Impact of the introduction of a specialist critical care pharmacist on the level of pharmaceutical care provided to the Critical Care Unit

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Key words

Critical care, pharmacist, medication error, medicines optimisation, drug-related problem

Abstract

Objectives: To evaluate the impact of a dedicated specialist critical care pharmacist service on patient care at a UK critical care unit.

Methods: Pharmacist interventions data was collected in two phases. Phase 1 was with the provision of a non-specialist pharmacist chart review service and phase 2 was after the introduction of a specialist dedicated pharmacy service. Two critical care units with established critical care pharmacist services were used as controls. The impact of pharmacist interventions on optimising drug therapy or preventing harm from medication errors was rated on a 4-point scale.

Results: There was an increase in the mean daily rate of pharmacist interventions after the introduction of the specialist critical care pharmacist (5.45 vs 2.69 per day, $p<0.0005$). The critical care pharmacist intervened on more medication errors preventing potential harm and optimised more medications. There was no significant change to intervention rates at the control sites. Across all study sites the majority of pharmacist interventions were graded to have at least moderate impact on patient care.

Conclusion: The introduction of a specialist critical care pharmacist resulted in an increased rate of pharmacist interventions compared to a non-specialist pharmacist service thus improving the quality of patient care.

Introduction

Patients in Critical Care Units (CCU) are prescribed nearly twice as many medications as patients in other non CCU settings[1]. This increases the risk of drug interactions and medication errors[1]. Medications require constant review and alteration to treat the patients' rapidly changing clinical need and levels of organ dysfunction. Critically ill patients have limited physical reserves and are more likely to experience an adverse drug event than other patients[1].

It has been widely recognised that a highly skilled multidisciplinary team, which includes clinical pharmacists, is fundamental to provide optimal care for this vulnerable patient population[2-7]. Studies have shown that the involvement of a clinical pharmacist in the care of critically ill patients improves medication safety, e.g through identification of medication errors, drug interactions and avoidance of adverse events or through optimisation of medicines[2, 8-11]. Improved patient outcomes for critically ill patients as well as cost savings have been demonstrated in various therapeutic areas such as antimicrobial therapy or sedation management[3, 12]. However, the scope of pharmacy services to the CCU and the competence of the team members varies between CCUs both within the UK and internationally[13-15].

In our study, the pharmacy service to the active critical care site was previously provided by a senior clinical (non-specialist) pharmacist who had not received formal training in Critical Care and had core responsibilities to other clinical areas in the hospital. Following a service review, a specialist, dedicated, critical care pharmacist (defined at the time [prior to the introduction of formal assessments] as a senior pharmacist specializing in and with prior experience of caring for critically ill patients), was recruited (AR). This provided the opportunity to formally explore the effect of introducing a specialist critical care pharmacist to the identified critical care unit. The design of the service evaluation also included two CCUs in the same geographical area with established specialist critical care pharmacists as controls. We focused on the impact of expanding pharmacy resource to the CCU from a non-specialist pharmacist with responsibilities elsewhere in the hospital to a dedicated critical care pharmacist (AR).

The aim of this study was to evaluate the impact of a dedicated specialist critical care pharmacy service on patient care compared to a non-specialist clinical pharmacist service incorporating chart review.

Our objectives were to study:

- Pharmacist activity using mean pharmacist intervention rates per day as outcome measure
- The impact of the dedicated specialist critical care pharmacist on patient safety as defined by the number and type of medication errors intercepted (mean rate per day).
- The impact of the dedicated specialist critical care pharmacist on patient care defined by optimisation of medication regimens (mean rate per day).

Methods

This design was a pre-post controlled study, carried out in 2 phases. The Critical Care Unit where the pharmacy service changed between phase 1 and phase 2 was defined as the active site. The other two CCUs acted as comparators and had no change in pharmacy service.

Critical Care Units

All 3 participating CCUs were distinct units in different university-affiliated teaching hospitals in North Central London. The active site was a 15-bedded unit while the two comparator units were larger (25 and 35 beds) in hospitals that incorporate tertiary referral services. All CCUs were visited by the pharmacists each weekday (Monday to Friday) and pharmacists could be contacted via a pager when not on the ward. The base hospital's Ethics Committee deemed that approval was not required as this was an observational study of the impact of a service development that occurred irrespective of the study.

Data collection

Phase 1 involved prospective data collection in all 3 hospitals' CCUs during weekdays (Monday-Friday) over a 6 week period during April-June 2009 before the introduction of the specialist critical care pharmacist at the active site.

Phase 2 was a repeated data collection period over 6 weeks in April-June 2010, after the specialist critical care pharmacist had been established for 4 months.

