharmacy & Biomedical Sciences, University of Portsmouth. Tel: 02392 843590, email: david.brown@port.ac.uk

Thank you for taking the time to read this information sheet regardless of whether you participate or not. If you agreed to participate in an interview please contact the researcher by email or phone as soon as possible to arrange a mutually convenient date and time. If you are willing to participate please complete and return the attached consent form.

Participant Information Sheet B v6 (12 July 2015)

I would like to explore with you the circumstances in which the following potential prescribing error occurred. This is purely for research purposes to try and gain a better understanding of why prescribing errors occur, and is not intended in any way to be punitive.

On (date) _____ *you prescribed (drug)* _____

for (patient) _____ *on (ward)* _____

and (error details) _____

was identified by (pharmacist) _____ *on the ward*

or in the pharmacy department.

_____ *doses were administered to the patient before it was detected.*

Appendix 13: Participant consent form (Interviews)

School of Pharmacy & Biomedical Sciences
University of Portsmouth
St Michael's Building
White Swan Road
Portsmouth
PO14 3HZ
Email: hilary.scott@myport.ac.uk

Participant Consent Form

"Investigating the role of the decision making process and human factors in prescribing errors within an inpatient mental health setting"

Interview

		Please initial box
1	I confirm that I have read and understand the information sheet dated 12 July 2015 (version 6) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	☐
2	I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reasons. I understand that if I decide to withdraw from the interview I can ask for my data not to be used in the study.	☐
3	I understand that data collected during the study may be looked at by individuals from the University of Portsmouth, and may be included in the study's final report and any resulting publications and presentations. I give permission for these individuals to have access to this information in an anonymised format.	☐
4	I agree to my interview being audio-recorded.	☐
5	I agree to be quoted verbatim as long as this is not personally attributed.	☐
6.	I agree to take part in the above study.	☐

Name of participant: _____ Date: _____ Signature: _____

Name of researcher: _____ Date: _____ Signature: _____

When completed: one for participant; one (signed) for researcher's file

1

Consent Form B v4 (12 July 2015)

Appendix 14: Causes of prescribing error interview schedule

University of Portsmouth

SEPT

EXPLORING THE CAUSES OF PRESCRIBING ERRORS

Interviewee Code:	
Profession:	
Consent form signed:	

Date:	
Interviewer:	
Interview taped: ☐	Not taped: ☐

General pre-amble

All prescribers are human and therefore prone to making errors. Many factors can contribute to increasing the risk of error. As you are aware I am carrying out a study to find out the prevalence, nature and causes of prescribing errors in mental health. Thank you for agreeing to be part of this research project.

The main purpose of this interview is to try and understand why prescribing errors occur. The interview should take no more than an hour and the areas covered will include a few questions about yourself, the particular incident(s) I asked you to think about, and a few general questions on the topic of prescribing errors. I'd like you to give each question some thought and answer frankly.

Your participation is entirely voluntary and you are free to withdraw at any point. If you don't want to answer any particular questions or you want to stop, then please say so. I'd like to stress that everything said here today will remain strictly confidential and it will not be possible for anyone to identify you from the final report. Your name will not appear on any documents or recordings from this interview. Patient information is not required; if however, patients are mentioned during the interview their details will be removed from the transcript.

There aren't any consequences from what you tell me today. The purpose of the interview is to discuss your views, opinions and experiences of prescribing errors.

Before we start I just want to remind you that our discussion will be audio-recorded so that I don't need to write everything down? Is that okay?

I've just started with these interviews so it would be really helpful if you could tell me if any question appears unclear so I can phrase it better the next time.

Does that all sound ok? Are you happy to proceed?

PROMPTS: *Can you give a more detailed description of what happened?* *Tell me what you are thinking?*
Could you say something more about that? *Why did you hesitate just then?*
You said ….. what do you mean by that?

Part ONE: Background (brief - to put interviewee at ease)

Can you tell me a bit of background about yourself?

- When did you qualify as a doctor?
- How long have you been working in mental health?
- How long have you been working in this Trust?
- What is your job role within the Trust?
- What sort of hours do you usually work?
- What education and training have you had in therapeutics and the practical aspects of prescribing as either an undergraduate or postgraduate?

Part TWO: The prescribing error (in-depth)

I'd like to talk about prescribing errors using this definition (hand over card with definition below) which is used by the NPSA, Department of Health and many researchers.

> *"A prescribing error occurs when, as a result of a prescribing decision or prescription writing process, there is an unintentional, significant, reduction in the probability of treatment being timely and effective or increase in the risk of harm when compared with generally accepted practice"*

(turn over card for error type information)

Errors can occur in either the decision making process or the prescription writing process, and range from things that you might perceive to be small "silly" errors to more serious ones. I'm interested in all of them.

While reviewing drug charts the pharmacist on your ward has come across the following:

(give details of the error)

This meets our definition of a possible prescribing error. I'd like to ask you a few questions relating to it. There are no right or wrong answers, and I'm interested in your own personal point of view.

Q1. What do you think about it?

Q. Would you regard this as an error? If so why? If not, why not?

Q2. What can you remember about prescribing this medicine?

If the interviewee is not very responsive use additional questions to explore further -

Q. What did you intend to prescribe?

PROMPTS: dosing, frequency, route, formulation, drug choice, contra-indications, interactions, lack of indication, omission of information etc.

PROMPTS: *Can you give a more detailed description of what happened?* *Tell me what you are thinking?*
Could you say something more about that? *Why did you hesitate just then?*
You said ….. what do you mean by that?

Q. What type of prescription was it?

PROMPTS: on admission / initiating a new medication / re-writing a previous prescription / generating a leave/discharge prescription?

Q. Did you refer to any other sources of information before prescribing the drug?

PROMPTS: BNF / local formulary / patient specific sources - GP letter, consultant letter / asked a colleague?

Q. Can you tell me about prescribing medication for this patient in general?

PROMPTS: severity / familiarity with condition / familiarity with the medicine

Q. Who made the decision to initiate the treatment?

PROMPTS: yourself / registrar / consultant / another person - in person, ward round, telephone, request in medical notes / request from nursing staff?

Q. How did you become aware that an error had occurred?

PROMPTS: when / who realised? If someone else, how were you made aware of it?

Q. What do you believe where the consequence (potential consequences) for the patient?

PROMPTS: on a scale of 1-10 where 1 is no effect and 10 is fatal

Q. How did the error make you feel?

PROMPTS: happened before / happened since / happened to anyone else?

PROMPTS: did you discuss it with your consultant / colleagues? What did they think?

PROMPTS: attitude to prescribing (important, simple etc.) / attitude to errors

Q. Has it changed the way you prescribe?

PROMPTS: doing anything different as a result? - self-checking, prescribing differently / coping strategies / mechanisms for complex or difficult prescribing?

Q. From the definition we looked at earlier, would you classify it as an error in decision making or in terms of the prescription writing process?

Q3. What can you remember about the circumstances?

If the interviewee is not very responsive use additional questions to explore further -

Q. Can you remember the situation under which you wrote the prescription?

PROMPTS: when / time of day / ward round / on-call?

Q. Was there anything different from normal about that day?

PROMPTS: tired / hungry / stressed / personal distractions / rushed, if so why / covering for others / unfamiliar with ward or patient?

Q. Who else was there on the ward at the time?

PROMPTS: medical team / nursing staff / pharmacist / ward round / visitors?

Q. Can you describe the patient involved?

PROMPTS: age / personality / ethnicity / doctor-patient relationship / seen before / own patient / unknown patient?

PROMPTS: *Can you give a more detailed description of what happened?* *Tell me what you are thinking?*
Could you say something more about that? *Why did you hesitate just then?*
You said ….. what do you mean by that?

Q4. What do you think were the main contributors to the error?

