Dosing omissions among medical patients in a hospital electronic prescribing and medicine administration (HEPMA) system

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Abstract

Background

Omitted doses are among the most common errors of medication errors in hospital. It is a need to identify the frequency of omitted doses and reasons for these to try to prevent them in the future. It is important to ensure all medication is available on the ward when needed and this can be evaluated by looking at different medicines management systems.

Aim and objectives

To identify recorded reasons for dosing omissions and evaluate the clinical significance of the omissions at individual patient level using an expert group of four clinical pharmacists. Describe the different medicines management systems by using process maps and compare the findings.

Methods

Reasons for dose omissions were recorded for several weeks in three different wards. Patients that had omissions recorded as *Unavailable medicine* were asked to take part in the study, and the clinical significance of these omissions was evaluated by an expert group. A suggestion for a guideline for nurses on what medicines that not should be omitted was developed by using results from this expert group meeting.

Results

A comparison of the three wards showed no significant differences in numbers of *unavailable medicines*, but other reasons turned out to be different. Of 74 cases of omissions presented to an expert group 21 was evaluated to category 2; Medicines that could cause major disturbance in symptom control and one in category 3; Major treat to stability of patients condition.

Conclusion

Omissions occur in different settings and can cause potential harm for patients. It is important to ensure that all medication is on ward when needed to avoid these types of omissions. The study identified that it is room for improvement in all three wards, but more and longer studies need to be carried out to be more conclusive in which changes that must me done.

Abbreviations:

BNF: British National Formulary

CI: Confidence Interval

EJ: Elisabeth Johansen

EPA: Electronic Prescribing and Administration

HEPMA: Hospital Electronic Prescribing and Medicine Administration

KRL: Kristin Reinaas Lysheim

MM: Medicines management

NHS: The National Health Service

NPSA: National Patient Safety Agency

OSD: One Stop dispensing

PAC: Patient Administration Chart

PC: Present complaint

POD: Patient own drugs

PRN: Pro Re Nata = as required

SAM: Self-administration of medicines

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1 Introduction

1.1   The National Health Service in UK

The National Health Service (NHS) is the name commonly used to refer to the four publicly funded healthcare systems in the United Kingdom, only the Health Service in England uses the name "National Health System" without further qualification. Since its launch 60 years ago, the NHS has grown to become the world's largest publicly funded health service.

When the NHS was launched in 1948 it had a budget of £437 million (roughly £9 billion at today's value). In 2007/8 it received 10 times that amount - more than £90 billion. Some 60% of the NHS budget is used to pay staff. A further 20% pays for drugs and other supplies, with the remaining 20% split between buildings, equipment and training costs on the one hand and medical equipment, catering and cleaning on the other. Nearly 80% of the total budget is distributed by local trusts in line with the particular health priorities in their areas[1].

The Department of Health (DH) is in overall charge of the NHS with a cabinet minister reporting as secretary of state for health to the prime minister. The department has control of England's 10 Strategic Health Authorities (SHAs), which oversee all NHS activities in England. The devolved administrations of Scotland, Wales, and Northern Ireland run their local NHS services separately[1].

NHS is divided into two sections: primary and secondary care. Primary care is generally regarded as a "frontline" service. It is the first point of contact for most people and is delivered by a wide range of independent contractors such as GPs, dentists, pharmacists and optometrists. Secondary care is known as acute health care and can be either elective care or emergency care. Elective care means planned specialist medical care or surgery, usually following referral from a primary or community health professional such as a GP[2].

1.1.1 NHS Scotland

In 2006 the NHS in Scotland had around 158 000 staff, including more than 47,500 nurses, midwives and health visitors and over 3,800 consultant. Health services in Scotland are delivered through 14 regional NHS Boards. These boards provide strategic leadership and performance management for the entire local NHS system in their areas and ensure that services are delivered effectively and efficiently. NHS Boards are responsible for the provision and management of the whole range of health services in an area including Hospital and General Practice[3].

Scotland has in addition a further 8 special Boards; NHS National Services Scotland, Scottish Ambulance Service, NHS24, The State hospital, NHS Health Scotland, NHS Quality Improvement Scotland, NHS Education for Scotland and National Waiting Times Centre Board[3].

1.2 Medication incidents and the situation in the UK today

Every day, about two and a half million medicines are prescribed in the community and in hospitals across the UK[4]. Most medicines are used safely and help people to get better or stay well. The number of prescribed medicines has increased the last years, and following the NHS' expenditure on medicines. Due to this it would be important to have focus on patient safety.

Patient safety is recognised as a priority for healthcare organisations and is the first domain in the NHS standards for better health. Improving quality of care and patient safety has always been at the heart of the Government's strategy for the NHS.

The National Patient Safety Agency, established in 2001, has the responsibility of improving the safety and quality of patient care through reporting, analysing, and disseminating the lessons of adverse events and 'near misses' involving NHS patients. Medication errors occur when human and system factors interact with the complex process of prescribing, dispensing and administering drugs to produce an unintended

and potentially harmful outcome. Awareness of the causes of medication errors and how they can be prevented has been growing in the NHS in recent years[5]

The publication of *An Organisation with a Memory*, the commitment by Government to the aim of a 40% reduction in serious error rates and establishment of the NPSA have, for the first time, provided a systematic focus on medication safety in the NHS.

Medication errors occur in all health care systems. Improving safety in the prescribing, dispensing and administration of medicines is a priority for health services in Europe, North America, Australia and many other countries. The Government has set out, for the first time, a clear agenda for improving patient safety in the NHS in England with, as a key element, the aim of a 40% reduction in the incidence of serious medication errors. This is the first truly national patient safety strategy to be developed anywhere in the world[5]

There is a need for safer use of medicines to get better and more convenient care. Different reports from the last years have focus on this; the safer use of medicines. One of them is the fourth report from the Patient Safety Observatory; Safety in doses: Medication Safety Incidents in the NHS. It was published in 2007 and brings into the public arena nearly 60,000 safety incidents reported by staff up to June 2006, as well as litigation and negligence data. The report describes the types of medication incident that can be prevented and includes examples of severe harm to patients. It also identifies seven priority actions for healthcare staff, NHS Organisations and healthcare commissioners. There are three general recommendations and four relating to particular risks that accounted for 65 per cent of all medication incidents reported to the NRLS[4]

Seven key actions to improve medication safety[4]:

1. Increase reporting and learning from medication incidents
Increase reporting and learning from medication incidents and identify actions against local risks in an annual medication report.

2. Implement NPSA safer medication practice recommendations

Implement and audit the NPSA safer medication practice recommendations, including the alerts on anticoagulants, injectable medicines and wrong route errors published in March 2007.

3. Improve staff skills and competences

Healthcare workers should ensure they have the required work competences and support to use medicines safely. Work competences for anticoagulant therapy, use of injectable medicines and paediatric infusions are set out in the NPSA safe medication practice work programme for 2007-08.

4. Minimise dosing errors

Provide information, training and tools for staff to make calculations of doses easier, and target efforts towards high-risk areas (such as children) and high-risk drugs (such as insulin).

5. Ensure medicines are not omitted

Identify current levels of omitted medicines and target areas for action (for instance, anticoagulation or other high risk medication). Review medicine storage and medication supply chains.

6. Ensure the correct medicines are given to the correct patients

Improve packaging and labelling of medicines and support local systems that make it harder for staff to select wrong medicines or give medicines to wrong patients.

7. Document patients' medicine allergy status

Improve recording of patient allergies, and raise awareness amongst staff of high-risk products and the importance of knowing the patient's allergy status.

1.3 Medication errors in hospitals

The Department of Health (DoH) has defined a medication error as 'any preventable event that may cause or lead to inappropriate medication use or patient harm'.

Recent UK studies have suggested that up to 6.5 per cent of all patients admitted to hospital and up to nine per cent of all patients staying in hospital experience medication-related harm. The three most frequently occurring types of medication error (wrong dose, strength or frequency of medicine, omitted medicine and wrong medicine) accounted for over half of all reported medication incidents (57.3 per cent). Of these, the most common type of error was wrong dose, strength or frequency of medication (28.7 per cent)[4].

The DoH's report "An Organisation with a Memory", found that 10,000 hospitals patients each year have serious adverse effects to medicines, and one-fifth of clinical negligence litigation stems from hospital medication errors. 10.8 per cent of patients on medical wards experience an adverse event, 46 per cent of which were judged to be preventable[6].

Up to 38% of inpatient medication errors occur at the administration stage[7]. In hospitals there are often seen that single doses are omitted and there is many reasons for this, such as patients refusing to take the dose or that they are unable swallow the medicine. Another important reason is unavailable medicines; the item is not on the ward and must be ordered from pharmacy before it can be administered. Communication between wards and hospital pharmacies is important in ensuring the appropriate, safe and timely supply of medicines[4].

1.3.1 Omitted medicines

"Safety in doses: medication safety incidents in the NHS" reported that omitted medicines were the second most commonly reported type of medication incident in hospitals. An omission is not always considered as a serious error but the National Reporting and Learning System (NRLS) data included reports of permanent harm or death where vital medicines (for instance, medicines used to treat epilepsy or prevent strokes) had been omitted[4].

There could be many different reasons for omitted medicines; medicines not prescribed, not dispensed or not administered to the patient. As mentioned earlier a lot of medication errors occur at the administration stage, and often this includes omitted medicines. Sometimes the medicine are withheld or discontinued by doctor with good medical/clinical reasons. But very often other reasons are charted such as the patient refused to take the medicine or was unable to swallow, patient not on ward or unavailable medicine. Many omitted doses can be prevented for example by using alternative routes for the patients that can't swallow, and the nurses could make sure that every medicine needed is on the ward before starting medicine round.

1.3.1.1 Clinical significance of dosing omissions

Missed doses are medication errors and by definition, they are avoidable. The impact on individual patients varies depending on the drug and the clinical situation, where the consequences can range from no harm to death[8].

In most cases, short term medication omissions are unlikely to cause harm to patients. However, for patients who rely on taking medicines regularly to stay well, such as people with diabetes, epilepsy or transplants, missed doses may result in severe harm. Similarly, for patients who are acutely unwell and require immediate treatment, the omission of a medicine, for example, intravenous antibiotics over a weekend, may cause harm. In addition age, sex of patient and other medicines prescribed could have an importance in the evaluation of clinical significance of the dose omission.

It is always important that patients get their medicine, but if the medicine is prescribed once daily, it is more important not to miss that dose, than if the medicine is prescribed for several times during the day. Omitting three consecutive doses of the 8-hourly regimen does not produce as low a concentration as the omission of single daily doses[9].

1.3.1.2 Studies of omitted doses in the UK

Several studies have been done on omitted doses in the UK, and the clinical significance has been evaluated. In Dowling's study "Missed doses audit" around 14

reasons for omitted doses were recorded and in total there was 714 missed doses. Out of these 182 were classified as high risk missed doses, and the largest drug class were cardiac medication and antibiotics. The missed doses that were considered to be low risk included mainly senna, lactulose, paracetamol and co – codamol. Dowling wrote that it was difficult to define a high risk drug without knowing the indication for its use; this was not recorded in this audit[10].

Another study "Aetiology of Omitted Medication Doses at Kings College Hospital NHS Foundation Trust" was done by the Pharmacy Department, King's College Hospital Foundation Trust, London (Garcia M). Twenty-two of the forty-four wards in the hospital were selected. These represented all the specialties within the hospital and were the same wards used to assess other clinical pharmacy quality indicators. On each ward, the total number of regular doses prescribed and omitted on all drug charts, in the previous 24 hours was counted for each patient. The majority of doses were omitted for clinical reasons (Category D - 72.9%, 345 doses). 6.1% (29) of omitted doses were due to unavailability outside pharmacy working hours (category C) and 3.6% (17 doses) were omitted because of unavailability during pharmacy working hours[11].