Pharmacists make interventions to solve drug-related problems, i.e. circumstances that are related or potentially related to drug therapy that would interfere with optimal patient care.

We collected self-reported data on pharmacist interventions in the three CCUs using a standardised data collection form based on Allenet et al[16]. The form is available from the authors on request.

All pharmacists working on the 3 CCUs were trained in the use of the form by discussing common example interventions and definitions for terms used were provided on the back of the form to allow for consistent data collection amongst all pharmacists. The data collected were:

- The type of drug related problem leading to pharmacist interventions
- The drug(s) and drug classes involved
- Whether a medication error had occurred or the pharmacist intervention was to optimise medication
- Whether the pharmacist intervention was proactive or in reaction to the request of another health care professional
- Whether the pharmacist intervention was made while attending the consultant-led multidisciplinary ward round
- Whether the pharmacist intervention was accepted by the medical team

The data collection form was adapted following a pilot prior to phase 1. In the original data collection tool by Allenet et al[16] the drug related problem category "failure to receive drug" related to intravenous incompatibilities and non-compliance. It was felt that intravenous compatibility issues were better reflected in the category "drug interaction" and that patient non-compliance was irrelevant in a CCU. A new category "supply failure", i.e. unavailability of a medicine e.g. due to drug shortages, was introduced as the researchers perceived this to be a drug-related problem of increasing relevance in CCU. Other categories remained unchanged from the original tool, which were:

- Non-conformity to guidelines/best practice or contra indication
- Untreated indication
- Subtherapeutic dose
- Supratherapeutic dose
- Drug without indication
- Drug interaction / intravenous compatibility
- Adverse drug reaction
- Administration related
- Drug monitoring

Pharmacists also self-reported additional clinical activities undertaken as part of their CCU pharmacist role.

Patient activity data, defined as level 1, level 2 and level 3 bed days[20] was obtained retrospectively for the quarters during which data collection occurred.

Data management and analysis

After data collection was complete, one researcher (RS), a specialist critical care pharmacist at one of the comparator hospitals, reviewed the categorisation of all pharmacist interventions into medication error-related or optimisation of medication to ensure consistency throughout the data set. A medication error was defined as an error in the process of prescribing, dispensing, preparing, administering, monitoring or providing medicine advice, regardless of whether harm had occurred[17]. 'Optimisations' were recommendations made to improve pharmacotherapy which did not involve an error.

RS also assessed the potential risk of harm from intercepted medication errors and the impact of optimisation on patient outcome. A 4-point rating scale (low, moderate, severe, death) was used for medication errors, adapted from the National Patient Safety Agency[18] and work by Folli et al[19]. A corresponding 4-point scale (low, moderate, high, life-saving) was developed for optimisation interventions. In order to address validity a random sample of 10% of all pharmacist interventions were also scored by a second pharmacist, who was a medication safety expert and had not been involved in the data collection (YJ). Any differences were resolved through discussion, and the agreed principles were applied to the whole data set by RS.

Pharmacist intervention data was standardised by calculating the mean daily rate of pharmacist interventions per hospital per study phase.

For data analysis of drug-related problems the two categories of drug related problems 'subtherapeutic dose' and 'supratherapeutic dose' on the data collection form were combined into a single category 'change dose'. .

Differences between study phases within each CCU were tested with independent sample T-tests or Chi-squared tests.

Data was analysed using PASW Statistics 18 (SPSS Inc, Aug 2009).

Results

Critical Care Units

Baseline differences between the Critical Care Units are outlined in Table 1.

Activity data

Quarterly bed occupancy data at all 3 hospitals during both study phases showed that although the level of pharmacy service did not change at the comparator sites, there was a significant increase in patient bed days at both comparator sites in phase 2 (Comparator 1 +13%, Comparator 2 +18%, $p<0.005$). The increase in number of bed days (+10%) at the active site did not reach statistically significance ($p=0.054$).

The mean rate of pharmacist interventions per day doubled at the active site from 2.69 in phase 1 to 5.45 in phase 2 ($p<0.0005$). There was no significant change in daily mean intervention rate between study phases at the comparator hospitals, despite an increase in patient activity ($p>0.05$). This increase in overall pharmacist intervention rate at the active site was largely due to an increase in proactive interventions by the specialist pharmacist (2.05 vs 4.89, $p<0.0005$). The mean rate of reactive pharmacist interventions (interventions in response to another health professional's enquiry) remained unchanged between study phases (0.64 vs 0.55, $p>0.05$). The specialist pharmacist at the active site made most interventions (62.5%) while participating on the consultant-led multidisciplinary ward round. There had been no participation in the ward round previously. Both comparator units showed no statistically significant differences in mean rate of proactive pharmacist interventions between study phases ($p>0.05$), while a decrease in the rate of reactive pharmacist interventions reached statistical significance for comparator 1 ($p<0.05$).