If the interviewee is not very responsive use additional questions to explore further -

Individual	***Knowledge & skills / Competence / Physical and mental health*** *Where you tired, hungry, unwell?* *Did you feel unappreciated, low morale?* *Do you believe your knowledge of the drug(s) and its use was adequate?* *Did problems arise from look-alike or sound alike drugs, abbreviations, ambiguous nomenclature?* *Do you feel that you had inadequate knowledge or experience to deal with this case?*	
Team	***Verbal communication / written communication (medical notes etc) / supervision and seeking help / team structure (consistency, leadership)*** *Was there a lack of guidance or miscommunication from more senior / experienced staff?* *Where the relevant notes unavailable, illegible, incomplete?* *Were you unaware of any risk factors in this case?* *Did you feel your opinions were not accepted, unappreciated, questioned?*	
Patient	***Condition (complexity & seriousness) / language and communication / personality and social factors*** *Was the patient (or visitors) unhelpful or uncooperative?* *Was this case complex or unusual?*	
Task / Technology	***Task design & clarity of structure / availability & use of protocols / availability & accuracy of test results / decision making aids*** *Were protocols unavailable or inadequate?* *Were routine tests omitted or results not documented in the notes?* *Were test results unavailable* *Did you have sufficient and convenient / timely access to information about the drug and its use*	
Work environment	***Staffing levels & skill mix / workload / shift patterns / admin & managerial support / environment / physical*** *Did the working environment affect you (temperature, noise etc)?* *Were you short staffed?* *Were you busier than average that day / at that time?*	
Organisational & Management	***Financial resources / organisational structure / policy, standards & goals / safety culture and priorities*** *Was supervision or support inadequate?* *Do you feel that management didn't show appropriate care or concern?* *Were there any disagreements about responsibility in this case?* *Did you have to rely on a new or locum member of staff with whom you have not worked before?*	

Q. Can you think of anything else that may have contributed to the error?

PROMPTS: lack of support / lack of knowledge / lack of communication / lack of information / memory lapse / 'slip of the pen' / failure to do what you meant to do?

Q. Can you think of any way in which it could have been prevented?

PROMPTS: drug knowledge / access to information / communication / supervision / protocols / guidelines?

Q. Are there other factors that you think are important in causing or preventing prescribing errors?

Q. Has the error been reported via DATIX?

General close

Is there anything else that we've not covered that you feel is important or anything else you would like to say?

Thank you very much for your time and for being willing to talk to me. Your comments have been very helpful and they will be used together with those of other participants to gain an understanding of prescribing errors in mental health and why they occur. However, the identity of all individuals will remain confidential.

Once the study is completed the findings will be presented via the academic programme on a Thursday morning.

In the meantime please feel free to contact me if you have any questions or other issues about the study you would like to discuss.

Post interview

Post a thank you letter to the participant.

Appendix 15: Cognitive style questionnaire

Investigating the role of the decision making process and human factors

Participant Information Sheet and Consent Form

You are being invited to take part in the above study; however, before you decide to take part, it is important to understand why the research is being done and what it would involve for you. This page provides you with a brief explanation about the study and what it covers. Please take the time to read the information provided below.

What is the purpose of the study? The aim is to identify the prevalence, nature and causes of prescribing errors in a mental health setting, and to investigate whether there is any correlation between prescribers' cognitive decision-making style and making prescribing errors. The study is being undertaken as part of my PhD.

Why have you been invited to participate? You have been identified as a potential participant because you prescribe for inpatients in Essex mental health services where the study is being undertaken.

Do I have to take part? It is up to you to decide whether or not to take part. If you decide to take part you are still free to withdraw at any time, and without giving a reason, although it may not be possible to disaggregate your data once processed.

What will I have to do if I decide to take part? The first part of the study involves completion of this online questionnaire designed to assess cognitive style and in particular whether you are an intuitive or rational decision-maker. This will then be correlated to the incidence and nature of any prescribing errors made by you that are detected by SEPT ward pharmacists as part of their routine work. A small number of prescribers will also be asked to participate in a semi-structured interview to try and gain a better understanding of the cause(s) of one or more prescribing error.

If you decide to take part, the questionnaire will require about 10 minutes of your time.

What are the possible benefits and disadvantages of taking part? Participating in the study will help the researcher gain a more accurate estimate of the prevalence of prescribing errors in a mental health setting, and understand the nature and causes of these errors, and whether they differ from those in other settings.This may help in the development of strategies for preventing or reducing errors in the future. If you decide to take part, the questionnaire will require about 10 minutes of your time. If you are asked, and agree, to take part in an interview this will require about 1 hour.

Will my participation remain confidential? All information which is collected during the course of the questionnaire will remain confidential. It is possible that some of the data collected will be viewed by authorised persons within the University to check that the study is being carried out correctly. All will have a duty of confidentiality to you as a research participant.

What will happen to the results of the study? These will form the basis of the researcher's PhD thesis, may be presented at conferences or published in journals. The results will be shared with prescribers via the SEPT academic programme. No participants will be named and any verbatim quotes will not be attributed to named individuals.

Who has reviewed the study? The study has been reviewed by the Science Faculty Research Ethics Committee and by the SEPT Research Governance Committee and received a favourable opinion.

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Investigating the role of the decision making process and human factors

Contact for further information If you wish to ask any questions about this study you may contact the researcher Hilary Scott (07983 577234; hilary.scott@myport.ac.uk) or Prof David Brown (02392 843590; david.brown@port.ac.uk).

If you agree to participate in this study, please select "I agree" below to be directed to the questionnaire. If you do not wish to take part in this study please select "I do not agree" to leave the site.

1. Consent to participate

◯ I agree ◯ I do not agree

Investigating the role of the decision making process and human factors

Demographic Information

Demographic information is needed to analysis the information obtained about cognitive style. Your name is needed in order to match this information to any prescribing errors detected by ward pharmacists in the course of their normal clinical pharmacy work.

This information will only be seen by the researcher and possibly by the academic supervisor at the university.

2. Contact Details

This is needed in order to match your cognitive style to any prescribing errors identified by ward pharmacists

Name

3. Gender

◯ Male ◯ Female

4. What is your age?

◯ 21-29
◯ 30-39
◯ 40-49
◯ 50-59
◯ 60 or older

5. Number of years in practice

As a registered healthcare professional

As a prescriber

6. Grade of Prescriber

◯ Foundation Year Trainee (FY1; FY2)
◯ Specialist Trainee (StR1-6)
◯ Staff Grade
◯ Consultant
◯ Non Medical Prescriber - Nurse
◯ Non Medical Prescriber - Pharmacist
◯ Other (please specify)

7. Area of sub-specialisation

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Investigating the role of the decision making process and human factors

Please answer these questions without using any external resources (eg inte...

8. Mary's mother had four children. The youngest three are named Spring, Summer and Autumn. What is the oldest child's name?

9. A bat and a ball cost £1.10 in total. The bat costs £1.00 more than the ball. How much does the ball cost?

Please enter your answer in pounds

10. If you flipped a fair coin 3 times, what is the probability that it would land "heads" *at least* once?

Please enter your answer as a percentage

11. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

Please enter you answer in minutes

12. In a lake, there is a patch of lilypads. Every day the patch doubles in size. If it take 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

13. If John can drink one barrel of water in 6 days, and Mary can drink one barrel of water in 12 days, how long would it take to drink one barret of water together?

14. Jerry received both the 15th highest and the 15th lowest mark in the class. How many students are in the class?

15. A bear loses 20% of its weight during hibernation. If it weights 100 kilos after hibernation, how many kilos did it weight before?

Please enter your answer in kilos

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Investigating the role of the decision making process and human factors

Decision Making

16. Below are a series of statements that describe how various people make decisions. Read each statement carefully and think about the extent to which the statement describes you. Please rate each question using the scale.

