Factors influencing the implementation of clinical pharmacy services on paediatric patient care in hospital settings

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ABSTRACT

Objectives This systematic review (SR) was undertaken to identify and summarise any factors which influence the implementation of paediatric clinical pharmacy service (CPS) from service users' perspectives in hospital settings.

Methods Literature search from EMBASE, MEDLINE, Web of Science (Core Collection), Cochrane Library, Scopus and CINAHL databases were performed in order to identify any relevant peer-reviewed quantitative and qualitative studies from inception until October 2019 by following the inclusion criteria. Boolean search operators were used which consisted of service, patient subgroup and attribute domains. Studies were screened independently and included studies were quality assessed using Mixed Methods Appraisal Tool. The study was reported against the 'Enhancing Transparency in Reporting the Synthesis of Qualitative Research' statement.

Results 4199 citations were screened by title and abstract and 6 of 32 full publications screened were included. There were two studies that were graded as 'high' in quality, with four graded as 'moderate'. The analysis has led to the identification of seven factors categorised in five predetermined overarching themes. These were: other healthcare professionals' attitudes and acceptance; availability of clinical pharmacist on ward or outpatient settings; using drug-related knowledge to perform clinical activities; resources for service provision and coverage; involvement in a multidisciplinary team; training in the highly specialised areas and development of communication skills.

Conclusion Evidence for paediatric CPS was sparse in comparison to a similar SR conducted in the adult population. An extensive knowledge gap within this area of practice has therefore been identified. Nevertheless, majority of the factors identified were viewed as facilitators which enabled a successful implementation of CPS in paediatrics. Further research is needed to identify more factors and exploration of these would be necessary in order to provide a strong foundation for strategic planning for paediatric CPS implementation and development.

INTRODUCTION

Special attention needs to be paid in optimising medicines use in children as they are at high risk of harm as the result of medication errors, since such errors are potentially more hazardous to them than to adults.[1–3] In 2014, the American Academy of Paediatrics has reported that paediatric medication orders resulted in a medication error with rates as high as 5%–27% in their systematic review.[4] Factors that contribute to paediatric medication errors include the manipulation of formulations, calculation according to children's weight or body surface area, the change in pharmacokinetics and off-label use of drugs with no standardised dosing.[5 6]

A joint opinion of the Paediatric Pharmacy Advocacy Group and the Paediatrics Practice and Research Network has advocated the need for clinical pharmacy services (CPSs) in the paediatric population.[7] Evidence on benefits of CPS were shown in literature across the wide array of clinical settings;[8–10] however, most studies were conducted in a controlled setting. When the evidence is translated into the 'real world' situation, the results might not always be the same.[11] The difference may arise from the context of the interventions, which plays a key role in the uptake and sustainability of what are being tested.[11] For instance, a recent systematic review has evaluated the benefits of CPSs in paediatrics in comparison with adult patients in hospital settings.[12] The authors concluded that clinical pharmacist (CP) in paediatric wards may improve patient outcomes but have also highlighted that there are barriers to the involvement of pharmacists.[12] How these barriers affect the involvement of CPS was beyond the scope of their review and hence were not elaborated; however, the context of implementation plays a critical role because it includes various factors that could influence the process of the service, thus affecting the results of service outcome.[13] Therefore, by identifying these factors that enable or hinder the implementation of CPS, solutions to overcome process barriers can be developed and the introduction of innovations in healthcare system can be promoted on a larger scale.[14]

Currently, there is no known systematic review that has examined the factors that influence the implementation of paediatric CPS in the hospital settings. The aim of this systematic review was to identify factors that influence paediatric hospital CPS implementation from service users' perspectives, which include healthcare professionals, children, parents or caregivers who had received any type of services provided by CPs. The objectives of this review were to identify:

- any facilitators that enable or
- any barriers that hinder a successful implementation of paediatric CPS in hospital setting.

METHODS

Search strategy

The identifying and screening process were reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

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Table 1 Search strategies for MEDLINE and other selected databases

	Service domain	Patient subgroup domain	Attribute domain
MeSH terms	► Pharmaceutical Services ► Pharmacist ► Pharmacy Services, Hospital	► Adolescent ► Child ► Infant ► Paediatrics	► Attitude ► Attitude of Health Personnel
Text words	► Exp clinical pharmac*/ ► Exp hospital pharmac*/	► Exp adolescent*/ ► Exp child*/ ► Exp infant*/ ► Exp p$ediatric*/	► Exp attitude*/ ► Exp belief*/ ► Exp experience*/ ► Exp opinion*/ ► Exp satisfaction*/

flow diagram.[15] EMBASE, MEDLINE, Web of Science (Core Collection), Cochrane Library, Scopus and Cumulative Index to Nursing and Allied Health Literature (CINAHL) were searched for studies published from inception up until October 2019. Search strategy consisted of domains of service involved, patient subgroup and attributes, with the use of Boolean logic to combine the search (see online supplemental appendix 1). Table 1 outlines the search strategies. The searched results were exported to EndNote Web (Clarivate Analytics, USA) to facilitate screening with duplications identified and removed.