At the active site, the specialist pharmacist identified significantly more medication errors than the non-specialist pharmacist. At both comparator hospitals the mean rate of medication error interventions did not change significantly between study phases ($p>0.05$).

There was a numerical but not statistically significant increase in the rate of optimisation interventions after the introduction of the specialist pharmacist, while there was a decrease of this type of pharmacist intervention at the comparator hospitals ($p<0.05$ for comparator 2).

Table 2 provides a summary of pharmacist intervention rates for the active and comparator sites.

Over 90% of interventions by pharmacists were accepted by the medical team during both study periods across all critical care units. There was no difference in clinician acceptance between study phases at any of the hospitals ($p>0.05$).

Additional Clinical Pharmacist Activities

Additional clinical activities carried out by the specialist critical care pharmacist in phase 2 and not previously available to the CCU during phase 1, were participation in the consultant-led multidisciplinary ward round, medicines reconciliation, pharmacist involvement in CCU therapy audit and guidelines, staff education and financial reporting. These activities were also carried out by pharmacists at comparator sites during both study phases. Additionally, comparator sites had pharmacist prescribers and offered a critical care training programme for junior pharmacists, which was not available at the active site.

Categories of drug-related problems that resulted in pharmacist intervention

Pharmacists intervened in a wide range of drug related problems (Figure 1). Examples of these are shown in Table 3. The most common categories of drug related problems at the active site were sub- or supratherapeutic dose resulting in changing doses of medicines, non-conformity to guideline/best practice or contraindication and administration-related problems. Interventions in the category conformity to guidelines/contraindications were mostly related to guideline conformity, a much smaller number addressed contraindications. During phase 2 there was a significant increase in pharmacist interventions related to starting treatment for untreated indications, i.e. the specialist pharmacist identified where an additional treatment for the patient was required, making this the second most common type of intervention during phase 2. There were also significantly more pharmacist interventions to stop medicines that were no longer required (drug without indication) in phase 2 (Figure 1).

Across all three sites the most frequent pharmacist interventions made were changing drug doses and ensuring guideline/best practice conformity). Fewer interventions were made by pharmacists in all hospitals regarding drug interactions, adverse events and supply failures. There was no change in proportions of drug related problems across study phases at comparator 2 ($p>0.05$), the only category that had an apparent change at comparator 1 was non-conformity to best practice guidelines.

The drug classes with the most frequent pharmacist intervention were anti-infectives, cardiac medicines, as well as medicines affecting the central nervous system and the gastrointestinal tract.

Impact of pharmacist interventions on patient safety and optimisation of therapy

The significance of pharmacist interventions to patient care was assessed by grading the impact of optimisation interventions and the severity of potential harm prevented from medication errors (table 4). Examples of interventions and their impact are provided in Table 3.

Across both study phases the majority of pharmacist interventions potentially prevented moderate harm from drug errors or had a moderate impact on optimisation of medicines. Numerically, there was an increase in high impact optimisation and severe error interventions in phase 2 at the active site, although changes did not reach statistical significance. In contrast, at both comparator sites the proportion of severe errors and high impact optimisation interventions was lower in phase 2 ($p<0.001$ for drug errors). Changes in proportions of different grades of optimisation interventions did not reach statistically significance at any study site.

Discussion

The introduction of a specialist critical care pharmacist led to a greater number of pharmacist interventions, and regular pharmacist attendance at the physician-led multidisciplinary ward round.

Strengths and Limitations

The critical care specialist pharmacist at the active site increased pharmacist presence on the ward by approximately 40%, including participation in the physician-led ward round. Previous work in general wards has shown that ward round attendance increases the number of pharmacist interventions compared to a standard clinical pharmacy service[23]. The same was true for our CCU. Leape et al[2] demonstrated a 66% reduction in adverse drug events through the introduction of a specialist critical care pharmacist who also attended consultant ward rounds versus their standard ward pharmacist service .This reduction in adverse drug events shown by Leape et al[2] was mainly achieved through pharmacist interventions on medication errors. The introduction of a specialist pharmacist in our study also led to the detection and prevention of significantly more medication

errors. Our study design did not include patient outcome data to quantify whether this translated into fewer actual adverse drug events but if more errors are intercepted, one might expect less adverse events to follow. Moyen et al[24] report a rate of 10% of medication errors resulting in an adverse drug event. Therefore it can be extrapolated that the increased pharmacist intervention rate after the introduction of the specialist pharmacist at the active site will have improved patient safety by detecting and preventing a greater number of medication errors.