	Strongly disagree	Disagree	Neither disagree Nor agree	Agree	Strongly agree
I have a logical mind	◯	◯	◯	◯	◯
I prefer complex problems to simple problems	◯	◯	◯	◯	◯
I believe in trusting my hunches	◯	◯	◯	◯	◯
I am not a very analytical thinker	◯	◯	◯	◯	◯
I trust my initial feelings about people	◯	◯	◯	◯	◯
I try to avoid situations that require thinking in depth about something	◯	◯	◯	◯	◯
I like to rely on my intuitive impressions	◯	◯	◯	◯	◯
I don't reason well under pressure	◯	◯	◯	◯	◯
I don't like situations in which I have to rely on intuition	◯	◯	◯	◯	◯
Thinking hard and for a long time about something gives me little satisfaction	◯	◯	◯	◯	◯
Intuition can be a very useful way to solve problems	◯	◯	◯	◯	◯
I would not want to depend on anyone who described himself or herself as intuitive	◯	◯	◯	◯	◯
I am much better at	◯	◯	◯	◯	◯

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Investigating the role of the decision making process and human factors

figuring things out logically than most people					
I usually have clear, explainable reasons for my decisions	○	○	○	○	○
I don't think it is a good idea to rely on one's intuition for important decisions	○	○	○	○	○
Thinking is not my idea of an enjoyable activity	○	○	○	○	○
I have no problem thinking things through carefully	○	○	○	○	○
When it comes to trusting people, I can usually rely on my gut feelings	○	○	○	○	○
I can usually feel when a person is right or wrong, even if I can't explain how I know	○	○	○	○	○
Learning new ways to think would be very appealing to me	○	○	○	○	○
I hardly ever go wrong when I listen to my deepest gut feelings to find an answer	○	○	○	○	○
I think it is foolish to make important decisions based on feelings	○	○	○	○	○
I tend to use my heart as a guide for my actions	○	○	○	○	○
I often go by my instincts when deciding on a course of action	○	○	○	○	○
I'm not that good at	○	○	○	○	○

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Investigating the role of the decision making process and human factors

figuring out complicated problems					
I enjoy intellectual challenges	○	○	○	○	○
Reasoning things out carefully is not one of my strong points	○	○	○	○	○
I enjoy thinking in abstract terms	○	○	○	○	○
I generally don't depend on my feelings to help me make decisions	○	○	○	○	○
Using logic usually works well for me in figuring out problems in my life	○	○	○	○	○
I think there are times when one should rely on one's intuition	○	○	○	○	○
I don't like to have to do a lot of thinking	○	○	○	○	○
Knowing the answer without having to understand the reasoning behind it is good enough for me	○	○	○	○	○
Using my gut feelings usually works well for me in figuring out problems in my life	○	○	○	○	○
I don't have a very good sense of intuition	○	○	○	○	○
If I were to rely on my gut feelings, I would often make mistakes	○	○	○	○	○
I suspect my hunches are inaccurate as often as they are accurate	○	○	○	○	○
My snap judgements	○	○	○	○	○

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Investigating the role of the decision making process and human factors

are probably not as good as most people's					
I am not very good at solving problems that require careful logical analysis	○	○	○	○	○
I enjoy solving problems that require hard thinking	○	○	○	○	○

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Investigating the role of the decision making process and human factors

Thinking and Problem Solving

17. Below are several statements about thinking and problem solving. Please read each statement carefully and choose the response that best describes your opinion.

	Very strongly disagree	Strongly disagree	Moderately disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Moderately agree	Strongly agree	Very strongly agree
I prefer complex to simple problems.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I like to have the responsibity of handling a situation that requires a lot of thinking.	◯	◯	◯	◯	◯	◯	◯	◯	◯
Thinking is not my idea of fun.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I would rather do something that requires little thought than something that is sure to challenge my thinking abilities.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I try to anticipate and avoid situations where there is likely chance I will have to think in depth about something.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I find satisfaction in deliberating hard and for long hours.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I only think as hard as I have to.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I prefer to think about small, daily projects to long-term ones.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I like tasks that require little thought once I've learned them.	◯	◯	◯	◯	◯	◯	◯	◯	◯
The idea of relying on thought to make my way to the top appeals to me.	◯	◯	◯	◯	◯	◯	◯	◯	◯
I really enjoy a task that involves coming up	◯	◯	◯	◯	◯	◯	◯	◯	◯

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with new solutions to problems.									
Learning new ways to think doesn't excite me very much.	○	○	○	○	○	○	○	○	○
I prefer my life to be filled with puzzles that I must solve.	○	○	○	○	○	○	○	○	○
The notion of thinking abstractly is appealing to me.	○	○	○	○	○	○	○	○	○
I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.	○	○	○	○	○	○	○	○	○
I feel relief rather than satisfaction after completing a task that required a lot of mental effort.	○	○	○	○	○	○	○	○	○
It's enough for me that something gets the job done; I don't care how or why it works.	○	○	○	○	○	○	○	○	○
I usually end up deliberating about issues even when they do not affect me personally.	○	○	○	○	○	○	○	○	○

Investigating the role of the decision making process and human factors

18. Do you have any comments you would like to add about cognitive styles or clinical decision making?

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Investigating the role of the decision making process and human factors

You have finished the questionnaire.

Thank you for completing the questionnaire; your input will be extremely valuable to me in this study. It will help me to understand the cognitive decision-making styles found amongst mental health prescribers, and whether there is any link to the occurrence of prescribing errors.

The study will take place over the next few years, but results will be presented at a future academic programme meeting.

Hilary Scott
PhD Researcher, University of Portsmouth
Chief Pharmacist, SEPT

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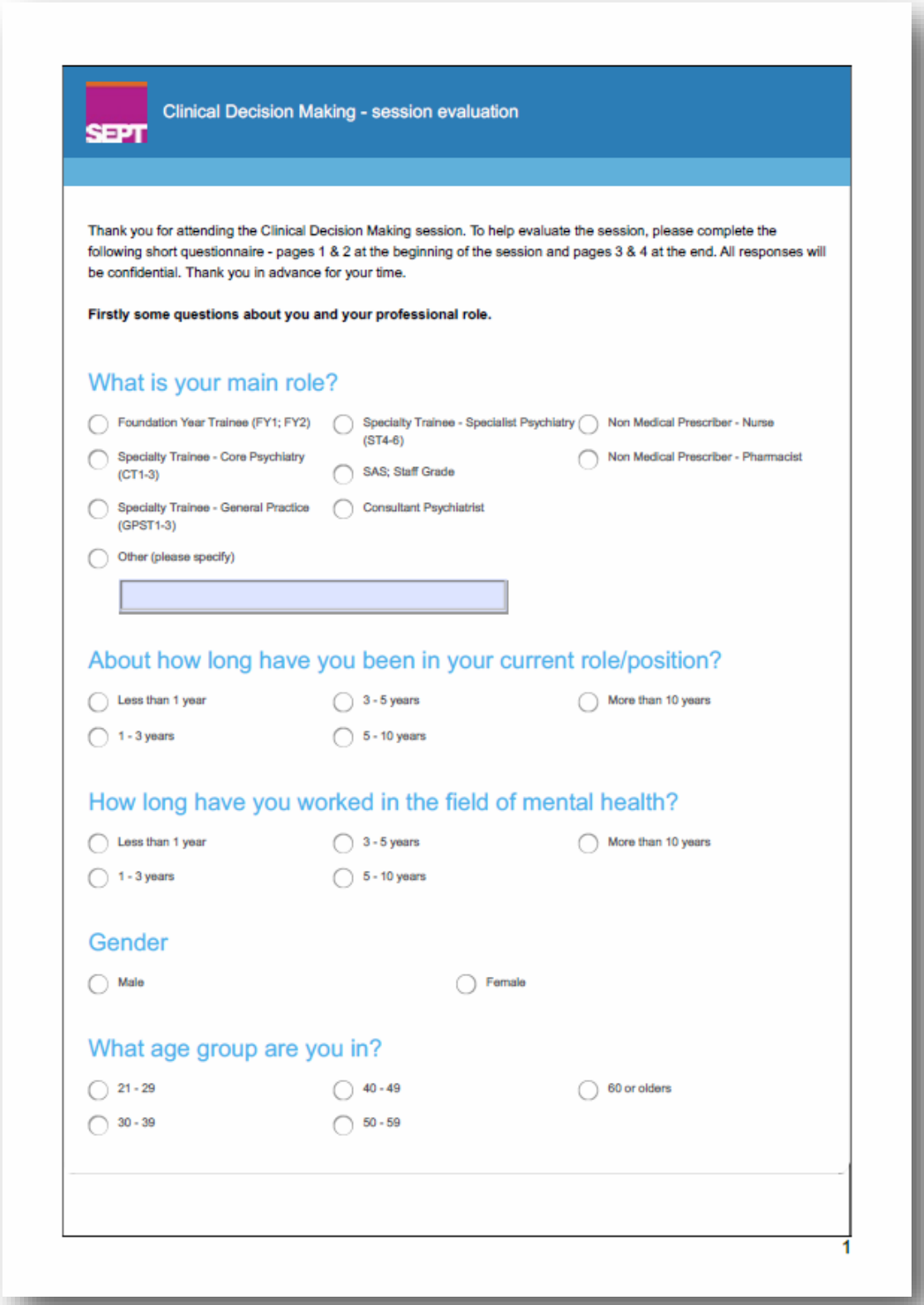
Appendix 16: Clinical decision-making session evaluation questionnaire