A similar study was done by Dhruti Bhatt, "Audit of Dose omission and completed drug allergy status". The author investigated what percentage of doses that were omitted in three hospitals Highgate Mental Health Centre, St Pancras Hospital and St Lukes hospital. All dose omissions were obtained from patients' drug charts across a five day period. In total 37 % of all doses were omitted (the three hospitals had 23%, 22% and 69 %). Patient not available counted for 60 % of the dose omissions, followed by patient refusal (24 %). The third biggest reason was unavailable medicine[12].

Some of the numbers found in these studies are unacceptable high, and there is a need to focus on this. The supply systems need to be reviewed where unavailable medicines are a big problem, and information on the importance of administrating single doses should be given to the nurses, as well as the patients. One of the seven keys to patients' safety in NHS report is to ensure medicines are not omitted, and with more studies done and more information on this area the number of missed doses should decrease.

1.4 Medicine management systems in the UK

1.4.1 Medicines management –definition and categorisation

Managing medicines safely is a key component of the NHS Standards of better health[4,13].

There are several definitions of MM systems. Medicines and healthcare products regulatory agency (MHRA) has defined managing medicines as: The clinical, cost effective and safe use of medicines to ensure patients get the maximum benefit from the medicines they need, while at the same time minimising potential harm.[14]

Medicines management in hospitals encompasses the entire way that medicines are selected, procured, delivered, prescribed, administered and reviewed to optimise the contribution that medicines make to producing informed and desired outcomes of patient care[6]. Medicines management services provide patient focused care based on need. They can include all aspects of supply and use of medicines, from an individual patient level to an organisational level[15].

A survey carried out by the National Prescribing Centre (NPC) in 2001 together with other work done in the area of medicines management, led to the classification of such services into five main types[15]:

1.   Clinical medicines management
Clinical medicines management services involve assessment, monitoring and
review of prescribing for individuals.

2.   Systems and processes
Improving repeat prescribing, ensuring that guidance and policies are implemented, and undertaking audits are all part of medicines management.

3.   Health of the public
Medicines management services appear in their broadest sense when they are included in schemes that address public health and provide education about medicines.

4.   Medicines management at the interface

Systems and communication often break down at the interface between health care settings leading to poor patient care. Examples of services include use of formularies and guidelines, discharge planning and the use of patients' own drugs in hospital.

5.   Patients and their medicines

Integration of health and social care is an important part of current NHS reforms. Medicines management services could help bring together

1.4.2 Self administration of medicines (SAM)

Self administration of medicines is a programme where patients have responsibility to manage and administer their own medicines whilst in hospital. This is thought to have many benefits such as improving patient knowledge and compliance with their medication and increasing patient empowerment and rehabilitation. Medication timing can be more accurate and medicines management problems can be indentified before discharge, making this a speedier process. There is a new trust policy for self administration of medicines which states that practitioners should assess all patients on the ward with the 'SAM quick step check' and the patients meeting these criteria should be fully assessed to determine their level of SAM. Level 1 is when the practitioner educates the patient whilst administering the medicines, level 2 is where the patient takes their medicines under supervision but the practitioner retains responsibility for storage and security and level 3 is when the patient administers their medicines themselves and is also responsible for storage and security[16].

A recent study was done to assess the potential impact the new trust policy will have on medical, surgical and elderly wards by assessing the number of patients suitable for self administration, and to estimate the time taken for the assessments. Of 156 patients assessed in total, 53 (34 %) were likely to be self administering on discharge, and were suitable for the full assessment. Of this one patient was at level 1, six patients were at level 2 and seven patients were assessed to be at level 3[16].

Combining SAM with reuse of patients' own drugs mean patients can continue to use medicines they are familiar with during their hospital stay. The benefit of SAM is that patients maintain control of their medicines. Any changes in treatment while in hospital can be discussed and implemented with each patient's involvement. It also means that when patients are discharged from hospital, they are informed to their treatment and are much more likely to take their medicines as intended[17].

The study "Are patients who self-administer their medicines in hospital more satisfied with their care?" surveys patients' views on self-administration and on their care. In particular it looks at the discharge process and the way information was given to the patient on discharge. The study found that a majority of patients under 60-years-old would choose to self-administer their medicines in hospital even if they had not been given the opportunity to do so recently. It was also found that patients who had administered their own medicines in hospital were more likely to report their overall care as excellent and were more satisfied with the discharge process than patients who had not[18].

1.4.3 JAC Computer Services

JAC Computer Services Ltd (JAC) is the leading supplier of medicines management solutions to the NHS. JAC's UK user-base now accounts for around half of all NHS trusts in England as well as sites in Scotland, Wales and Northern Ireland. JAC provides pharmacy stock control, e-prescribing and medicines administration as a single integrated solution along with associated services and third-party interfaces. JAC is also the exclusive distributor in the UK and Ireland of ServeRx ward-based automation technologies for medicines and medical equipment.

The JAC solution for ePrescribing and Medicines Administration (EPMA) includes integrated in-patient and out-patient prescribing, discharge prescribing, decision support for providing warnings on allergies, drug-drug interactions and therapeutic duplicates, as well as bed-side medicines administration support and recording. In May 1996, JAC was acquired by Mediware Inc and continues to operate as a wholly owned subsidiary. The acquisition by Mediware Inc created the world's largest supplier of medicines management systems for hospital pharmacies[19].

1.5 Medicines management at Ayr hospital

Ayr hospital has three different medicines management systems; redesign system (at ward 10 and 14), a pilot at ward 16 using reports from HEPMA system and the traditional top-up (on all remaining wards)

1.5.1 Redesigned system

For the patient journey to be successful there is a requirement to minimise delays and provide continuity of care. Thus removing unnecessary steps and to involve patients more in their own care and treatment. As a part of the redesign process, a scheme that encompasses one-step dispensing (OSD) with the re-use of patient's own drugs (PODs) has been implemented in the hospitals in NHS Ayrshire and Arran[20]. All wards with this system have been supplied with bedside lockers which include a POD locker. Each patient's PODs are stored in their bedside lockers but painkillers, antibiotics, lactulose and nebules are not stored here.

The concept of using PODs during a patients hospital stay was first introduced by the report 'A Spoonful of Sugar'. The audit highlighted that by introducing a POD system the cost of medicines to be supplied during a patients hospital stay could be reduced and the incidence of missed medication doses would also be reduced[21].

It makes sense to use the patient's own supply during their hospital stay and also at discharge. One-stop dispensing is dispensing only once for the patient during a single hospital admission. All the medications for each individual patient, where possible, are dispensed in original pack(s), include a patient information leaflet and labelled with the full instructions. This is provided in a sufficient quantity to allow the patient to take the same supply home on discharge.

Admissions can be divided into two- arranged and emergency admissions. All patients that have arranged admissions are asked to bring in their own medications to hospital. Some patients are seen by a pharmacist at pre-op clinic and these patients will receive an explanation of the medicines redesign system. Arranged admission patients are

receiving a leaflet "using your medicines during your hospital stay" with their appointment. The patients are given a green POD bag to have their own medication in at admission. Before any PODs can be used in hospital they must be assessed for suitability and any POD trained pharmacy technician or nurse can do this.

Every day a technician is on the ward with a list over new patient that have been arriving the last day. It is checked what these new patients have been prescribed and if the pharmacist has verified the drug list. The technician takes the medications which are a stock item from the ward cupboard. If there are some medicines which are non-stock items the technicians order this from the pharmacy, and minutes after it comes with the tube system. After this the medications are labelled and put in patients' bedside locker, a locker beside every bed. Medicines called PRN is drugs the patients can have when required, for example painkillers. If any patients need something of PRN medicines when they are going home, this is prescribed at discharge.

It's a lot of benefits with the redesign system with OSD/PODs. Because the patients have their own medicines with them and these are kept in the patient's bedside locker, the chance to get another patient's medicines is being reduced. Also the risk of medication errors, duplications or omissions is reduced. Because of the one-stop dispensing there will be faster discharges from hospital as there will be fewer delays waiting for discharge medication. In addition clinical pharmacists will be able to spend more time with patients and the nursing staff will get an improved relationship with pharmacy staff.

One other important benefit of the system is less wastage of medicines and a reduction in overall expenditure of medicines.

1.5.2 HEPMA (Hospital Electronic Prescribing and Medicines Administration)

The Station 16 Pilot Proposal was started on Monday 15th September 2008. The pilot involved utilising IT information from the JAC prescribing system to identify non stock medicines prescribed. The non stock medicine is issued and labelled for the individual patient and kept in the medicine storage area of patient locker. Stock item medicines used ward cupboard stock. The indication is that the pilot system is equally if not

potentially more time efficient than the current system[22]. The staff involved in supporting the pilot considers this system is suitable to expand to other wards within Ayr Hospital and would be the standard process for the supply of medicines.

There are three options to proceed in the near future and the recommendation is to use option 3; Option 3 – expand the station 16 pilot to all wards within Ayr hospital. After the medicine supply system is established in all wards the plan would be to revisit each ward following the initial implementation route to expand the process to utilise non-stock medicines for discharge where appropriate.

The results from the first 4 week before the pilot show that the number of medicines charted as unavailable was 143. During the pilot the number of medicines charted as unavailable was 68 of which 54 % was at 10 pm, this was usually due to late patient transfers into Station 16. In the last week of the pilot there were 21 missed doses compared to 48 the same week in the 4 week period before the pilot[23].

The system in practice

- Patients get prescribed medicines on JAC-electronic prescribing. 8am dose is not written as unavailable until 9.30 am. The technician checks of bedside locker for non stock medicines first and stock trolley for ward stock medicines.

- Pharmacy review new non stock items prescribed report 3 times every day, at 8am, 12.45pm and 03.00pm. Non-stock medicines are dispensed for individual patient, bagged and sent via tube or porter. Non-stock medicines that no longer are prescribed are bagged, identified and returned to pharmacy.

- Pharmacy also review a list printed 3 times daily including all medicines charted as unavailable since the last report

- Pharmacy monitor eye drops, insulin, non stock oral antibiotics and IVs. Every Wednesday a technician monitors and reviews further supplies for patients with longer than 14 days stay. Ward stock is topped up twice weekly.

- Because this is a pilot they are not aloud to use the same medicine boxes at discharge.

1.5.3 The traditional top-up

The traditional top-up system is used on most of the hospital wards. Pharmacy technicians top up the stock cupboards twice a week, and check ward trolley once a week. If any medicines are needed, these are ordered by a nurse and sent via tube system or via porter.

1.6 Electronic prescribing

Traditionally, for patients staying in hospital, doctors wrote a prescription by hand. This was taken to the hospital's pharmacy and a number of staff were involved in preparing and checking the medication before ward staff collected it and finally administered it. An electronic prescription can now be with the pharmacy immediately; pharmacy staff then prepares the medication more quickly – and this speeds up the patient's treatment[24].

The main aim of electronic prescribing systems is to reduce medication errors (incorrect dosages, a drug-drug interactions or drug-allergy interactions etc.) and adverse drug events (ADEs - problems that result from medication errors) and consequently improve standards in patient safety[25].

An electronic prescribing system could improve patient safety by reducing prescribing and administration errors that could result in medication errors and adverse drug events. At its simplest level, E-Prescribing can be defined as "the utilisation of electronic systems to facilitate and enhance the communication of a prescription or medicine order, aiding the choice, administration and supply of a medicine through information and decision support and providing a robust audit trail for the entire medicines use process"[26].

1.6.1 Electronic prescribing in the UK

There are several studies that demonstrate that an EPA system can improve the quality of prescription writing and reduce medication errors compared with a paper system.

An audit done by Andrew Barker and Julie Kay concludes with the following; Electronic prescribing improves patient safety[27].

