Clinical pharmacists and inpatient medical care: a systematic review
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CRD summary
This review assessed the effects of intervention by clinical pharmacists on process and care outcomes for hospitalised adults. The authors concluded that clinical pharmacist services generally improved care without any adverse effects. It was difficult to assess the reliability of the review given the incomplete reporting of review methods and that the synthesis did not account for study design or quality.

Authors' objectives
To assess the effects of intervention by clinical pharmacists on process and care outcomes for hospitalised adults.

Searching
MEDLINE and International Pharmaceutical Abstracts were searched for studies published in full in English in peer-reviewed journals (1985 to April 2005); the search terms were reported. The reference lists of identified studies were screened and the authors' personal files were searched.

Study selection
Study designs of evaluations included in the review
Studies with a control or comparison group were eligible for inclusion. The studies could be randomised controlled trials (RCTs), controlled or quasi-experimental studies, pre-test post-test studies, use a historical control or have a crossover design. Observational studies, surveys, reviews and studies that only described the intervention were excluded.

Specific interventions included in the review
Studies that evaluated various clinical pharmacist interventions were eligible for inclusion (full details of eligible interventions were reported in the paper). Studies in ambulatory settings and those in which pharmacy interventions were part of guidelines, protocol or provider education, were excluded. The interventions in the review were classified as: patient care with pharmacist participation on rounds; admission or discharge medication reconciliation; and drug class-specific pharmacist services.

Participants included in the review
Studies of hospitalised adult patients were eligible for inclusion. The included studies were performed in patients in intensive care units (ICUs) and general medical, surgical and psychiatric units.

Outcomes assessed in the review
Studies that assessed the following objective patient-specific health outcomes were eligible for inclusion: mortality; adverse drug events or reactions (ADEs and ADRs, respectively); health service use; measures of process of therapeutic management and professional practice; changes in medication regimen; and other measures such as quality of life, patient satisfaction, adherence to medication and knowledge of medication regimen. Studies that only assessed pharmacoeconomic outcomes were excluded. The included studies used different definitions for ADEs, ADRs and medication errors.

How were decisions on the relevance of primary studies made?
Two reviewers selected studies for inclusion.

Assessment of study quality
The authors did not state that they assessed validity.
**Data extraction**
The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction. Data on the outcomes of interest for each intervention and comparison group, together with the level of statistical significance, were extracted.

**Methods of synthesis**

*How were the studies combined?*

The studies were grouped by type of intervention and individual studies were described. The studies were also grouped by outcome and combined in a narrative.

*How were differences between studies investigated?*

Some differences between the studies were described in the text and differences in outcomes were evident from tables.

**Results of the review**

Thirty-six studies (n=18,553) were included: 22 RCTs (n=5,433), 1 non-randomised controlled study (n=165), 1 quasi-experimental study (n=3,081), 8 pre-test post-test studies (n=9,512), 2 prospective cohort studies (n=216), 1 retrospective study with a control group (n=46) and 1 repeated cross-sectional study (n=100).

Patient care with pharmacist participation on rounds (4 RCTs, 1 non-randomised controlled study, 1 quasi-experimental study and 4 before-and-after studies).

ICUs (2 before-and-after studies): one of the studies found that the intervention was associated with reduced ADEs while the other found fewer ADRs were reported following the intervention, although no difference was shown in patient transfers to the ICU, readmission or hospital length of stay (LOS).

General medicine, surgery and psychiatry (4 RCTs, 1 quasi-controlled trial, 1 non-randomised study and 2 before-and-after studies): one of the studies showed fewer patients were transferred to intensive care and LOS was shorter, whereas another showed no change in readmissions or mortality and increased ADRs; one showed reductions in medication errors, the number of patients without medication errors, and reduced persistence of errors; one showed non significant reductions in LOS and increased pharmacist satisfaction; two showed reduced LOS; one showed reduced preventable ADEs; one showed fewer medications at 3 days but not at 6 weeks or 3 months; one showed an improved clinical response and extrapyramidal symptoms in psychiatric patients but no effect on LOS.