SEPT

Clinical Decision Making - session evaluation

Thank you for attending the Clinical Decision Making session. To help evaluate the session, please complete the following short questionnaire - pages 1 & 2 at the beginning of the session and pages 3 & 4 at the end. All responses will be confidential. Thank you in advance for your time.

Firstly some questions about you and your professional role.

What is your main role?

- Foundation Year Trainee (FY1; FY2)
- Specialty Trainee - Core Psychiatry (CT1-3)
- Specialty Trainee - General Practice (GPST1-3)
- Other (please specify)
- Specialty Trainee - Specialist Psychiatry (ST4-6)
- SAS; Staff Grade
- Consultant Psychiatrist
- Non Medical Prescriber - Nurse
- Non Medical Prescriber - Pharmacist

About how long have you been in your current role/position?

- Less than 1 year
- 1 - 3 years
- 3 - 5 years
- 5 - 10 years
- More than 10 years

How long have you worked in the field of mental health?

- Less than 1 year
- 1 - 3 years
- 3 - 5 years
- 5 - 10 years
- More than 10 years

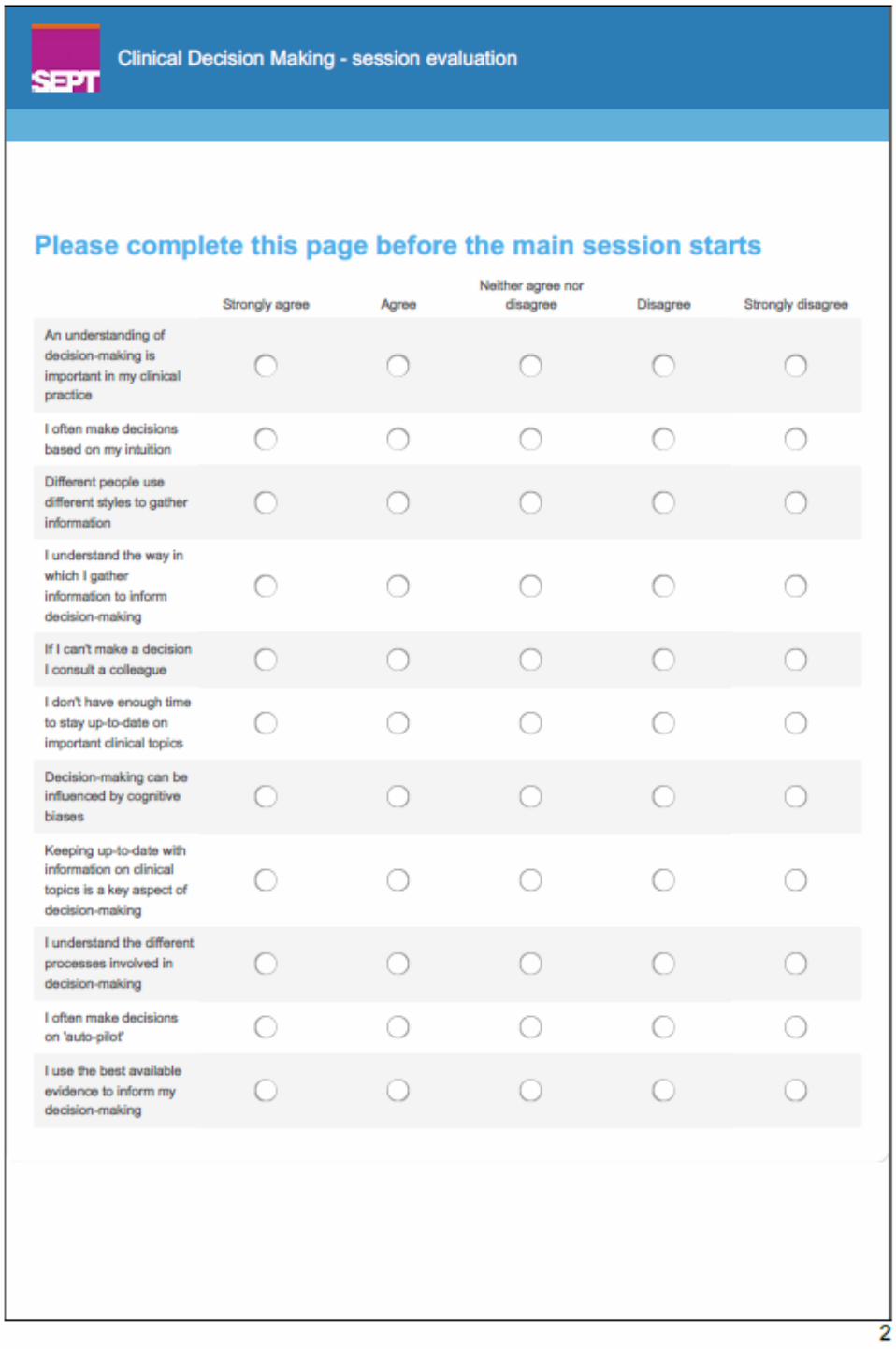
Gender

- Male
- Female

What age group are you in?