A study done in 2007 showed that electronic prescribing significantly increased quality in a UK hospital, this was shown by fewer pharmacists' interventions and fewer prescribing errors. Interventions were reduced from 73 (3.0 % of all medication orders) to 45 (1.9 %) (95 % confidence interval for the absolute reduction 0.2, 2.0 %), and errors from 94 (3.8 %) to 48 (2.0 %) (95 % confidence interval 0.9%, 2.7%)[28].

1.6.2 Electronic prescribing at the Ayr hospital

An extended trial of electronic prescribing and administration (EPA) began in six wards at Ayr Hospital, Ayrshire and Arran Acute Hospitals NHS Trust, in Nov 2001. The extension of EPA followed a small-scale trial of a similar system which started in 1998 and demonstrated that an EPA system reduced medications errors and improved quality of prescription writing. After three years co-operation with the company that produced the software, JAC, the new EPA system was introduced over a three week period adding two wards per week[29].

Ayr Hospital is the only hospital in Scotland which has a fully computerised electronic prescribing and medicines administration system (EPMA). The Association of Scottish Trust Chief Pharmacists presented a conference on electronic prescribing in Stirling on 1st November 2000-11-03. The conference was aimed at increasing the level of understanding of the issues around electronic prescribing in health professionals in Scotland. The evaluation of the electronic prescribing pilot at Ayr hospital was

presented and it showed that the electronic prescribing and administration system was as least as safe as the previous paper based system and that the incidence of medication errors was reduced in most types of error[30].

1.7 Process maps

A process map is a flow chart where actions are represented by different symbols; each symbol contains one step of the total process. The process map describes the process as it is performed most of the time, but differences from it can occur.

Process mapping is designed to provide a framework for developing, testing and implementing changes that lead to improvement. The core benefit of any process mapping exercise is improved efficiency. This can largely be expressed in terms of operational cost savings, such as time saved, better use of available resources, improved communications between departments, ultimately less frustration and a more effective service for carers and patients alike. Any current process can be analysed to investigate if changes could make efficiency gains[31].

As a part of the ongoing efforts of the Modernisation Agency and the continued focus on constructing a better NHS built around the people it serves, process mapping is an effective and proven method of developing changes that can really start to make difference[31].

1.8 Clinical setting

Station 16 Geriatric ward

Elderly people are admitted to this station. From this ward the patients either get discharged to another hospital, to a nursing home or they are deceased. The ward includes around 22 beds and 3-4 patients are admitted to the ward every day. This is also a ward with stroke patients. Every day around 11 o'clock a doctor, a chief nurse and a pharmacist are doing a ward round, checking every patient and prescribe new medication.

Station 14 – Medical ward

Station 14 is a general medical ward where patients are admitted with all different kinds of complaints. The ward has 30 beds which normally are occupied all the time, and around 5 new patients are admitted to the ward every day. The ward has a rheumatologist, two endocrinologists and one doctor with speciality in care of elderly people. In addition two pharmacists are at the ward for several hours during the day. This ward has the redesigned system for medicines management which includes using patients own drugs and one stop dispensing.

Station 6 – Cardiology ward

Station 6 is a general medical and cardiology ward with 24 beds. Normally all beds are occupied and about 3 new patients are admitted to the ward daily. This ward has the traditional top up system for supply of medicines.

2 The project – aim and objectives and setting

2.1 Aim

The aim of the project is to compare three medicines management systems in medical patients in terms of; (1) the nature and the incidence of medicines dose omissions; and (2) the relative safety risk from assessment of clinical impact of the omissions

2.2 Objectives

1. Review the NHS literature on risks to patient safety of errors in medication use and on hospital medicines management systems

2. Interrogate the HEPMA system prospectively to identify recorded reasons for a dose omission. Dose omissions recorded as 'Unavailable Medicine' will be confirmed from inspection of the medicines room or talking to a pharmacy technician.

3. Design a template to summarise anonymously the clinical context for each patient that is the subject of an 'Unavailable Medicine'.

4. Evaluate the clinical significance of the subset of dose omissions at individual patient level, using an expert group of four clinical pharmacists

5. Describe in detail using a process map (flow diagram) the three medicines management systems and compare the findings.

6. Develop guidelines to help inform ward staff about medicines that should not be omitted. Validate the guidelines through group interview with pharmacy and nursing staff.

2.3 Setting

The study was carried out on three wards with different medicines management system at Ayr hospital. A data collection on a general medical ward (ward 14), a geriatric ward (ward 16) and a cardiology ward (ward 6) was done for two weeks on each ward in January to March (and a week in april).

3 Methods

All three researchers at Ayr hospital were introduced to the different systems at the hospital. The researcher was following different pharmacists around at several wards and was introduced to the electronic prescribing system and the pharmaceutical care plan used at the hospital. Station 7, acute medical receiving ward and the medical wards station 6 and 14 were visited.

3.1 Ethical approval

A short summary of the project including introduction, aim, objectives and methods was written in December, and sent to ethics committee with a request if approval was needed. They replied in January with an answer that ethical wasn't needed and the data collection and including of patients could start.

3.2 Literature review

The literature was obtained from research in different electronic library databases such as PubMed, and from accessing other relevant NHS documents locally and from standard operating procedures at Ayr hospital. Some research was done via different internet engines as well, such as Google, when the other sources mentioned were insufficient.

The investigator visited some of the wards at the hospital to find out if the nurses have any written procedures (standard operating procedures) about administration of medicines. A standard operating procedure written in 1996 was the only one found; no updated version about administration of medicines was on the hospital. The nurses used standard guidelines on managing medicines (from the Nurse and Midwifery council) during their nurse training, but no written procedures are used daily on the ward.

3.3 Pilot phase

After having the project summary from University there was focused on the different medicine management systems on Ayr hospital. EJ and KRL were introduced to the pilot on the HEPMA system at station 16 by a pharmacy technician, and both of the researchers visited a ward with the traditional top-up system and the redesign system. Information about how the different systems work in supplying medicines to the ward and managing medicines in general was given by pharmacy technicians on these wards. The researcher also followed one technician on ward when doing top up of ward cupboard to see how this was done.

In January templates were designed for recording the dosing omissions (See appendix 1 and 2) Separate templates were made to collect all dose omissions during one day and the clinical context for each patient with a dose omission. The template had a part with patient information; a short summary of medical history, current drugs and present complaints. The other part contained recorded dose omissions, and time and date of the omission. The template was made to summarize anonymously the clinical context for each patient to enable the expert group to evaluate the clinical significance of the dose omission. Each template had patient number instead of patient name to keep it anonymously; the patient name was written down on a list and kept separate from the templates.

All templates were tested several times at ward 14. Changes made in one of the templates was followed up by more testing to make sure that they were sufficient for using at data gathering. After testing the templates and getting used to the JAC system to find information about drug administration for each patient, the data collection and patient inclusion were started on 27th of January. The first two patients were included by pharmacist RM at the general medical ward (station 14). This was done to introduce the researcher to the methods of consenting patients, and to ensure right and appropriate information was given to each patient.

3.4 The study

3.4.1 Data collection

A survey of omitted doses was conducted using the HEPMA system. Reasons for dose omissions were recorded at three wards with different medicines management systems for several weeks. The data gathering took place at a cardiology ward, a general medical ward and a geriatric ward at the Ayr hospital for 2 weeks on each ward.

A PAC (Patient Administration Chart) on the computer system is an inquiry function detailing all administrations for a patient. All medication prescribed for a patient for a selected episode is listed. The medications are sorted in the same order as is currently being used for the Prescriber Order Entry (POE). Behind every drug there are white boxes for the different dates which are marked green when the doses are given. If the doses for any reason aren't given, the box remains white and the reason for the omission is chosen by a nurse from a list of several reasons. The system forces the nurse to write a reason if not administrated, the next dose of the medicine can't be charted as given until the dose before is charted as given or a reason for not given.

Table 1 Reasons for dose omissions the researcher chose to record in the study

- Absent from ward
- Fasting patient
- IV Access unavailable
- Refused
- Unable to swallow
- Unavailable medicines
- Withheld

Several other reasons for omitted medicines were not recorded in the study, for example administration discontinued, alternative route used, alternative administered and discontinued drug. The investigator chose to record omissions from the 7 first reasons listed because these ones results in that the patient don't get their medicine

and often these omissions can be prevented. Where "alternative route" or "alternative administered" is charted as reason the patient actually get some sort of medication/treatment. Other reasons that weren't included were for example discontinued drug, administration discontinued or order suspended. Since these are resolutions made by a doctor and normally have a medical reason, they are not really omitted doses.

Every day the patients' administration charts were checked for omitted doses. Administration of medicines at 6 pm and 10 pm were checked and written down the next morning. Information on the evening doses was obtained by checking a 24 hours PAC which shows all drugs administrated to the patient the last 24 hours. Every omitted drug in the 7 listed categories was written down to try to find out if any certain drug were omitted more often than others.

3.4.2 Inclusion of patients

Every patient that had a medicine charted as "unavailable medicine" in the period of the data collection was asked to take part in the study. Because the researcher isn't a part of the patients' treatment group, consent is needed to use any information from medical notes about the patients' medical history and present clinical conditions. (Health Rights Information Scotland)

The patients got a sheet of information about the study; why it was carried out, why they were asked to take part and possible benefits from taking part of it. If they agreed to take part in the study, they signed a 'Consent Form' (see Appendix 3 and 4). When this form was completed the patient had one copy and the researcher one. The original form was filed in the patient's medical notes. A nurse or a pharmacist on the ward was always asked if the patients were suitable to speak to the researcher about the study. Patients that were unable to or didn't want to give consent were excluded from the study. Omissions from these patients were included in the recording of total omissions from each ward, but left out of the cases that were going to be presented to the expert group.

After 2 weeks of data collection on each ward the researcher only had managed to include 25 patients in total. 46 % of the patients that had an "Unavailable Medicine", and therefore should have been included in the study, were not able to speak to the researcher and sign the consent form. Most of these patients were not well enough or were confused/had dementia. To get more patients included another period with recruitment of patients was needed.

Another week on each ward in addition to the two first weeks of data gathering was done in the beginning of April. This time all the three wards were done at the same time and only unavailable medicines were written down; all the other reason for dose omissions were left out. This was done to get more time to speak to the patients, and try to avoid those patients that were well enough to speak to the researcher, not were discharged before they had signed the consent form.

3.5 Expert group

All omitted drugs from the patients included were categorized after a system in British National Formulary (BNF) (Appendix 5)

There was made a summary of the clinical context for each patient included in the study. Each context/summary was marked with patient number instead of name so it would be totally anonymous. Information about patients' conditions and medical history were obtained by reading in patient journal, acute medicine leaflet and the pharmaceutical care plan. An example of a case is presented in appendix

The expert group consisted of 4 pharmacists from different medical wards. Two meetings were arranged, where the first one was to inform the pharmacists about the study and how to evaluate the clinical significance of each dose omission. Some cases needed more details to be evaluated, such as when the patients were admitted and results from blood tests. These details were added and a short meeting were arranged to evaluate the last cases.

The clinical significance of dose omissions was evaluated by a category system from 0-4. The four pharmacists made a decision together about the clinical significance, and any different opinions were written down.

0 No threat to patients care
1 Minor disturbance to symptom control
2 Major disturbance to symptom control
3 Major threat to stability of patients condition
4 Potentially able to precipitate a life threatening event

3.6 Developing guidelines

After the expert group had evaluated each omission, all in category 2 and 3 were written down as a summary for the nurses over medicines that should not be omitted. The guidelines were presented to some of the pharmacists from the expert group to check if something important were left out.