Study selection

Inclusion criteria were peer-reviewed quantitative and qualitative studies on CPSs with the participants, interventions and outcomes addressed below. Only English-language publications or articles in other languages with full English translation were included in this review. Any studies not meeting the following inclusion criteria were excluded in this review.

I. Participants: Hospitalised children from 0 to 18 years of age. When both adults and children participants were recruited in a study, only data that explicitly referred to the paediatric population were included.
II. Interventions: Any CPs' interventions, activities or duties.
III. Outcome measures: Direct or indirect findings which report factors that influence the implementation of paediatric CPS.

Data collection

A list was created for all identified studies from all the databases searched. Citation search for included articles was performed. CS and DD assessed the titles of the studies, and if the title seemed relevant to the objective of this review, the abstract was retrieved. CS and DD independently assessed these abstracts to evaluate their potential eligibility. The full-text of all articles identified as potentially inclusive studies by both researchers were retrieved. These studies were then assessed independently by CD and DD based on the inclusion criteria, with CH checked against the selected full-text articles for relevancy and appropriateness. IM oversaw the data analysis process and acted as an impartial evaluator for making consensus decisions in disagreements that arose. Finally, all four reviewers were met and key concepts emerged from data analysis were discussed.

A standardised form (Microsoft Excel 2010, Microsoft, USA) was used to extract data from the included studies for quality assessment and evidence syntheses. Table 2 outlines the categories from the data extracted.

Table 2 Data extraction categories

General information	Methodologies	Study findings
1. Main author 2. Year published 3. Study location 4. Study objective(s)	5. Study design 6. Nature of study 7. Study population 8. Recruitment method 9. Inclusion/exclusion criteria 10. Data collection 11. Data analysis	12. Study results or any relevant findings

Data analysis and synthesis

The Enhancing Transparency in Reporting the Synthesis of Qualitative Research (ENTREQ) checklist was followed on the reporting of the synthesis.[16] An integrated convergent synthesis approach, as adopted from Jennings *et al*, was performed in this systematic review.[17] Rather than segregating the qualitative and quantitative synthesis, the findings were assimilated to each other during the same phase of the process in a parallel manner. Once transformed and merged, all data were subject to thematic synthesis using the steps described by Braun and Clarke.[18] The software package QSR NVivo v11 (QSR International, Australia) was used to facilitate data analysis and synthesis.

Quality assessment

CS and DD independently assessed the study quality of included studies using the Mixed Methods Appraisal Tool (MMAT).[19] The quality rating approach was adopted from Wranik *et al*, with studies ranked from 0 to 5 points based on meeting the five-item MMAT criteria.[20] Studies scoring between 0–2 points were rated as low, 3–4 points as moderate and 5 points as high in terms of quality. CS, DD and CH discussed and agreed on the final quality rating for each study.

This systematic review was registered with PROSPERO database (registration number: CRD42019137123).

RESULTS

Search results and characteristics

A total of 4199 citations were identified from the initial literature search and 32 full-texts articles were assessed for eligibility. At the end of the selection process, six studies were included. Figure 1 describes the steps involved for the selection process.

Of the six included studies, two were qualitative, three were quantitative and one was mixed methods. The study characteristics of the included studies are listed in table 3 (see online supplemental appendix 2 for full version).

Quality appraisal

There were two studies that were graded as 'high' in quality,[21 22] with four graded as 'moderate'.[23–26] Common areas of weakness were lack of sample representativeness of the target population,[23] questionnaires were not tested nor piloted for validity or reliability[24] and lack of clarity on minimising biases such as socially desirable and nonresponse bias (see online supplemental appendix 3 for full appraisal).[23 26]

A framework approach was employed with themes derived from studies which have analysed indicators that address implementation quality in healthcare services.[27] These indicators have been successfully adopted into pharmacy settings by Garcia-Cardenas *et al*.[28] Table 4 shows these adopted themes with their definitions for the purpose of results reporting in this systematic review.