- 21 - 29
- 30 - 39
- 40 - 49
- 50 - 59
- 60 or olders

1



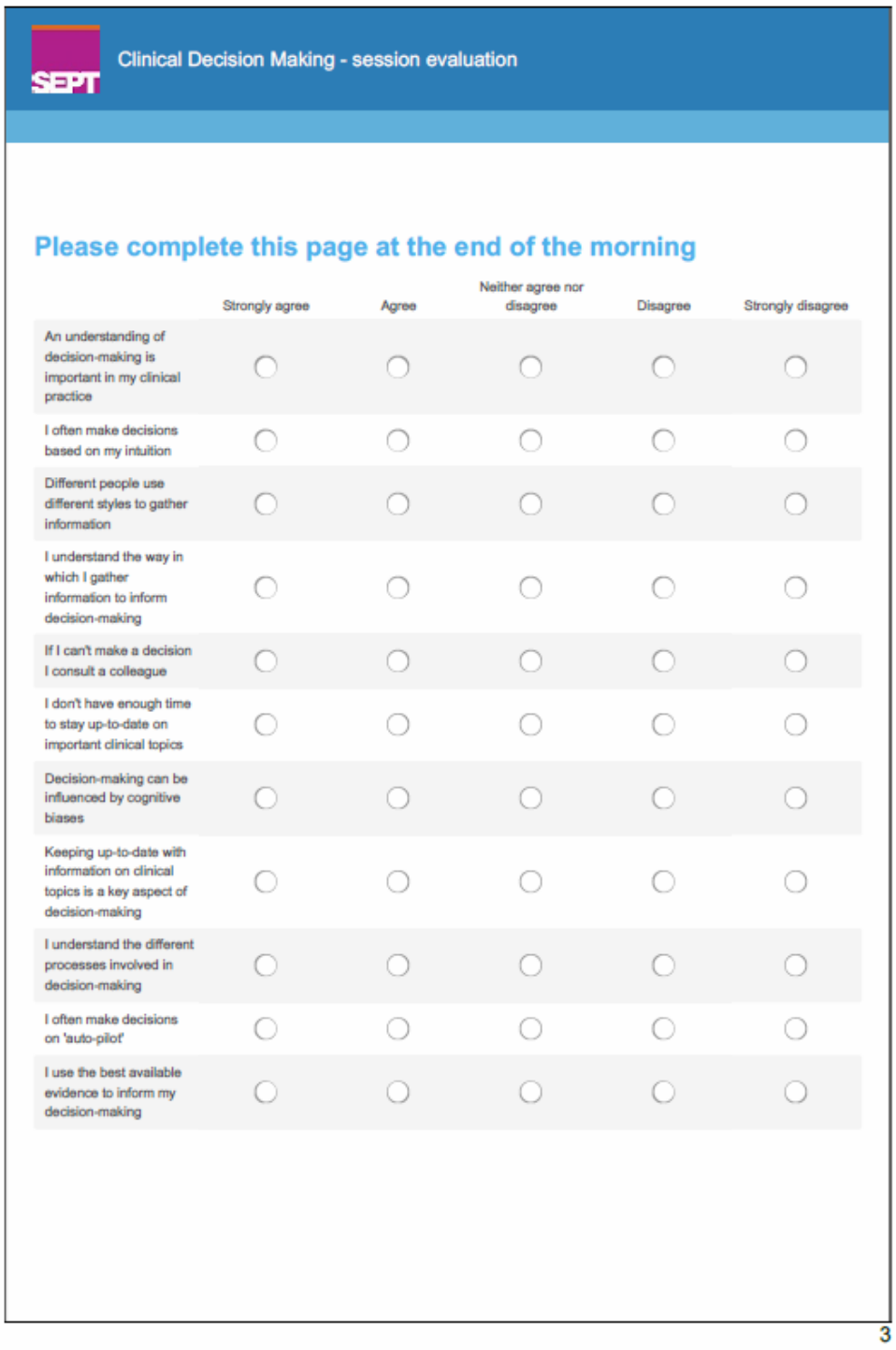
SEPT

Clinical Decision Making - session evaluation

Please complete this page before the main session starts

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
An understanding of decision-making is important in my clinical practice	○	○	○	○	○
I often make decisions based on my intuition	○	○	○	○	○
Different people use different styles to gather information	○	○	○	○	○
I understand the way in which I gather information to inform decision-making	○	○	○	○	○
If I can't make a decision I consult a colleague	○	○	○	○	○
I don't have enough time to stay up-to-date on important clinical topics	○	○	○	○	○
Decision-making can be influenced by cognitive biases	○	○	○	○	○
Keeping up-to-date with information on clinical topics is a key aspect of decision-making	○	○	○	○	○
I understand the different processes involved in decision-making	○	○	○	○	○
I often make decisions on 'auto-pilot'	○	○	○	○	○
I use the best available evidence to inform my decision-making	○	○	○	○	○

2



SEPT

Clinical Decision Making - session evaluation

Please complete this page at the end of the morning

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
An understanding of decision-making is important in my clinical practice	○	○	○	○	○
I often make decisions based on my intuition	○	○	○	○	○
Different people use different styles to gather information	○	○	○	○	○
I understand the way in which I gather information to inform decision-making	○	○	○	○	○
If I can't make a decision I consult a colleague	○	○	○	○	○
I don't have enough time to stay up-to-date on important clinical topics	○	○	○	○	○
Decision-making can be influenced by cognitive biases	○	○	○	○	○
Keeping up-to-date with information on clinical topics is a key aspect of decision-making	○	○	○	○	○
I understand the different processes involved in decision-making	○	○	○	○	○
I often make decisions on 'auto-pilot'	○	○	○	○	○
I use the best available evidence to inform my decision-making	○	○	○	○	○

3

Please comment on the training session

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The programme provided me with a good understanding of the topic	◯	◯	◯	◯	◯
The content was relevant to my training / practice	◯	◯	◯	◯	◯
The training experience will be useful in my work	◯	◯	◯	◯	◯
I will be able to apply the knowledge learned	◯	◯	◯	◯	◯

Session 1: Preliminary findings on prescribing error study

	Poor	Fair	Good	Excellent
How did you find the way it was presented / delivered	◯	◯	◯	◯
Overall, how would you rate the session?	◯	◯	◯	◯

Please use this space to provide any further feedback on the session

Session 2: Decision making

	Poor	Fair	Good	Excellent
How did you find the way it was presented / delivered	◯	◯	◯	◯
Overall, how would you rate the session?	◯	◯	◯	◯

Please use this space to provide any further feedback on the session

Thank you

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Appendix 17: Science Faculty Ethics Committee favourable opinion

Science Faculty Ethics Committee
Science Faculty Office
University of Portsmouth
St Michael\s Building
White Swan Road
PORTSMOUTH
PO1 2DT

T: 023 9284 3379
ethics-sci@port.ac.uk

29 April 2015

Hilary Frances Scott
School of Pharmacy and Biomedical SciencesUniversity of Portsmouth

hilary.scott@myport.ac.uk

FAVOURABLE ETHICAL OPINION WITH CONDITION – SFEC 2015-015 SCOTT

Protocol Title: An investigation into the effect of the decision making process and human factors in prescribing errors within an inpatient mental health setting.
SFEC Code: SFEC 2015-015
Date Submitted: 11 April 2015
Date reviewed: 20-29 April 2015

Thank you for resubmitting your application to the Science Faculty Ethics Committee (SEFC) for ethical review following the 1st SFEC review, in accordance with current procedures[1]. Thank you for the clarifications provided and the changes you have made in response. I am pleased to inform you that your application has been given a favourable opinion by SFEC, subject to the following condition:

Condition 1 Please use a standard template consent form, adapted for your own department. An example is given in the enclosed DSES protocol template (Annex A), or can be downloaded from http://www.port.ac.uk/research/ethics/

Please:

a. Do let us know if this condition causes any problems for your research or your participants.

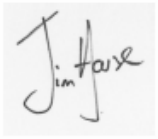
b. Submit a copy of the final consent form used.

c. Notify us in the future of any substantial amendments that may be required to this study, by making an application for protocol amendment[2].

d. Also submit to ethics-sci@port.ac.uk an annual report on the progress of the study, and a final study report / publication when the study has concluded.

[1] Procedures for Ethical Review, Science Faculty Ethics Committee, University of Portsmouth, October 2012 (to be updated).
[2] Using the SFEC protocol amendment form.

SFEC wishes you well with your study[3].



Dr Jim House
Vice-Chair Science Faculty Ethics Committee - Review Chair

Enclosure:

1. DSES Protocol template including example consent form

Information:

Professor David Brown david.brown@port.ac.uk
Dr Helena Herrera helena.herrera@port.ac.uk
Holly Shawyer - Faculty Administrator

[3] If you would like to offer any feedback on the SFEC process please email ethics-sci@port.ac.uk, to be forwarded to the Chair.