3.7 Process mapping

To describe the three medicines management systems a process map (flow diagram) for each ward was made. The process maps contain how medicines are supplied on the different wards to try to compare and identify differences in the three systems. Information about the systems was obtained from reading documents on the systems and by asking questions to pharmacy technicians. The final process maps were discussed with a pharmacy technician to ensure every step in the process was correct.

4. Results
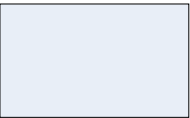
4.1 Literature review

Relevant articles and reports about medication incidents and medication errors were found on different websites. The search engine 'Google' was also used sometimes to find relevant articles. Some standard operating procedures and guidelines were found on the hospital, and the researcher got information about the different medicines managements from pharmacy staff. This included nurse training documents on the Redesign system, information about the pilot on station 16 which are using information from the JAC prescribing system to identify non stock medicines prescribed and "Code of practice- Administration of Medicines".

4.2 Process maps

In this project a process map was made of each of the three medicines management systems at Ayr hospital. They were made to describe differences between the ways to supply medicines in the three wards.

Table 2 Process map: Description of symbols

Symbol	Name	Meaning of symbol
	Terminator	Represents the first and last step of process
	Process	Represents a step in a process (activity or task)
	Question	A question with a Yes or No answer
	Connector	An arrow that connects the different boxes in the process map

Patient admitted to hospital

Patient already on ward

New medicines prescribed

Did the patient bring own medicines?

Are all medicines on the ward?

Is pharmacy open?

Is the medicine in emergency cupboard or on another ward?

Yes

POD assessment by POD trained nurse or technician

No

No

No

Is the medicines ok to use?

Is a pharmacy technician on ward?

No

Nurses order medicines

No

Yes

Yes

Yes

Technician on ward orders medicines*

On-call pharmacist contacted

Yes

No

Patient has all medicines

Yes

Medicines put in patients bedside locker

Medicines delivered to ward

Yes

Are all medicines in pharmacy?

Yes

Medicine charted as "Unavailable" and supplied when pharmacy is open

No

Is it important to give the medicine this day?

Yes

Medicine is supplied from another hospital or from medicine factory

* One stop dispensing: On admission pharmacy technician ensure that patients has at least 14 days of supply at discharge.

Figure 1. Description of medicines management system – Redesigned system
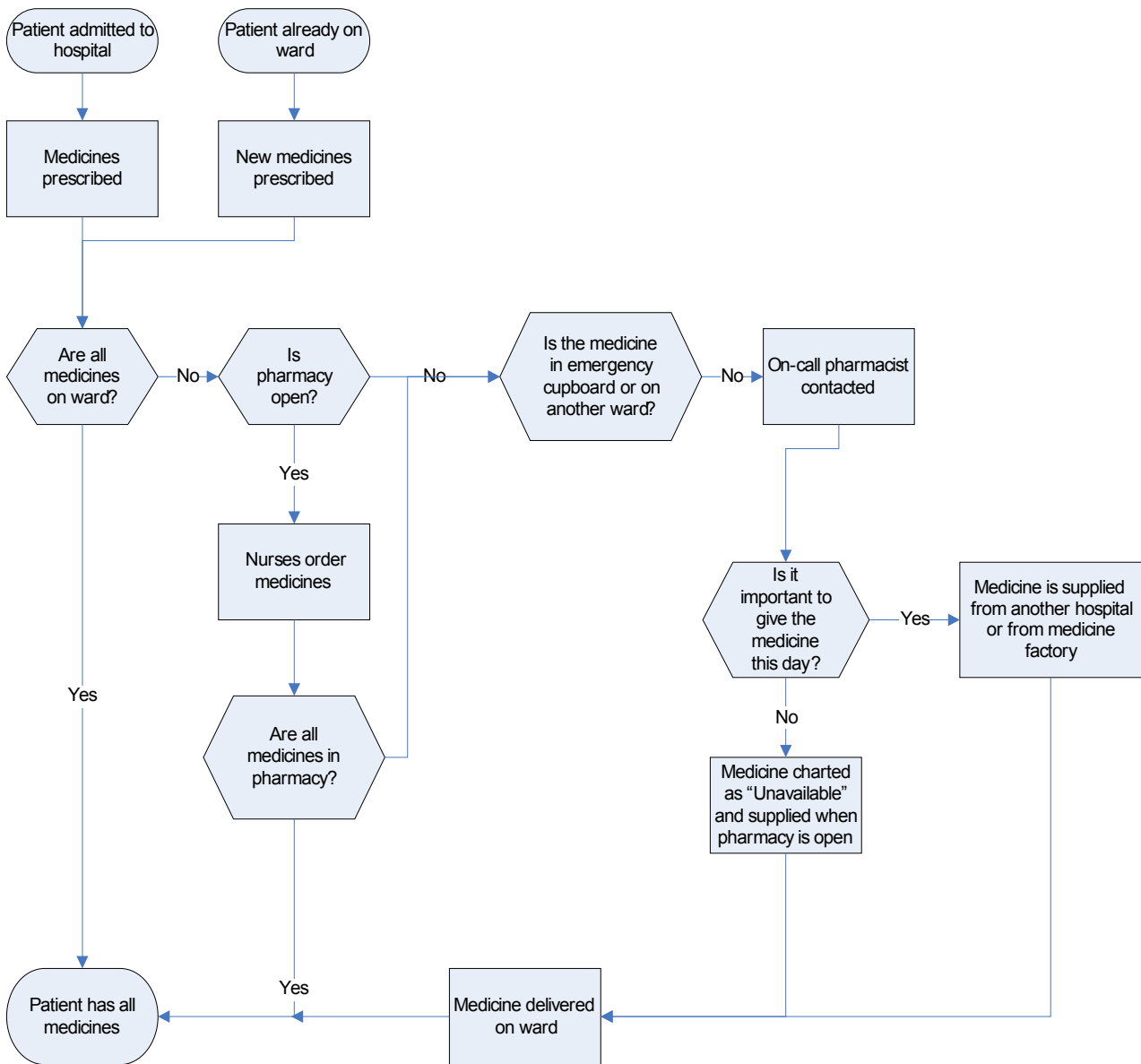
Figure 2. Description of medicines management system – Traditional top up
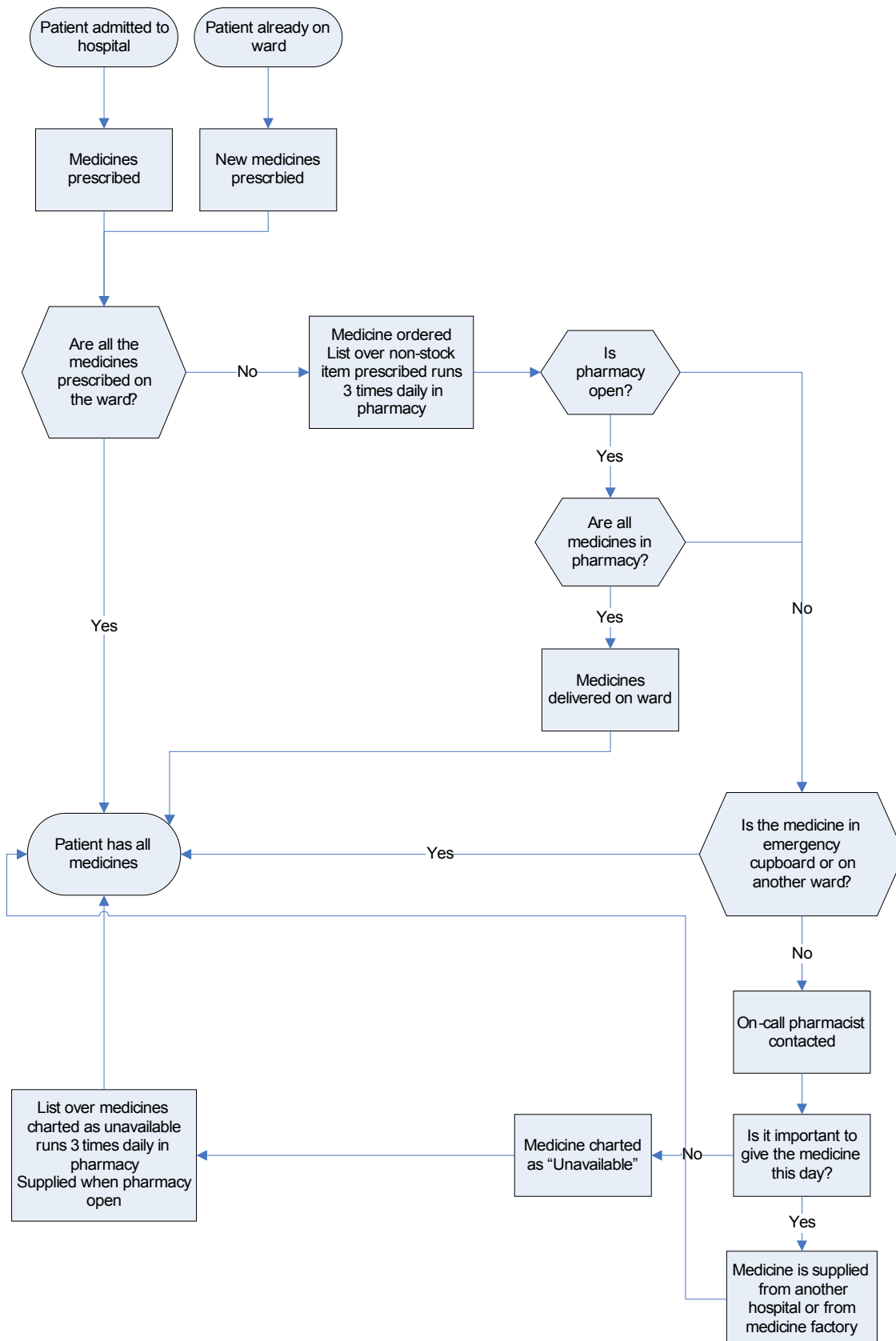
Figure 3. Description of medicines management system - HEPMA

4.3 Data collection of omitted doses

Numbers of omitted doses from all three wards are presented in tables (appendix 6). Ward 16, the geriatric ward had the highest percentage of omitted doses in the 2 weeks period the data collection was carried out. In total 489 doses of 4973 were omitted in the seven reasons which gives a per cent of 9.8 %. Ward 14 had 511/6165 (8.3 %) and Ward 6 331/4360 (7.6 %).

 For all three wards the reason for most of the omitted doses was the omitted doses charted as "Refused". This reason made 205 of 4973 doses (4.1%) for the geriatric ward, 247/6165 (4.0%) for the general medical ward and 148/4360 (3.4 %) for the medical cardiology ward. The reason that was observed to be charted second most was "Unable to swallow". In ward 16 this reason was calculated to 150/4973 (3.0 %) of total doses available for administration. The third reason charted most were not the same on the three wards; "Withheld" was the reason for ward 6 and 16 and "Unavailable medicine" for ward 14.

The comparison of the distribution of reasons of dose omissions was performed by using Fischer's exact test. Fisher's test is the best choice as it always gives the exact P value, while the chi-square test only calculates an approximate P value. A p-value less than 0.06 shows a significant difference between two settings; the lower the p-value the more significant is the difference.

When comparing three wards, two and two wards were compared with each other to say if there were any significant differences between the three wards. The comparisons between the three settings are shown in tables below. Table 3 is presenting the frequency distribution of reasons for omissions and what they make out of total omitted doses. Table 4 is a comparison of the three wards based on numbers from table 3. P-values were calculated from Fischer's exact test from 2x2 tables.