Admission or discharge medication reconciliation (11 RCTs). Admission interventions (2 RCTs): one of the studies showed that pharmacists performed more accurate histories of medication and allergies and increased computer recording, but no difference in drug interactions or ADRs; one showed increased changes in medications by pharmacists, fewer health care visits and non significant reductions in admissions, but no change in LOS, mortality or health status.

Discharge counselling (9 RCTs): one of the studies showed a significantly higher level of adherence to medication; one showed increased correlation between discharge and home medications, increased knowledge of drug name, dosage and frequency but no effect on re-admission rates; one showed no effect on patients’ knowledge or compliance; two related studies showed reduced number of medications, daily doses, missed doses and prescribing problems; one showed an increase in the number of correct critical items recalled by patients; one showed no difference in readmissions, outpatient visits or mortality; one showed improved knowledge, compliance, outpatient visits and readmissions; and one showed fewer preventable ADEs, medication-related emergency admissions and readmissions.

Drug-class specific pharmacist services (15 studies including 7 RCTs).

Inpatient anticoagulant services (1 prospective cohort and 3 before-and-after studies): the studies assessed several different measures of anticoagulant efficacy. One study showed positive effects on four anticoagulant outcomes and no effect on three other anticoagulant outcomes and LOS. One study showed positive effects on four anticoagulant outcomes. One study showed positive effects on five anticoagulant outcomes and no effect for bleeding or thromboembolism rates. One study showed no intervention effect on three anticoagulant outcomes and positive effects.
on one other anticoagulant measure.

Antibiotic treatment and infectious diseases (3 RCTs and 1 before-and-after study): one of the studies showed no effect on mortality, clinical response, antibiotic toxicity or LOS; one showed reduced in-hospital mortality and LOS, but no change in hospital readmissions; one showed reduced days of intravenous therapy, increased readmissions, and no effect of mortality and LOS; and one showed reduced LOS with no effect on mortality.

Therapeutic drug-monitoring services (4 RCTs, 1 prospective cohort study, 1 retrospective study and 1 cross-sectional study): these were associated with reduced febrile periods, and LOS and hastened return to normal vital signs (1 study); non significantly reduced nephrotoxicity (1 study); a reduction in vancomycin-related renal insufficiency (1 study); improvements in peak aminoglycoside concentrations (1 study); improved appropriate aminoglycoside concentrations (1 study); improved pharmacokinetic parameters (1 study); and significant reductions in the number of phenytoin assays performed or not indicated, blood samples drawn incorrectly and seizure-related readmissions (1 study).

Cost information
Four studies of pharmacist participation on rounds reported cost outcomes: one showed a significant reduction in total average care costs and a non significant reduction in drug costs; two found that the intervention reduced hospital and pharmacy costs; and one found no difference in medication costs. Three studies of antibiotic therapy consultation reported costs and all showed antibiotic cost-savings.

Authors’ conclusions
Clinical pharmacist services generally improved care without any adverse effects.

CRD commentary
The review addressed a clear question that was defined in terms of the participants, intervention, outcomes and study design, although the inclusion criteria for study design, intervention and outcomes were broad. The search was not comprehensive and was restricted to English language publications, which raises the possibility of publication and language bias. Methods were used to minimise reviewer errors and bias in the selection of studies, but it was unclear whether similar steps were taken in the data extraction process. Study validity was not assessed, so it is not possible to adequately comment on the reliability of the results presented.

Tables in the review presented major selected outcomes, although the methods used to select the outcomes were not reported. The studies were appropriately grouped by type of intervention, but individual studies were described rather than combined in a narrative. The studies were also grouped by outcome and were combined in a narrative by reporting the number of studies showing positive results for each outcome. In addition, studies assessed multiple outcomes and there was no discussion of how this might have impacted on the significance of the results reported. Furthermore, the synthesis of the evidence took no account of study design or any aspect of study quality. This, in combination with incomplete reporting of review methods, made it difficult to assess the reliability of the results.

Implications of the review for practice and research
Practice: The authors did not state any implications for practice.

Research: The authors stated that further research is required to determine which clinical areas benefit most from clinical pharmacists and which patient-specific characteristics are associated with benefits. Future studies should provide detailed descriptions of the interventions and use validated measures to assess outcomes. The authors also suggested that larger multi-site RCTs should be used to examine the generalisability of the interventions and to assess their value to health care systems.

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