Appendix 18: Prescribing indicators relevant to mental health

Prescribing safety indicator title	Error type	Risk
Lithium dose not adjusted or omitted in a patient with a lithium concentration above the therapeutic range (>1,0 mmol l^{-1}) (*risk of lithium toxicity*)	Dosing	High
Benzodiazepine or benzodiazepine-like drug prescribed to a patient with chronic obstructive pulmonary disease *(risk of respiratory depression*)	Clinical contraindication	High
Antipsychotic, other than risperidone, prescribed to a patient for the management of behavioural and psychological symptoms of dementia (*increased risk of stroke*)	Clinical contraindication	High
Tricyclic antidepressant prescribed to a patient with dementia (*increased risk of worsening cognitive impairment*)	Clinical contraindication	High
Selective serotonin reuptake inhibitor prescribed to a patient with epilepsy (*increased risk of seizure threshold being reduced)*	Clinical contraindication	High
Selective serotonin reuptake inhibitor prescribed to a patient with a history of clinically significant hyponatraemia (non-iatrogenic, sodium <130 mmol l^{-1} in the previous 2 months) (*increased risk of hyponatraemia*)	Clinical contraindication	High
Prochlorperazine prescribed to a patient with parkinsonism. (*risk of exacerbating parkinsonism symptoms*)	Clinical contraindication	High
Lithium prescribed in conjunction with newly prescribed nonsteroidal anti-inflammatory drugs without dose adjustment or increased monitoring (*increased risk of toxicity*)	Drug-drug interaction	High
Lithium prescribed in conjunction with newly prescribed loop or thiazide diuretics without dose adjustment or increase monitoring (*increased risk of toxicity*)	Drug-drug interaction	High
Tricyclic antidepressant prescribed at the same time as a monoamine oxidase inhibitor (*increased risk of serotonin syndrome*)	Drug-drug interaction	High
Tramadol prescribed concomitantly with a monoamine oxidase inhibitor (*increased risk of serotonin syndrome*)	Drug-drug interaction	High
Selective serotonin reuptake inhibitor prescribed concomitantly with tramadol (*increased risk of serotonin syndrome*)	Drug-drug interaction	High
Selective serotonin reuptake inhibitor prescribed concomitantly with aspirin without appropriate prophylaxis with antisecretory drugs or mucosal protectant (*increased risk of gastrointestinal bleeding*)	Drug-drug interaction	High
Citalopram prescribed concomitantly with other QT-prolonging drugs (*increased risk of arrhythmias*)	Drug-drug interaction	High
Benzodiazepines prescribed long term (i.e. more than 2-4 weeks) (*risk of dependence and withdrawal reactions)*	Duration	High
Benzodiazepine or benzodiazepine-like drug prescribed long term to a patient with depression (*risk of dependence and withdrawal reactions)*	Duration	High
Benzodiazepine-like drugs (e.g. zopiclone) prescribed long term (i.e. more than 2-4 weeks) (*risk of dependence reactions*)	Duration	High
Antipsychotic prescribed long term (i.e. > 1 month) to a patient with parkinsonism (*increased risk of worsening of extrapyramidal side-effect*)	Duration	High

Source: Thomas et al[308]

Appendix 19: Summary of errors considered to be potentially 'severe' by either the ward pharmacist or expert panel

Type of error	Prescriber	Prescribing stage	Sub-specialty	Description	Ward pharmacist assessment	Expert panel assessment
Allergy	Consultant	Leave	Older People	Co-Amoxiclav 625 mg three times daily prescribed for a patient with a documented penicillin allergy.	severe (8.0)	severe (7.9)
Allergy	Staff grade	During stay	Older People	Co-Amoxiclav 625 mg three times daily prescribed for a patient with a documented penicillin allergy.	severe (9.0)	severe (7.9)
Dose	Staff grade	Admission	Older People	Fluoxetine liquid 20 mg/5 ml prescribed with a dose of 10 ml (40 mg) daily when the dose should have been 10 mg (2.5 ml) daily.	severe (8.0)	moderate (4.3)
Dose	Consultant	During stay	Adult	Haloperidol 1 g twice daily prescribed, when maximum daily dose is 20 mg.	severe (9.0)	moderate (7.0)
Dose	Core trainee	Admission	Older People	Paracetamol 1 g four times daily prescribed for a patient with a weight of 47.3 kg, when transfer document from acute trust states dose of 500 mg four times daily.	severe (8.0)	moderate (5.4)
Dose	GP trainee	Re-write	Adult	Quetiapine 800 mg daily prescribed without specifying that formulation should be modified release.	severe (9.0)	moderate (3.2)
Dose	Core trainee	Admission	Adult	Seretide Accuhaler© twice daily prescribed without specifying strength. Salmeterol/fluticasone available as 50/100 mcg, 50/250 mcg and 50/500 mcg strengths	severe (8.0)	moderate (3.3)
Dose	Staff grade	Admission	Older People	Solifenacin 70 mg daily prescribed when dose should have been 10 mg daily.	severe (8.0)	moderate (6.6)
Dose	GP trainee	Admission	Adult	Symbicort© inhaler twice daily prescribed without specifying strength. Budesonide/formoterol available as 100/6 mcg, 200/6 mcg and 400/12 mcg strengths.	severe (8.0)	moderate (3.7)
Dose	Staff grade	Re-write	Forensic	Venlafaxine modified release 225 mg prescribed three times daily when modified release formulation should be once daily dose.	severe (9.0)	moderate (6.9)
Duplication	Higher specialty trainee	Not known	Older People	Warfarin 5 mg daily prescribed on both anticoagulation chart and main drug chart.	severe (8.0)	severe (7.8)
Duplication	Consultant	During stay	Adult	Lithium carbonate 400 mg twice daily prescribed without discontinuing previous prescription for 800 mg daily.	severe (8.0)	severe (7.9)
Duplication	Staff grade	During stay	Adult	Co-codamol 30/500 four times daily prescribed when patient already had both co-codamol and paracetamol prescribed on other drug charts (i.e. double duplication).	severe (8.0)	moderate (6.3)
Duplication	Staff grade	During stay	Older People	Co-codamol 8/500, two tablets four times daily as required prescribed when patient already prescribed two tablets twice daily as regular medication and two tablets twice daily as required medication.	severe (8.0)	moderate (6.3)
Duplication	Foundation year 1	During stay	Older People	Co-dydramol 10/500, one to two tablets four times daily as required prescribed when patient already prescribed paracetamol 1 g four times daily as regular medication.	severe (9.0)	moderate (5.6)

Type of error	Prescriber	Prescribing stage	Sub-specialty	Description	Ward pharmacist assessment	Expert panel assessment
Duplication	Consultant	During stay	Adult	New prescription written for olanzapine 25 mg once daily, without discontinuing previous prescription for 20 mg daily.	severe (8.0)	moderate (5.6)
Duplication	Consultant	Admission	Older People	Paracetamol 1 g four times daily prescribed when patient already prescribed paracetamol 1 g four times daily as required.	severe (9.0)	moderate (5.1)
Duplication	Staff grade	During stay	Older People	Paracetamol 1 g four times daily prescribed when patient already prescribed paracetamol 1 g four times daily as required.	severe (8.0)	moderate (5.2)
Duplication	GP trainee	Admission	Older People	Paracetamol 500 mg - 1 g six-hourly as required prescribed when patient already prescribed co-codamol 30/500, two tablets four times daily as regular medication.	severe (8.0)	moderate (5.2)
Duration	Staff grade	Discharge	Forensic	28 day's supply of Clozapine 150 mg each morning prescribed. Patient required weekly blood tests with a 'green' result before release of further weekly supplies.	minor (0.0)	severe (7.4)
Duration	Staff grade	Discharge	Forensic	28 day's supply of Clozapine 175 mg at night prescribed. Patient required weekly blood tests with a 'green' result before release of further weekly supplies.	minor (0.0)	severe (7.4)
Frequency	Staff grade	Re-write	Forensic	Zuclopenthixol decanoate 800 mg IM prescribed for weekly administration, when should have been prescribed for administration every two weeks.	minor (0.0)	severe (7.2)
Frequency	Core trainee	Admission	Older People	Furosemide 40 mg daily prescribed when patient's own drugs and discharge summary from acute hospital showed frequency of twice daily.	severe (8.0)	moderate (3.9)
Indication	Core trainee	Discharge	Adult	Quetiapine modified release 800 mg daily prescribed at discharge when patient not taking that medication	severe (8.0)	moderate (6.7)
Omission	Staff grade	Leave	Older People	Warfarin omitted from leave prescription.	not assessed	severe (7.5)
Omission	Consultant	Admission	Older People	Co-amoxiclav 625 mg three times daily omitted from prescription on transfer from acute hospital. Six doses missed before corrected and diabetic patient experienced erratic blood sugar levels requiring Actrapid© insulin PRN which could have been due to infection.	severe (8.0)	moderate (6.9)
Omission	GP trainee	Discharge	Adult	Mirtazapine 15 mg at night omitted from discharge prescription.	severe (8.0)	moderate (3.2)
Omission	Consultant	Discharge	Adult	Mirtazapine 45 mg once daily omitted from discharge prescription.	severe (8.0)	moderate (4.8)
Omission	Staff grade	Admission	Older People	Ramipril 5 mg daily omitted from prescription on transfer from acute hospital.	severe (9.0)	moderate (4.5)
Route	GP trainee	During stay	Adult	Pabrinex IV prescribed when should have been Pabrinex IM. Formulations for IV and IM use are not interchangeable.	moderate (3.0)	severe (7.3)
Legal	Consultant	Admission	Older People	Prescription for metformin 500 mg twice daily unsigned by prescriber.	severe (8.0)	not assessed