Table 3 Frequency Distribution of Reasons for Omissions Ward 14 (n=511), ward 16 (n= 489), ward 6 (n= 331)

Reason	Ward 14 General medical ward		Ward 16 Geriatric ward		Ward 6 Cardiology ward	
	Count (%)	95 % CI	Count (%)	95 % CI	Count (%)	95 % CI
Absent from ward	1 (0.2)	0.0,1.3	1 (0.2)	0.0,1.3	1 (0.3)	0.0,1.9
Fasting patient	18 (3.6)	2.2,5.6	13 (2.7)	1.5,4.6	27 (8.2)	5.7,11.6
IV Access unavailable	7 (1.4)	0.6,2.9	15 (3.1)	1.8,5.1	3 (0.9)	0.2,2.9
Patient refused	247 (48.8)	43.9,52.7	205 (41.9)	37.5,46.4	148 (43.7)	39.3,50.3
Unable to swallow	101 (20.0)	16.5,23.6	150 (30.7)	26.6,35.0	9 (2.7)	1.3,5.3
Withheld	59 (11.7)	8.9,14.7	56 (11.5)	8.8,14.7	88 (26.6)	22.0,31.8
Unavailable medicine	78* (15.4)	12.3,18.7	49 (10.0)	7.6,13.1	54 (16.3)	12.6,20.8
Total	511 (100.0)		489 (100.0)		331 (100.0)	

Table 4 Comparison of the three wards

Reason	p-value (Fischer's exact test) Ward 14/Ward 16	p-value (Fischer's exact test) Ward 16/Ward 6	p-value (Fischer's exact test) Ward 14/Ward 6
Absent from ward	p = 1.000	p = 1.000	p = 1.000
Fasting patient	p = 0.468	p < 0.001	p = 0.005
IV access unavailable	p = 0.085	p = 0.050	p < 0.748
Refused	p = 0.031	p = 0.430	p < 0.257
Unable to swallow	p < 0.001	p < 0.001	p < 0.001
Withheld	p = 0.921	p < 0.001	p < 0.001
Unavailable	p = 0.013	p = 0.009	p = 0.771

A comparison of the three wards shows that numbers of several reasons for dose omissions are significant different. When comparing ward 14 with ward 16, the numbers of *refused*, *unable to swallow* and *unavailable medicine* were significant different from each other. The comparison between ward 16 and 6 shows significant difference between all reasons except from *refused* and *absent from ward*. When comparing ward 14 with ward 6 numbers were different for several reasons; *fasting patient, unable to swallow* and *withheld*.

Table 5 presents frequency distribution of reasons for omissions and what percentage they made out of total doses that should have been administered in the 2 weeks of data collection. Table 6 presents compares data for the three wards.

Table 5. Frequency Distribution of Reasons for Omissions n= 6165 for ward 14, n= 4973 for ward 16 and n= 4360 for ward 16)

Reason	Ward 14 General medical ward		Ward 16 Geriatric ward		Ward 6 Cardiology ward	
	Count (%)	95 % CI	Count (%)	95 % CI	Count (%)	95 % CI
Absent from ward	1 (0.0)	0,0.1	1 (0.0)	0,0.1	1 (0.0)	0,0.1
Fasting patient	18 (0.3)	0.2,0.5	13 (0.3)	0.1,0.5	27 (0.6)	0.4,0.9
IV Access unavailable	7 (0.1)	0.1,0.2	15 (0.3)	0.2,0.5	3 (0.1)	0.0,0.2
Patient refused	247 (4.0)	3.5,4.5	205 (4.1)	3.6,4.7	148 (3.4)	2.9, 4.0
Unable to swallow	101 (1.6)	1.3,2.0	150 (3.0)	2.6,3.5	9 (0.2)	0.1,0.4
Withheld	59 (1.0)	0.7,1.2	56 (1.1)	0.9,1.5	88 (2.0)	1.6,2.5
Unavailable medicine	99* (1.0)	0.8,1.3	67* (0.9)	0.7,1.2	82* (1.3)	1.0,1.6
Total omissions	511 (8.3)	7.6,8.9	489 (9.8)	9.0,10.7	331 (7.6)	6.8,8.4

* The numbers for 'Unavailable Medicine' are from 3 weeks of data collection, and the total number of doses used is n= 9574 for ward 14, n= 7162 for ward 16 and n=6383 for ward 6.

Table 6 Comparison of the three wards

Reason	p-value (Chi-square)	p-value (Fischers exact test)	p-value (Chi-square)
	Ward 14/Ward 16	Ward 16/Ward 6	Ward 14/Ward 6
Absent from ward	$p = 0.879$	$p = 1.000$	$p = 0.805$
Fasting patient	$p = 0.902$	$p = 0.010$	$p = 0.017$
IV access unavailable	$p = 0.045$	$p = 0.015$	$p < 0.679$
Refused	$p = 0.795$	$p = 0.073$	$p < 0.115$
Unable to swallow	$p < 0.001$	$p < 0.001$	$p < 0.001$
Withheld	$p = 0.434$	$p < 0.001$	$p < 0.001$
Unavailable	$p = 0.577$	$p = 0.062^*$	$p = 0.063$
Total omissions	$p = 0.003$	$p < 0.001$	$p < 0.001$

* The total number used here was too large to use a Fischer's exact test, a Chi-square with Yates correction was used instead.

A comparison of the three wards on how much the number of omissions in each reason made out of total doses available for administrating, several differences was found. Between ward 14 and ward 16 following reasons were significant different: *IV access unavailable, unable to swallow* and number of total omissions. Comparing ward 16 and ward 6 showed significant differences in all reasons except from *absent from ward* and *unavailable medicine.* The last comparison between ward 14 and ward 6 shows significant differences in the reasons *fasting patient, unable to swallow, withheld* and total omissions.

The three tables below show the 5 most omitted medicines on the wards. For all three wards lactulose was omitted the most, at ward 14 there were 81 doses missed of this laxative. Paracetamol, senna and different inhalation preparations against chronic obstructive pulmonary disease (COPD) and asthma were the other medicines most commonly not given to the patients. A major part of these doses were refused by the patients.

Table 6 Count of most omitted doses of medicines at ward 14

	Omitted medicine	Total number of omitted doses
1	Lactulose oral solution	81
2	Paracetamol	33
3	Ipratropium bromide	20
4	Salbutamol	18
5	Metochlopramide	18

Table 7 Count of omitted doses of medicines at ward 16

	Omitted medicine	Total number of omitted doses
1	Lactulose oral solution	52
2	Paracetamol	44
3	Aspirin	27
4	Senna	25
5	Carvedilol	19

Table 8 Count of omitted doses of medicines at ward 6

	Omitted medicine	Total number of omitted doses
1	Lactulose oral solution	36
2	Movichol sachets	23
3	Senna	17
4	Paracetamol	16
5	Ipratropium bromide	14
5	Sodium chloride	14

4.4 Omissions recorded as "Unavailable medicine"

Because patients with a medicine charted as *unavailable medicine* was the only category the researcher was going to include in the study, there was a need to collect data in more than two weeks, to have more patients to include in the study. On each of the three wards a period of three weeks data collection were carried out.

Count of doses recorded as unavailable and explanations on each of these doses are presented in tables which can be seen in Appendix 7.

On ward 14 36 out of 99 doses (33.4%) were written as unavailable, when the item was on the ward; 33 in ward cupboard/fridge and 3 in patients bed side locker. In addition to this in 26 out of 99 cases (26.3 %) the medicines were not on ward, but not ordered before the technician came up in the afternoon. In most of these cases the morning dose (7.00 am) were charted as unavailable. Often seen on ward 14 was that some doses are charted as unavailable in the morning, not ordered by nurse and then charted unavailable again at 13 pm. When first charted as unavailable it can not be changed back, but the nurses could still give the medicine outside of this.

In total for ward, there were 14 99 doses charted as unavailable distributed on 66 different medicines. Out of these 66 medicines 16 were stock items; item the ward always have on ward. A pharmacy technician tops up the ward cupboard twice a week to ensure there always are enough of these medicines

In 3 doses (3.0 %) the items unavailable were non-stock items and therefore not on ward, but alternatives that were stock item could have been given.

In one case at ward 14 a patient had 7 of the 14 regular medicines omitted with the charted reason "Unavailable medicine". 5 of these medicines were stock items, which tell that the medicines should be on the ward. It was confirmed by a technician on ward that the medicines actually were there.

At ward 16, there were 35.8 % of medicines charted as unavailable were actually on ward. Since there isn't a pharmacy technician on this ward daily, the unavailable medicines were checked from pharmacy/dispensary with help from a pharmacy technician. By using the patients hospital number there was checked when a supply was sent to the ward last time, and identified if the medicine were on ward or not.

At ward 16 all patients' medicines, both PRN medicines and other medicines are kept in the medicine trolleys and the researcher didn't have access to these ones. In 15 % of the cases the patients were admitted in the evening after pharmacy had closed, new medicines were prescribed and these were non-stock items and not on ward. A print over new patients arrived the night before is printed 3 times daily, with list over new non-stock items prescribed. A list over all drugs for the patients is printed out, checked

for non stock or stock items, and necessary medicines are supplied to ward via porter or tube system.

It was found that 7 out of 47 (14.9 %) different medicines omitted were stock items on ward 16.

At the cardiology ward, station 6, 40.2 % of all medicines charted as unavailable was actually on the ward. In 12 % of the cases the patient was admitted in the evening and the prescribed medicines were non-stock items not on ward.

Table 10 shows how many of the medicines written as unavailable that actually was on the ward. Table 11 compares the three settings to find out if any ward is significant different from one of the others when looking at how many medicines that was on the ward, but still charted as unavailable.

Table 10 Medicines charted as unavailable

	Ward 14	Ward 16	Ward 6
	Count (%)	Count (%)	Count (%)
Medicines on ward	36 (36.3)	24 (35.8)	33 (40.2)
Medicines not on ward	63 (63.6)	43 (64.2)	49 (59.8)
Total	99 (100.0)	67 (100.0)	82 (100.0)

Table 11 Comparison of ward settings using Fischer's exact test

	Ward 14/ ward 16	Ward 16/ward 6	Ward 14/ward 6
Medicines charted as unavailable but found on ward	p = 1.000	p = 0.614	p = 0.645

No significant difference was found between the wards when comparing the number of *unavailable medicines* that actually were on the ward.

The tables below show the number of unavailable medicines in weekends for each ward and a comparison of the different settings. The table shows that there were no

differences in the number of *unavailable medicines* in the weekends between the wards.