Although in general not all errors lead to adverse drug events, a NICE review[25] reported that treating or managing potentially avoidable adverse drug reactions that occur during inpatient stays may increase the length of stay in hospital by 3 days. As the bed stay costs of intensive care are high, the specialist critical care pharmacist contribution may lead to an improved healthcare cost avoidance and an improvement in the utilisation of the finite number of critical care beds.

In this study it was shown that, in addition to the prevention and detection of medication errors, critical care pharmacists also frequently optimised drug therapy. There was a numerical but not statistical increase in optimisation interventions at the active site. Medication optimisation aims to help patients benefit the most from their medicines, and further studies could focus on this aspect of the critical care pharmacist's role.

A national study that has yet to report has found many UK CCUs are operating with a pharmacy contribution well below the national standards[26], in terms of specialism and time available. Our study throws light on what may be expected by investing in specialist critical care pharmacist provision over and above cover by a generalist with other responsibilities.

Aside from the demonstrated impact on pharmacist intervention rates, critical care pharmacists in this study provided a greater range of additional clinical activities than the generalist pharmacist. It is not intended for these to be the focus of this study but addition roles which were developed medication safety initiatives, expenditure reporting, educational provision, contribution to the local and national pharmacy initiatives and conducting audit and research.

The introduction of a specialist pharmacist increased the number of pharmacist interventions; however this did not appear to change the proportion of high, moderate or low impact interventions.

The majority of both medication error and optimisation interventions were rated as having moderate impact, a finding in line with another multi-centre critical care pharmacy intervention study[11,].

The inherent difficulty in rating impact is that the potential patient outcome without pharmacist intervention can only be estimated, as pharmacist interventions are usually preventative in nature. This applies even more to optimisation interventions.

Another possible explanation may be our observation that pharmacist interventions classified as potentially having the highest impact were not necessarily the most complex interventions but could in fact be simple. An example of this could be identifying that a penicillin allergic patient was prescribed penicillin, or correcting an obvious overdose error. This is within the knowledge and skills of a non-specialist pharmacist. However, the strengths of critical care specialist pharmacists lie in assessing complex patients with complex medication regimens in a specialty with often limited evidence base to support practice[27,28]. It is recognised that a certain level of training and expertise is required in order to fulfil this role to best effect[26]. Therefore, minimum recommended knowledge and skills for Critical Care pharmacists to support training and assessment have been published[29].

Both comparator CCUs offered a junior pharmacist training programme for wider workforce development, while this was only implemented at the active site after the study.

Formal assessment and accreditation of critical care specialist pharmacist practice did not exist in the UK when the study was undertaken, but has since been developed[26].

This study's key limitations are related to the design, which was prospective but pragmatic in nature. It was not possible to control for the influence of acuity of patient groups, experience, grade, speciality and competency of prescribers on pharmacist interventions rates.

Attributing the observed changes to the introduction of the specialist pharmacist is supported by no change in these parameters at the comparator hospitals over the same time period. It is possible that patient cohorts during both study periods differed, which may affect the number and types of pharmacist intervention. We sought to avoid seasonal changes by carrying out the data collection during the same months in consecutive years. None of the hospitals underwent major service changes during our study; however bed occupancy data showed higher patient activity at all study

sites, though the 10% increase at the active site did not reach statistical significance. While higher patient activity may be clinically relevant, it does not explain the disproportionately larger increase (100%) in intervention rate at the active site. Furthermore the increase in patient activity at the comparator sites did not result in a corresponding significant increase in pharmacist intervention rate. This supports the suggestion that the increase in pharmacist intervention rate at the active site is due to the introduction of the critical care pharmacist post.

From our pragmatic study it was not possible to distinguish whether the increase volume of interventions at the active site were due to the introduction of a dedicated pharmacist with increased time allocated to the CCU or to increased critical care specialist knowledge and experience that the individual had, though both may contribute. There is published data showing increased intervention rates when pharmacist responsibility changes from multiple units to a dedicated CCU service[21], as well as data showing an inverse correlation between intervention rate of critical care pharmacists and patients reviewed[22].

Conclusions

In this pragmatic observational study we demonstrated a beneficial effect of increasing specialist pharmacist resource to the Critical Care Unit to a level recommended nationally for critical care service provision[4,23]. Although a randomized controlled trial would ideally be required to confirm our findings, this study supports the international evidence of the positive impact of critical care pharmacists and importantly provides new insights into the additional benefit that can be expected from developing the pharmacy provision from a non-specialist generalist pharmacist with other responsibilities in the hospital to a dedicated CCU specialist pharmacist. The use of multicentre control sites supports the validity of the observed differences and adds to the limited published evidence specific to critical care pharmacy services outside the US.

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Tables

Figures