Appendix 20: Data collection by prescriber

FY= foundation year; CT = core trainee; ST = specialty trainee; GPST = general practice specialty trainee. Missing prescriber codes did not prescribe and/or attend the educational session

Prescriber code & grade/type		Pre-intervention data collection												Education session	Post-intervention data collection											Total items prescribed
		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
0	Unidentified	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓		✓	✓		✓		158
1	Consultant	✓	✓	✓														✓	✓	✓	✓	✓		✓	✓	✓	48
2	Staff Grade	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓			✓	✓										149
3	Consultant	✓	✓	✓		✓	✓	✓	✓	✓			✓	Yes		✓				✓				✓	✓		107
4	CT2	✓	✓		✓					✓	✓	✓	✓				✓		✓	✓		✓	✓	✓	✓	✓	254
5	CT3	✓	✓		✓			✓		✓	✓	✓									✓	✓	✓				94
6	Consultant	✓	✓	✓	✓	✓		✓		✓	✓			Yes	✓		✓		✓	✓		✓	✓	✓			255
7	FY2	✓		✓	✓	✓																					19
8	GPST2	✓	✓				✓	✓																			61
9	ST4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Yes				✓						✓		✓	186
10	Consultant	✓		✓	✓	✓	✓	✓		✓	✓	✓		Yes			✓		✓	✓				✓	✓		86
11	GPST2	✓		✓	✓	✓	✓	✓																			64
12	Consultant	✓																									12
13	Consultant	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		343
14	Consultant	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓		✓				✓	✓	✓	220
15	Consultant	✓		✓	✓			✓	✓		✓	✓	✓	Yes	✓		✓	✓		✓		✓					64
16	Staff Grade	✓	✓	✓	✓	✓	✓	✓	✓	✓																	128
17	CT2	✓	✓	✓	✓	✓	✓	✓			✓	✓					✓		✓			✓	✓	✓	✓	✓	207
18	GPST2	✓	✓	✓	✓	✓	✓																				166

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection											Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
19 FY1	✓	✓	✓		✓																				42
20 Consultant	✓																								3
21 Staff Grade	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	Yes			✓	✓		✓	✓	✓		✓	✓	✓	150
22 FY2	✓																								1
23 FY1	✓	✓		✓																					18
24 Staff Grade	✓			✓	✓																				74
25 Staff Grade	✓	✓	✓	✓	✓		✓				✓														34
26 Visiting GP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓														592
27 Geriatrician	✓			✓		✓			✓	✓	✓				✓	✓	✓	✓			✓				✓	47
28 Staff Grade	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓			✓	✓		✓		✓	✓	✓	153
29 CT2	✓		✓	✓	✓	✓		✓			✓															217
30 Staff Grade	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓															342
31 Consultant	✓			✓	✓																				21
32 Consultant	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓					✓		✓						✓		45
33 Consultant	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	Yes			✓		✓			✓	✓	✓		✓	167
34 Consultant	✓	✓		✓		✓	✓		✓				Yes													27
35 Consultant	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓														79
36 GPST2	✓	✓	✓																						28
37 CT3		✓				✓		✓		✓																14
38 ST6		✓	✓	✓	✓	✓	✓			✓	✓					✓		✓		✓	✓	✓	✓	✓	✓	238
39 CT3		✓																								121
40 Consultant		✓	✓		✓					✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		166

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection											Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
41 Staff Grade		✓	✓	✓	✓	✓	✓	✓			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1450
42 Visiting GP		✓		✓		✓		✓		✓	✓						✓	✓	✓		✓	✓			✓	56
43 ST6		✓	✓	✓	✓	✓	✓	✓	✓		✓											✓	✓	✓		229
44 Consultant		✓			✓					✓											✓	✓			✓	33
45 FY1		✓			✓																					51
46 Consultant		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓		✓		✓		✓	91
47 Consultant		✓	✓	✓	✓	✓																				101
48 FY1		✓	✓	✓																						76
49 Nurse		✓																								2
50 Staff Grade		✓	✓						✓	✓																29
51 CT2		✓																								12
52 FY2		✓	✓	✓																						19
53 Geriatrician		✓																								2
54 Staff Grade		✓																								1
55 CT3		✓	✓	✓				✓	✓															✓		102
56 Nurse		✓									✓														✓	8
57 Consultant		✓	✓				✓	✓		✓	✓											✓				22
58 Staff Grade		✓																								142
59 Staff Grade		✓																								19
60 FY1		✓	✓	✓																						27
61 CT3			✓			✓	✓	✓	✓	✓		✓				✓	✓			✓	✓		✓	✓	✓	152
63 FY2				✓																						4

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection											Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
64 FY2			✓																						9
65 ST4		✓	✓							✓	✓		Yes													16
67 ST4			✓	✓	✓	✓		✓	✓		✓		Yes	✓	✓	✓			✓				✓			119
68 ST6			✓						✓	✓	✓															79
69 CT3		✓		✓						✓	✓						✓	✓	✓			✓	✓	✓		95
71 ST4				✓		✓							Yes													12
72 Staff Grade			✓	✓	✓		✓	✓		✓	✓	✓					✓									71
73 Staff Grade			✓						✓							✓					✓					12
74 FY2		✓	✓	✓	✓																					28
75 Staff Grade			✓	✓	✓	✓																				90
76 Nurse			✓				✓	✓		✓																16
77 Consultant			✓	✓	✓	✓	✓	✓								4					✓	✓	✓		✓	79
78 Consultant			✓																							27
79 Consultant			✓																							12
80 Consultant			✓	✓			✓			✓			Yes													20
81 GPST1			✓																							8
82 Staff Grade			✓	✓	✓		✓	✓	✓	✓								✓	✓							378
83 CT3				✓									Yes				✓				✓	✓			✓	31
84 Consultant																						✓				5
86 ST6																✓										1
87 ST6													Yes		✓		✓		✓						✓	19
88 FY2						✓			✓																	3

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection											Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
89 FY1							✓	✓																		22
90 FY2						✓	✓		✓	✓																34
91 FY1						✓		✓	✓																	9
93 CT3								✓		✓			Yes			✓					✓	✓		✓		42
94 FY2						✓	✓	✓	✓																	19
95 FY1						✓	✓	✓																		31
96 FY1									✓																	29
99 ST4							✓																✓			6
100 GPST1					✓	✓	✓																			15
101 FY2							✓		✓																	22
102 FY2						✓	✓		✓																	12
103 FY1						✓		✓	✓																	20
107 Consultant													Yes													0
110 Consultant													Yes													0
112 Staff Grade					✓			✓															✓	✓		36
113 Consultant								✓					Yes													25
115 Consultant											✓							✓								10
116 Consultant													Yes													0
118 Consultant											✓															18
119 Consultant							✓	✓	✓	✓	✓	✓						✓					✓			25
124 Consultant													Yes								✓					3
125 Consultant													Yes													0