Table 11 Distribution of unavailable in weekend and weekdays (total number of unavailable doses n= 248)

	Ward 14 Count (%)	Ward 16 Count (%)	Ward 6 Count (%)
Unavailable in weekend	17 (17.1)	13 (19.4)	14 (17.1)
Unavailable in weekdays	82 (82.8)	54 (80.6)	68 (82.9)
Total	99 (100.0)	67 (100.0)	82 (100.0)

Table 12 Comparison of three wards

	Ward 14/ward 16 p-value	Ward 16/ ward 6 p-value	Ward 14/ward 6 p-value
Unavailable in weekends **Unavailable in weekdays**	p = 0.837	p = 0.831	p = 1.000

4.5 Inclusion of patients

Number of included patients is shown in the following figure (Figure 4)
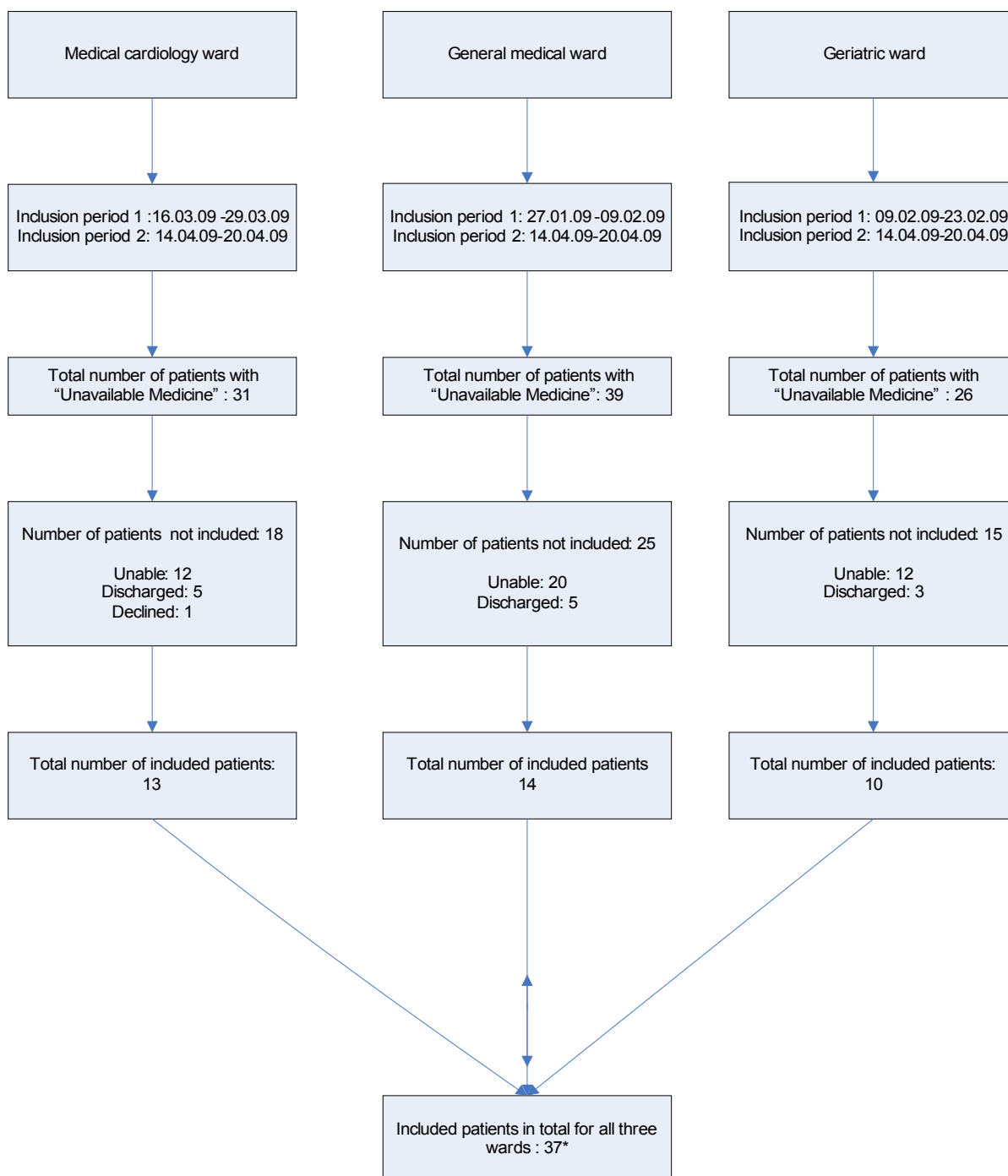
Figure 4 Patients included in study

* Two of the 37 patients were admitted two times during the period therefore used as different cases. In total this gave 39 patient cases to present to the expert group.

Two inclusion periods on each ward were needed to get a suitable number of patients to present for the expert group. The researcher only managed to include 25 patients in the first inclusion period. 46 % of the patients that had an "Unavailable Medicine" were not able to speak to the researcher because of a serious condition such as stroke etc. At the geriatric ward many patients were too confused to speak to. A chief nurse or pharmacist on the ward was always asked if the patients were suitable to talk to the researcher and sign the consent form.

13 patients were discharged before the researcher got the chance to speak to them. If a patient had a medicine charted as unavailable in the evening, this wasn't recorded until the next day and often these patients got discharged in the morning before the researcher went up to the ward.

There was a quite even distribution of gender in the included patients, with 40.5 % females, see table 10. The mean age (SD) among the females were 72.1 years (12.4) and mean age (SD) among the included males were 73.3 (8.3). The mean age of all patients included was 72.8.

Table 14 Patients included in the study (n=37)

	Number of patients	Per cent of patients (%)	Mean age (SD)
Female	15	40.5 %	72.1 (12.4)
Male	22	59.5 %	73.3 (8.3)
TOTAL	37	100 %	72.8 (10.0)

The most common presenting complaints among the patients from all three ward settings were shortness of breath, weakness, feeling unwell and chest pain, see table 11. Most of the patients included in the study had several symptoms when admitted to the hospital. The most common chronic medical conditions of the included patients were chronic obstructive pulmonary disease (COPD) and cerebrovascular accident.

Table 15 Present complaints for the 37 included patients (39 cases)

Present complaints	Counts	Prevalence
Shortness of breath	16	41 %
Weakness/numbness	9	23 %
Feeling unwell	6	15 %
Chest pain	4	10 %

4.6 Clinical significance of omitted doses

The expert group evaluated 74 dosing omissions distributed on 39 patient cases. Most of the patients only had one omitted medicine but some of the patients had several omitted doses and the clinical significance of each dose was evaluated separately. The following tables show number of doses in each category and how they were distributed on each ward. An example of a patient case could be seen in Appendix 8.

Table 16: Number of omitted doses under each category of clinical significance (n= 74).

	0 No threat to patients care	1 Minor disturbance to symptom control	2 Major disturbance to symptom control	3 Major treat to stability of patients condition
Gastro-intestinal system	-	4	1	-
Cardiovascular system	1	11	-	-
Respiratory system	-	12	-	-
Central nervous system	-	8	-	-
Infections	1	-	2	1
Endocrine system	-	3	7	-
Obstetric, gynaecology and urinary tract disorders	1	2	-	-
Malignant disease and immunosuppression	-	-	1	-
Nutrition and blood	-	2	7	-
Musculoskeletal and joint diseases	-	2	-	-
Eye	-	2	-	-
Ear, nose and oropharynx	-	-	-	-
Skin	1	2	2	-
Immunological products and vaccines	-	-	-	-
Anaesthesia	-	-	-	-
Others	-	-	1	
TOTAL	**4**	**48**	**21**	**1**
(%)	**(5.4 %)**	**(64.9 %)**	**(28.4 %)**	**(1.4 %)**

Table 17 Clinical significance distributed on the three wards

	0 No threat to patients care	1 Minor disturbance to symptom control	2 Major disturbance to symptom control	3 Major treat to stability of patients condition
Ward 14		21	7	1
Ward 16	4	14		
Ward 6		13	14	
TOTAL	**4**	**48**	**21**	**1**

Most of the omitted doses were medicines in the BNF category cardiovascular and respiratory system. In these categories the omitted doses were evaluated to be in category 1 except from two drugs which was evaluated to category 0.

Most of the omitted doses under the category gastrointestinal system were proton pump inhibitors and all of them were categorized in number 1 with one exception; one patient missed a dose of esomeprazole and this omission was evaluated to have a clinical significance in category 2; Major disturbance of symptom control. The explanation is that the patient was admitted with abdominal pain.

In three of the cases presented for the expert group an antibacterial drug was the omitted drug. Two of them were evaluated to be in category 2. The last one was evaluated to be in category 3. In this case a patient missed two doses of doxycycline (the first and second dose).The medicine was prescribed for use once daily, and missing two doses of this antibiotic was therefore evaluated to be a major treat to stability of patient's condition.

Among the omitted medicines in the endocrine system there were category 1 and 2. In one case an immunosuppressive drug was omitted. This omission was categorized as a 2: Major disturbance to symptom control. In addition to this medicine (Azathiorpine) the patient was on steroids. Azathiorpine is a steroid sparing drug, and missing this dose gives less control over steroid levels.

4.7 Guidelines

The following table show the guideline developed after meeting with expert group. Medicines missions categorised as a category 2 or 3 was included as basis for the guidelines.

Table 18 Medicines that should not be omitted

Medicines	Example
Antibiotics - Especially first doses (Dose 1-4) are very important not to miss	Clindamycin Doxycycline
Glucocorticoids	Prednisolone
Immunosuppressants	Azathioprine
Different cures with a specific number of days treatment - It is important for patients to have all doses in such cures	Clotrimazole (3 days cure) Estradiol (3 days cure)

5. Discussion

5.1 Data collection

5.1.1 Recorded reasons for dose omissions

When deciding what reasons to record, several reasons for charting a medicine as not given was not included. Examples here are reasons where the doctors had decided to withhold, withdraw or discontinue a medicine of any reason. The researcher didn't think of these ones as omitted medicines, since there normally are medical reasons for these decisions. If all reasons for not giving a medicine have been included, the numbers of omissions would have been higher.

The following reasons; *Refused, IV access unavailable, unavailable medicine, unable to swallow, absent from ward* and *fasting patient* are all thought to be preventable dosing omissions, and were therefore recorded in the study.

5.1.2 Results from data collection

Of all the reasons recorded in the 2 weeks of data collection, *refused* was the most common and laxatives were seen as the most common medicines that the patients refused to take. The patients can decide themselves which medicines to take and refusing to take a medicine turned out to be more common than expected. Refused medicines was often laxatives or painkillers; these are medicines that the patients can decide themselves whether they need or not. This could indicate that the prescriber not is prescribing appropriately since laxatives and painkillers are often best prescribed as PRN medicine.

In the cases where important medicines are refused by patients it is of importance that both patients and nurses get information about the importance of taking such medicines.

The results of this study suggest that nurses sometimes write the wrong reason for not administrate a medicine. In one case a patient got 7 out of 14 regular drugs omitted because of "Unavailable medicine". Questions can be asked if this was the correct reason to chart since several of the omitted medicines were stock items, and the pharmacy technician on ward said that these were in the ward cupboard. It's therefore a possibility that the medicines were on the ward but not found by the nurse, or that wrong reason was charted. The rest of the medicines the patient should have been taken were charted as '*Unable to swallow'*, and it could have been this reason that should have been charted.

Several other examples could indicate that the nurses sometimes chose the wrong reason; in one case it was charted that the patient didn't have a medicine because the patient was absent from ward. It is likely to believe that this reason was wrong since the patient got all other medicines that should have been administered at the same administration time.

5.1.3 Inclusion of patients

It was experienced a difficulty to include patients in the study. To summarize the clinical context on the patients the researcher needed to get information by reading in the patients' medical notes. Because the researcher not was a part of the patient's treatment group, consent from each patient was needed before any information about the patient could be used. This turned out to be quite a challenge.

In total in all three wards 46 % of the patients that had an unavailable medicine, and therefore should have been included in the study, were unable to sign the consent from because of serious illness or dementia. Ward 16 is a geriatric ward and a major part of the patients have dementia or are too confused to speak to, and ward 14 had a lot of very sick patients. This resulted in only 37 included patients in total (14 from ward 14, 13 from ward 6 and 10 from ward 16).

If consent from the patients not was needed, all patients with an unavailable medicine could have been included and the numbers would be more correct.

A lot of the time during the collection period was used to write down every omission for every patient. Every patient needed to be checked separately, and this was quite time demanding.

5.2 Comparison of the three wards

In results the per cent of dosing omissions within each reason was calculated from total omitted doses during the collection period and from total medicines available for charting. The numbers calculated from total omitted doses don't say that much about the frequency of each reason. The number calculated from total omitted doses only tells how often a reason occur compared with the other reasons, while the number calculated from total doses available for charting says something about the frequency per prescribed dose.

One example could be if the number of *unavailable* is 20 in one week and the total number of omissions is 100. *Unavailable* then make 20 per cent of total omissions.
In another ward the number of *unavailable* could also be 20, but if the total number omissions is 200, this reason will only make 10 per cent of total omissions. This could give a wrong impression because if these percentages are compared, it looks like one ward has more unavailable than the other. When frequency of unavailable should be compared within wards, the numbers will be more informative if calculated from total doses prescribed at each ward.

When the wards were compared several differences were found. In the numbers of *unable to swallow,* all wards were significant different from each other. As shown in frequency tables, ward 6 was the ward with fewer medicines written as *unable to swallow.* This could be explained by the types of patients in the different wards; ward 14 has a lot of very sick patients and due to these difficulties in swallowing medicines can occur. Ward 16 is a geriatric ward and for elderly people it is also quite common to have difficulties with swallowing medicines. To avoid that this is becoming a major problem, a suggestion would be that the wards should have more suspensions and mixtures as replacement for tablets and capsules.

The numbers from some other reasons were also shown to be significant different between the wards, such as *withheld* and *IV access unavailable,* but it is difficult to think of a reason why this occur more in one ward than another.

5.3   Unavailable medicines

The three wards have different systems to supply medicines to the ward and before the study started it was suggested that the system on ward 16 should be the best one. As explained in the introduction this system is based on lists printed three times daily over new non-stock items prescribed. The nurses do not need to order it; a new medicine prescribed will show on the list and than supplied to the ward. Compared to the results from the first 4 week before the pilot the number of unavailable medicines has decreased. In total for these 4 weeks 143 medicines were charted as unavailable, in this study; 67 on three weeks. In the last week of the pilot there were 21 missed doses and this number is not that different from the one found in this study (in average 22.3 doses each week.)

Ward 14 has the redesign system, it was thought that using patient own drugs and one stop dispensing was going to keep number of unavailable medicines down. The system includes that a pharmacy technician is up on the ward every day ordering all needed medicines. If the technician not is there, the nurses could order any needed medicines themselves. In the study it was experienced that the nurses often charted medicines as unavailable in the morning instead of order the medicine from pharmacy and give it to the patient with a couple of hours delay.

Often seen on this ward was that nurses were charting medicines as unavailable in morning, and again at 13.00 pm. This was noticed by the technician when he/she came up on the ward in the afternoon, and not ordered until then; this could cause many hours delay for the patient, and possible two or three missed doses. In 26 of 99 doses (26,3 %) the medicines were not on ward, but could have been ordered from pharmacy in the morning instead of waiting for technician to come up in the afternoon.

If the pharmacy is closed when a medicine not on ward is needed, the theory says that a call around to other wards to check if someone has the medicine is necessary. In

addition there is an emergency cupboard which includes most medicines, this should also be checked. If the medicines can not be found either in ward cupboard or the emergency cupboard, an on-call pharmacist should be called to find out if the medicine is really important to take or not. This study gives a reason to believe that this is not done every time a medicine is unavailable. Even though this doesn't happen all the time, there is a need to explain to the nurses the importance of giving single doses, and that they shouldn't be omitted.

A comparison of the three wards didn't show any significant difference between the wards in number of unavailable medicines. The study therefore suggests that neither of the supply systems is different from another, but to be more conclusive here more and longer studies need to be carried out. But some theories can be made out from this study.

The redesign system includes more staff on ward, with technicians ordering all medicines for patients. It could seem like the nurses not are ordering needed medicines when they know that a technician comes up to the ward and takes care of the ordering in the afternoon.

Because it looks like the nurses often are charting wrong reasons, not order all medicines when needed and too often write a medicine as *unavailable* when the item is on ward, there could be a need for more information to nursing staff in addition to review the different supply systems, to avoid *unavailable medicines*.

5.4 Clinical significance

An omitted dose for the patients not included would probably be of a higher clinical significance than the healthier patients that the researcher got consent from. If a patient has a serious condition, it is often more important to have all medicines, and therefore an omission could cause more harm to this patient than if a healthier patient had the same medicine omitted.

After the expert group had evaluated the dosing omissions, the results were used to develop guidelines for nursing staff over medicines that should not be omitted. Since

the guidelines were developed only from omitted medicines for patients who gave their consent, several medicines were not included. In addition, not all the different categories in the BNF system was represented, and some of these categories could include medicines of big importance to patients. This guideline is therefore not appropriate to use before more studies have been done on the same field. Still it gives a good indication of what medicines are most important to give to patients.

5.5 Expert group

The expert group consisted of 4 pharmacists. All cases were discussed within the group and a common decision was made about clinical significance of the dosing omissions. For evaluation of the clinical importance it was planned to include a doctor but this was not done because the doctors didn't have time. There is likely to think that some difference in the categorisation would arise if a doctor were a part of the discussion. If a similar study is going to be done later, there could be interesting to include a doctor for different opinions and in addition; the expert group could evaluate individually the clinical significance is and eventually different opinions could have been written down and discussed if necessary. Some difference in opinions would probably appear if members of the expert group decide individually without discussing with the others first.

A short comparison of the results from the expert group with the other researcher EJ, showed that some cases were evaluated different. In some cases were the same drugs were omitted and patients had quite similar medical history, different evaluation of clinical significance was made. A limitation with this group could therefore be different opinions of the pharmacists

5.6 Limitations with the study

One of this study's limitations is that there was not any assessment of the charted reasons. The nurses were not aware of the study, so that they could not have a change to improve anything. Therefore it was difficult to check if the right reasons for not administrate a drug was written down.

There were not done any direct observations of nurses administrating drugs to patients but this could have detected more specific errors than this study does. Several studies done on the same area, omitted medicines in hospital, have used different methods than the researcher, such as following the nurse around for 24 hours to find out which doses are omitted and what the actual reasons for not administrate a medicines is (not only the charted reasons). Direct observations would have given more correct numbers.

In the study "Audit of dose omission and completed drug allergy status" by Dhruti Bhatt[12] it was found that 37 % of all doses were omitted. In this project the ward with the highest percentage was ward 16 with 9.8 % missed doses in total. There is a limitation by compare this study with other studies since the methods are different. Although the numbers found in this study seems to be quite low there is room for improvement in all three wards.

During the last two weeks of data collection at ward 6 a pilot of system was tried out. Based on the computer system every new non-stock item prescribed is printed on a list three times daily. In addition all new patient admitted from last report is on the same list, and all needed medicines for these patients are supplied to the ward. These changes could have given less unavailable medicines and this data then differ from the first week when these changes were not implemented yet.

One other limitation is the weekends. The numbers of omitted doses from weekends are not quite correct because patients get discharged and new patients arrive during weekends. A patient could possibly be admitted Friday night and miss some doses, but be discharged before the researcher came back on Monday. Some omissions would therefore be missed by researcher and not give the exact numbers.

This study of medicines written as *unavailable* was carried out only for 3 weeks. More data collection should have been done to say anything about the differences in the supply systems. More and longer studies need to be carried out to be more conclusive.

6. Conclusion

Omissions of medicine doses do not always cause any disturbance of symptom control or potential harm for the patients. But in some cases omitted doses could lead to harm such as omitting antibiotics or glucocorticoids. The guidelines developed after assessment of clinical significance of dose omissions is not sufficient to use before more medicines are included. Still the guideline gives a good indication of what medicines that it is important not to miss.

To ensure that medicines are available all the time, a review of supply systems is needed. In addition this study suggests the nurses should get more information about medicines the patients cannot miss, because a lot of the medicines charted as *unavailable* were still found on ward.

In this study no significant difference between the numbers of medicines written as *unavailable* in the three medicines management systems was found. More studies on this need to be done to be more conclusive in what changes need to be done in the systems.

In this study it was not done any direct observation when the nurses administrated medicines. No assessment of the charted reasons was done so it is not possible to say if the charted reasons were the correct ones. To avoid this in a similar study the researcher can follow the nurse when administrating medicines.

7 Appendices

Appendix 1 Template for recording all dose omissions

Data collection – Dose omissions

Station:

Date:

Number of patients on ward:

Medicine (name, administration route etc)	Reasons for dose omission						
	Absent from ward	Fasting patient	IV Access unav.	Patient refused	Unable to swallow	Unav Med.	Withheld
TOTAL							

Appendix 2 Template for patient summary

Station 6/14/16 – Dose omissions

<u>Patient information:</u>
Patient number:
Age:
Sex:

Medical history:

Drug history:

Present complaint:

Current drugs:

Name of medicine	Dose	Frequency

<u>Dose omissions (recorded as "Unavailable Medicine")</u>

Date	Time	Medicine omitted	Actual reason for omission

Appendix 3 Consent form

NHS
Ayrshire & Arran

CONSENT FORM

The study of Doses of Medicines not given in Surgical and Medical Patients in the Ayr Hospital

Name of Researchers: Elisabeth Johansen and Kristin Reinaas Lysheim

Please initial box

1. I confirm that I have read and understand the information sheet dated 12/12/2008 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 reason, without any medical care or legal rights being affected.

3. I understand that relevant sections of any of my medical notes and data collected during the study, may be looked at by responsible individuals from Ayr Hospital pharmacy department. I give permission for these individuals to have access to my records.

4.   I agree to take part in the above study.

_____   _____   _____
Name of Patient   Date   Signature

_____   _____   _____
Name of Person taking consent   Date   Signature
(if different from researcher)

_____   _____   _____
Researcher   Date
                              Signature

When completed, 1 for patient; 1 for researcher site file; 1 (original) to be kept in medical notes

PATIENT INFORMATION SHEET

NHS
Ayrshire & Arran

The study of Doses of Medicines not given in Surgical and Medical Patients in the Ayr Hospital

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You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. Talk to others about the study if you wish.

Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

What is the purpose of the study?

Sometimes doses are missed in medicines that have been prescribed. There can be lot of reasons for this to happen. The aim of this study is to find out the reasons why this happens and to try to prevent it happening in the future.

Two final year pharmacy university students from Norway who are currently working with the pharmacists in Ayr Hospital and Strathclyde University will carry out the study. The students' names are Elisabeth Johansen and Kristin Reinaas Lysheim.

Why have I been chosen?

You have been chosen because you have been admitted to the wards that the study is taking place, which are Stations 6, 10, 12, 14, 16 during the study time period.

It is hoped we will study a total of about 200 patients during the time period.

Do I have to take part?

No. It is up to you to decide whether or not to take part. If you do, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to with-draw at any time and without giving a reason.

A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive.

What will happen to me if I take part?

If you decide to take part in this study, your notes and the electronic prescribing system will be accessed when you in hospital. The electronic prescribing system also contains the information about which medicines you have received and which ones you have not received. This information will be used by the students in the research.

Any information taken from your notes will be kept anonymous.

What do I have to do?

You are only required to give permission for the information in your notes to be used as part of the study.

You will not have to do anything, complete any forms or visit any clinics or hospitals during the study.

If you decide to take part in the study, you will be asked to sign a consent form. This will allow us to access your notes when you are in hospital and use the information in your notes.

After this you will not be asked to do anything else.

What are the possible benefits of taking part?

There are no direct benefits to your treatment by taking part in the study.

However, if the study produces good results it will give us information on how to prevent doses being missed in the future.
This may benefit patients in Ayrshire and Arran in the future.

What if there is a problem?

Any complaint about the way you have been dealt with during the study will be addressed.

If you have any complaints or would like further information about the study please contact:

Gillian A Jardine
Principal Pharmacist
Ayr Hospital
Dalmellington Road
Ayr
KA6 6DX
Telephone: 01292 614504

If you remain unhappy and wish to complain formally, you can do this through the NHS Complaints Procedure. Details can be obtained from Ayr Hospital.

Will my taking part in the study be kept confidential?
Yes. All the information about your participation in this study will be kept confidential.