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection												Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
127 Consultant													Yes													0
129 Consultant													Yes													0
131 Consultant																✓	✓									4
132 Consultant													Yes													0
135 Staff Grade													Yes													0
136 Staff Grade												✓						✓	✓	✓				✓		68
139 Staff Grade				✓	✓	✓	✓	✓		✓																240
140 GPST1					✓		✓		✓																	23
141 Nurse					✓																					1
142 Consultant				✓	✓	✓	✓																			73
143 Unknown							✓																			4
144 Other							✓					✓			✓	✓	✓	✓	✓	✓				✓		283
145 GPST2								✓	✓	✓	✓	✓														94
146 Staff Grade								✓																		20
147 CT3								✓	✓	✓	✓	✓	Yes	✓	✓	✓									✓	122
148 GPST3								✓	✓	✓	✓	✓														64
149 GPST1										✓	✓	✓														8
150 GPST1											✓		Yes													2
151 GPST1													Yes													0
152 FY2										✓	✓	✓														19
155 FY2										✓		✓														34
156 FY1										✓	✓															6

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection												Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
157 FY2											✓	✓														17
158 FY1												✓														3
159 CT1									✓			✓										✓	✓	✓		25
161 FY1												✓														16
162 FY1										✓	✓	✓														40
163 GPST2									✓	✓	✓	✓														66
165 Unknown				✓																						1
166 Consultant										✓						✓										26
167 CT1										✓	✓	✓						✓				✓	✓			40
169 Staff Grade										✓	✓	✓		✓	✓	✓	✓	✓	✓		✓					353
170 Staff Grade										✓																23
171 Consultant											✓	✓	Yes		✓	✓	✓		✓		✓		✓	✓	✓	123
172 Staff Grade											✓	✓				✓			✓	✓	✓	✓				50
173 GPST1											✓	✓														3
174 Consultant												✓														4
175 Staff Grade												✓		✓	✓	✓	✓	✓								80
177 CT1													Yes		✓	✓	✓	✓	✓				✓			78
178 ST4													Yes					✓		✓			✓		✓	37
179 ST4													Yes					✓					✓	✓		27
180 ST4													Yes													0
181 CT1													Yes	✓	✓	✓				✓						17
182 CT1													Yes	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		143

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection											Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
183 CT2													Yes				✓		✓				✓			37
184 GPST3																✓				✓						12
185 FY2													Yes													0
186 FY2													Yes		✓											1
187 GPST1													Yes		✓											5
188 ST4																									✓	3
189 FY2													Yes													0
190 FY1													Yes													0
191 FY1																	✓		✓							17
192 FY2														✓	✓											50
193 GPST1														✓		✓										7
194 FY1													Yes	✓												18
195 FY1																✓			✓							4
196 CT1															✓	✓	✓		✓		✓					16
197 FY2													Yes		✓											1
198 FY1													Yes		✓											14
200 GPST1														✓		✓	✓									4
202 FY2													Yes													0
203 FY1													Yes													0
205 GPST2															✓		✓				✓					37
206 ST4														✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	367
207 Staff Grade													Yes				✓		✓				✓			20

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection												Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
208 Staff Grade															✓	✓	✓									79
210 Staff Grade															✓	✓										2
211 Staff Grade														✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		251
212 Nurse															✓											2
213 FY2																✓	✓		✓							17
214 FY1																✓			✓							8
215 Consultant																	✓		✓	✓	✓	✓	✓	✓		185
216 Consultant																	✓									1
217 Consultant																		✓								4
218 FY1																		✓								14
219 GPST2																		✓		✓	✓		✓			46
221 GPST2																					✓	✓				27
222 GPST1																			✓	✓		✓	✓	✓		51
223 FY1																		✓	✓							2
224 Staff Grade																			✓	✓	✓				✓	26
225 Staff Grade																			✓							31
226 FY2																			✓							33
227 FY2																			✓							1
228 FY2																		✓			✓					14
229 FY2																				✓						15
230 Staff Grade																				✓						10
231 Nurse																				✓		✓				7

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection											Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
232 FY2																				✓	✓		✓			6
233 Staff Grade																					✓		✓	✓		87
234 Visiting GP																					✓		✓	✓		107
235 FY2																						✓	✓	✓		46
236 Staff Grade																					✓		✓	✓		23
237 Staff Grade																					✓					1
238 GPST1																					✓					3
239 FY1																					✓					2
240 Staff Grade																					✓	✓	✓	✓	✓	158
241 FY2																						✓	✓	✓		20
242 Unknown																						✓				1
243 FY1																						✓	✓	✓		12
244 FY2																						✓	✓	✓		11
245 Unknown																						✓				1
246 Consultant																							✓	✓		5
248 FY1																							✓	✓		7
249 FY1																							✓			4
250 Consultant																							✓			2
251 Unknown																							✓			1
252 Staff Grade																								✓		11
253 FY1																								✓		6
254 Staff Grade																								✓	✓	56

Prescriber code & grade/type	Pre-intervention data collection												Education session	Post-intervention data collection												Total items prescribed
	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12		Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8	Period 9	Period 10	Period 11	Period 12	
255 GPST2																								✓	**15**
256 FY2																								✓	**36**
257 FY1																								✓	**10**
258 FY1																								✓	**6**
259 FY2																								✓	**2**
260 GPST2																								✓	**9**
261 FY2																								✓	**2**
262 FY1																								✓	**19**
263 FY2																								✓	**2**
264 Visiting GP																								✓	**1**
No of active prescribers	37	51	53	53	42	42	45	42	42	51	50	38	47	19	30	43	35	35	41	25	45	35	52	43	37	**212**
No. of medication orders reviewed	477	1,038	1,003	724	615	697	573	558	471	687	651	459		215	464	373	403	484	535	253	633	492	844	552	483	**13,684**

Appendix 21: Research Ethics Review Checklist (Form UPR16)

FORM UPR16

Research Ethics Review Checklist

Please include this completed form as an appendix to your thesis (see the Research Degrees Operational Handbook for more information

UNIVERSITY OF PORTSMOUTH

Postgraduate Research Student (PGRS) Information				Student ID:	11596
PGRS Name:	Hilary Frances Scott				
Department:	School of Pharmacy	First Supervisor:	Professor David Brown		
Start Date: (or progression date for Prof Doc students)	October 2013				
Study Mode and Route:	Part-time ☒ / Full-time ☐	MPhil ☐ / PhD ☒	MD ☐ / Professional Doctorate ☐		

Title of Thesis:	An investigation into the effect of the decision-making process and human factors in prescribing errors within an inpatient mental health setting
Thesis Word Count: (excluding ancillary data)	62,343

If you are unsure about any of the following, please contact the local representative on your Faculty Ethics Committee for advice. Please note that it is your responsibility to follow the University's Ethics Policy and any relevant University, academic or professional guidelines in the conduct of your study

Although the Ethics Committee may have given your study a favourable opinion, the final responsibility for the ethical conduct of this work lies with the researcher(s).

UKRIO Finished Research Checklist:
(If you would like to know more about the checklist, please see your Faculty or Departmental Ethics Committee rep or see the online version of the full checklist at: http://www.ukrio.org/what-we-do/code-of-practice-for-research/)

a)	Have all of your research and findings been reported accurately, honestly and within a reasonable time frame?	YES ☒ NO ☐
b)	Have all contributions to knowledge been acknowledged?	YES ☒ NO ☐
c)	Have you complied with all agreements relating to intellectual property, publication and authorship?	YES ☒ NO ☐
d)	Has your research data been retained in a secure and accessible form and will it remain so for the required duration?	YES ☒ NO ☐
e)	Does your research comply with all legal, ethical, and contractual requirements?	YES ☒ NO ☐

Candidate Statement:

I have considered the ethical dimensions of the above named research project, and have successfully obtained the necessary ethical approval(s)

Ethical review number(s) from Faculty Ethics Committee (or from NRES/SCREC):	SFEC 2015-015 SCOTT

If you have *not* submitted your work for ethical review, and/or you have answered 'No' to one or more of questions a) to e), please explain below why this is so:

Not applicable

Signed *(PGRS)*:		Date: 24/09/18

UPR16 – April 2018