You will be given a copy of the information sheet and a signed consent form to keep.
Thank you for taking time to read the information sheet and for considering taking part in this study

Appendix 5 BNF Category system

BNF category system:

1. Gastro-intestinal system
2. Cardiovascular system
3. Respiratory system
4. Central nervous system
5. Infections
6. Endocrine system
7. Obstetrics, gynaecology, and urinary-tract disorders
8. Malignant disease and immunosuppression
9. Nutrition and blood
10. Musculoskeletal and joint diseases
11. Eye
12. Ear, nose and oropharynx
13. Skin
14. Immunological products and vaccines
15. Anaesthesia

Appendix 6 Distribution of reasons for dose omissions

Ward 14

	Absent from ward	Fasting patient	IV Access unav.	Patient refused	Unable to swallow	Withheld	Unav. medicine	TOTAL	Total number of doses
1	0 (0.00)	11 (2,38)	0 (0.00)	23 (4.97)	1 (0.22)	8 (1.73)	**4 (0.86)**	**47 (10,15)**	**463**
2	1 (0.19)	0 (0,00)	0 (0.00)	23 (4.40)	5 (0.96)	5 (0.96)	**1 (0.19)**	**35 (6.69)**	**523**
3	0 (0.00)	0 (0.00)	0 (0.00)	15 (3.42)	2 (0.46)	1 (0.23)	**2 (0.46)**	**20 (4.56)**	**439**
4	0 (0.00)	0 (0.00)	1 (0.21)	23 (4.89)	0 (0.00)	2 (0.43)	**3 (0.64)**	**29 (6.17)**	**470**
5	0 (0.00)	0 (0.00)	2 (0.42)	17 (3.54)	2 (0.42)	2 (0.42)	**6 (1.25)**	**29 (6.04)**	**480**
6	0 (0.00)	0 (0.00)	2 (0.39)	12 (4.32)	0 (0.00)	2 (0.39)	**5 (0.98)**	**21 (6.09)**	**509**
7	0 (0.00)	0 (0.00)	0 (0.00)	21 (5.71)	4 (1.09)	2 (0.54)	**10 (2.72)**	**37 (10.05)**	**368**
8	0 (0.00)	4 (0.74)	0 (0.00)	10 (1.86)	0 (0.00)	9 (1.68)	**2 (0.37)**	**25 (4.66)**	**537**
9	0 (0.00)	3 (0.82)	0 (0.00)	8 (2.19)	0 (0.00)	1 (0.27)	**8 (2.19)**	**20 (5.46)**	**366**
10	0 (0.00)	0 (0.00)	1 (0.27)	9 (2.43)	5 (1.35)	3 (0.81)	**16 (4.31)**	**29 (7.82)**	**371**
11	0 (0.00)	0 (0.00)	1 (0.25)	37 (9.32)	6 (1.51)	5 (1.26)	**16 (4.03)**	**65 (16.37)**	**397**
12	0 (0.00)	0 (0.00)	0 (0.00)	22 (5.47)	21 (5.22)	9 (2.24)	**1 (0.25)**	**53 (13.18)**	**402**
13	0 (0.00)	0 (0.00)	0 (0.00)	16 (3.73)	30 (6.99)	4 (0.93)	**0 (0.00)**	**50 (11.66)**	**429**
14	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.24)	25 (6.08)	6 (1.46)	**4 (0.97)**	**36 (8.76)**	**411**
TOTAL	**1 (0.02)**	**18 (0.29)**	**7 (0.11)**	**247 (4.00)**	**101 (1.64)**	**59 (0.96)**	**78 (1.26)**	**511 (8.28)**	**6165**

Ward 16

	Absent from ward	Fasting patient	IV access unav.	Patient refused	Unable to swallow	Withheld	Unav. medicine	TOTAL	Total number of doses
1	0 (0.00)	0 (0.00)	1 (0.27)	19 (5.22)	11 (3.02)	4 (1.10)	**10 (2.75)**	**45 (12.36)**	**364**
2	0 (0.00)	0 (0.00)	1 (0.30)	13 (3.85)	9 (2.66)	8 (2.37)	**2 (0.59)**	**33 (9.76)**	**338**
3	0 (0.00)	6 (1.71)	3 (0.85)	10 (2.85)	18 (5.13)	2 (0.57)	**5 (1.42)**	**43 (12.25)**	**351**
4	0 (0.00)	0 (0.00)	4 (1.05)	10 (2.62)	11 (2.89)	1 (0.26)	**2 (0.52)**	**28 (7.35)**	**381**
5	0 (0.00)	0 (0.00)	2 (0.56)	12 (3.33)	23 (6.39)	6 (1.67)	**3 (0.83)**	**46 (12.78)**	**360**
6	0 (0.00)	0 (0.00)	0 (0.00)	21 (6.67)	7 (2.22)	6 (1.90)	**2 (0.63)**	**36 (11.43)**	**315**
7	0 (0.00)	0 (0.00)	0 (0.00)	20 (5.65)	3 (0.85)	4 (1.13)	**2 (0.56)**	**29 (8.19)**	**354**
8	0 (0.00)	6 (1.57)	4 (1.05)	12 (3.15)	5 (1.31)	7 (1.84)	**3 (0.79)**	**37 (9.71)**	**381**
9	1 (0.28)	0 (0.00)	0 (0.00)	22 (6.16)	8 (2.24)	1 (0.28)	**5 (1.4)**	**37 (10.36)**	**357**
10	0 (0.00)	0 (0.00)	0 (0.00)	15 (3.93)	1 (0.26)	5 (1.31)	**2 (0.52)**	**24 (6.28)**	**382**
11	0 (0.00)	0 (0.00)	0 (0.00)	14 (4.22)	7 (2.11)	2 (0.60)	**1 (0.3)**	**24 (7.23)**	**332**
12	0 (0.00)	1 (0.30)	0 (0.00)	14 (4.15)	6 (1.78)	3 (0.89)	**5 (1.48)**	**29 (8.61)**	**337**
13	0 (0.00)	0 (0.00)	0 (0.00)	7 (2.06)	21 (6.18)	4 (1.18)	**4 (1.18)**	**36 (10.09)**	**340**
14	0 (0.00)	0 (0.00)	0 (0.00)	16 (4.20)	20 (5.25)	3 (0.79)	**3 (0.79)**	**42 (11.02)**	**381**
TOTAL	**1 (0.02)**	**13 (0.26)**	**15 (0.30)**	**205 (4.12)**	**150 (3.01)**	**56 (1.13)**	**49 (0.98)**	**489 (9.83)**	**4973**

Ward 6

	Absent from ward	Fasting patient	IV Access unav.	Patient refused	Unable to swallow	Withheld	Unav. medicine	Total number of omitted doses	Total number of doses
1	0 (0.00)	4 (0.94)	0 (0.00)	14 (3.29)	1 (0.24)	3 (0.71)	**5 (1.18)**	**27 (6.35)**	**425**
2	0 (0.00)	0 (0.00)	0 (0.00)	14 (3.89)	0 (0.00)	5 (1.39)	**1 (0.28)**	**20 (5.56)**	**360**
3	0 (0.00)	18 (5.84)	2 (0.65)	10 (3.25)	8 (2.60)	8 (2.60)	**1 (0.32)**	**47 (15.26)**	**308**
4	0 (0.00)	0 (0.00)	0 (0.00)	12 (3.80)	0 (0.00)	7 (2.22)	**5 (1.58)**	**24 (7.59)**	**316**
5	1 (0.34)	0 (0.00)	0 (0.00)	14 (4.79)	0 (0.00)	4 (1.37)	**8 (2.74)**	**27 (9.25)**	**292**
6	0 (0.00)	0 (0.00)	0 (0.00)	22 (6.96)	0 (0.00)	5 (1.58)	**1 (0.32)**	**28 (8.86)**	**316**
7	0 (0.00)	0 (0.00)	0 (0.00)	8 (2.02)	0 (0.00)	6 (1.51)	**5 (1.26)**	**19 (4.79)**	**397**
8	0 (0.00)	0 (0.00)	0 (0.00)	5 (1.36)	0 (0.00)	11 (2.99)	**5 (1.36)**	**22 (5.98)**	**368**
9	0 (0.00)	0 (0.00)	0 (0.00)	4 (1.61)	0 (0.00)	12 (4.82)	**2 (0.80)**	**18 (7.23)**	**249**
10	0 (0.00)	0 (0.00)	0 (0.00)	18 (7.09)	0 (0.00)	8 (3.15)	**6 (2.36)**	**32 (12.60)**	**254**
1	0 (0.00)	5 (2.08)	0 (0.00)	14 (5.83)	0 (0.00)	3 (1.25)	**9 (3.75)**	**31 (12.92)**	**240**
12	0 (0.00)	0 (0.00)	0 (0.00)	6 (2.32)	0 (0.00)	4 (1.54)	**4 (1.54)**	**14 (5.41)**	**259**
13	0 (0.00)	0 (0.00)	1 (0.38)	5 (1.88)	0 (0.00)	5 (1.88)	**0 (0,00)**	**11 (4.14)**	**266**
14	0 (0.00)	0 (0.00)	0 (0.00)	2 (0.65)	0 (0.00)	7 (2.26)	**2 (0.65)**	**11 (3.55)**	**310**
TOTAL	**1 (0.02)**	**27 (0.62)**	**3 (0.07)**	**148 (3.39)**	**9 (0.21)**	**88 (2.01)**	**54 (1.23)**	**331 (7.59)**	**4360**

Appendix 7: Actual reasons for medicines recorded as *unavailable*

A Item on ward
B Item not on ward

Ward 14

Actual reason for medicine recorded as unavailable	Count of doses
A1 Item in ward cupboard/fridge	33
A2 Item in patient bedside locker	3
B1 Item not on ward	24
B2 Item not on ward, alternative route/strength could have been used	3
B3 Item not on ward, could have been ordered by nurse instead of waiting for technician	4
B4 Patient admitted after pharmacy had closed (evenings or weekends	10
B5 Not on ward - could have waited with charting unavailable	22

Ward 16

Actual reason for medicine recorded as unavailable	Count of doses
A1 Item in ward cupboard/fridge	24
B1 Item not on ward	31
B2 Another route /strength could have been used	1
B3 Could have waited	1
B4 Item not on ward – new patient admitted after pharmacy had closed	10

Ward 6

Actual reason for medicine recorded as unavailable	Count of doses
A1 Item in ward cupboard/fridge	33
B1 Item not on ward	27
B2 Item not on ward, alternative route/strength could have been used	0
B3 Patient admitted after pharmacy had closed (evenings or weekends	1
B4 Not on ward – could have waited with charting unavailable	9
C Unknown	12

Appendix 8 Example of patient case

Patient 17
Male, 71 years

Medical history:
- Severe COPD   - Hiatus hernia
- Osteoporosis   - Transurethral resection of the prostate(TURP)
- Prostate cancer

Present complaint:
- Infective exacerbation
- Increased BP
- SOB (Shortness of breath)

Current drugs:

Name of medicine	Dose	Frequency
Dalteparin	5000 units	OD
Ipratropium bromide 500µg	500 µg	Four times daily
Lansoprazole 30 mg	30 mg	OD
Prednisolone 5 mg	30 mg	OD
Zafirlukast 20 mg	20 mg	BD at 7am, 10 pm
Sodium chloride 0,9 %	1 nebule(s)	Four times daily
Terbutaline 5 mg in 2 ml	5 mg	Four times daily
Ciprofloxacin 500 mg	500 mg	BD (stopped march 16.)
Bumetanide 1 mg	1 mg	OD
Theophylline 200 mg	200 mg	OD at 10 pm
Solifenacin 5 mg	5 mg	OD
Theophylline 300 mg	300 mg	OD
Ramipril 5 mg	5 mg	OD
Clarithromycin 250 mg	500 mg	BD
Aledronic acid 70 mg	70 mg	Once weekly
Seretide 500 Accuhaler	2 blister(s)	BD

Dose omissions (recorded as "Unavailable Medicine")

Date	Time	Medicine omitted	Clinical significance
17/3	07:00	Clarithromycin 250 mg	

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