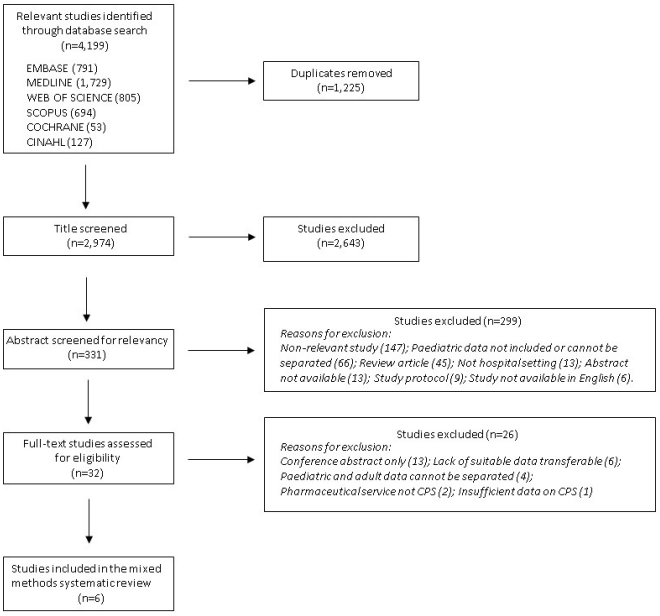

Figure 1 Flowchart of study selection process adapted from PRISMA. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

The analysis led to the identification of seven implementation factors which fell within five of the predetermined overarching themes. Figure 2 shows a thematic map presenting the themes and implementation factors identified from the included studies.

Acceptability of clinical pharmacist

Other healthcare professionals' attitudes and acceptance

There was generally a positive attitude towards the role of CP from both physicians and nurses.[22 24–26] Our data have showed that healthcare professionals' attitudes were found to be a prominent facilitator which interrelated to other implementation factors such as penetration into the institution and CP's self-efficacy:

> … junior doctors valued pharmacists' information… the strength of medications, the amounts per bottle or box, their possible adverse effects, and their paediatric application when doctors had mostly prescribed for adults.[22]

> Physician and nurses in our study considered medication preparation by hospital pharmacy staff and involvement of clinical pharmacists at the NICU as potential benefit…[21]

However, some physicians felt the involvement of CP might affect their prescribing which would in effect pose as a barrier to CPS implementation, as illustrated by the quote below:

> …study also reported some perception of loss of physician autonomy, interference in decision making, and even a feeling of being threatened by ASP (Antimicrobial Stewardship Programme) interventions.[24]

Feasibility of the clinical pharmacy service model in the setting

Availability of clinical pharmacist on ward and outpatient settings

The availability of CPs was found to be a strong facilitator which enables CPS implementation.[21 22 26] Studies described the benefits which physicians and nurses perceived when CPs were readily available to perform their duties:

> The proximity of the pharmacist to the department (Emergency Department) allows for direct consultation and medication review by the pharmacist.[26]

Using drug-related knowledge to perform clinical activities

Another subtheme that has submerged was that CPs can exert their expert knowledge in paediatric pharmacotherapy when performing activities which were more relevant to their roles.[23 26] Evidence suggested that with CP performing drug-related activities, other healthcare professionals could redirect their energies into performing other clinical activities.[26] Furthermore, with CP performing these activities, it was found that healthcare professionals' felt more confident in improving patient outcomes, such as medication safety:

> It is nice that you can just go out and pick it up without having to worry about looking for someone to perform double check… I also think that it is safer that way.[21]

Implementation costs of CPS

Resources for service provision and coverage

We found that the scarcity in financial resource was a barrier to CPS implementation, which has a subsequent negative effect on other factors such as the availability of CPs and training provided for them.[21–23] The lack of resources was reflected by the constraint in manpower or time that CPs face:

> Pharmacists' capacity for daily review of case notes was inhibited by the large volume of discharge interviews, admission reconciliation and discharge dispensing.[22]

Despite the limitation in resources, we found that the service users' expectation of CPS remained high, and this has caused enormous pressure on CPs who provided these services.[22]

Penetration into the institution

Involvement in a multidisciplinary team

The collaboration between CPs and other healthcare professionals was found to be a factor that facilitates the integration of CPS.[22 24–26] The level of collaboration was reflected by the philosophy of teamwork, which plays a key role in influencing a successful implementation.[22] The integration of hospital pharmacist into the multidisciplinary team was found to be highly desirable by healthcare professionals, especially in managing chronic illnesses.[23 25] Moreover, the recognition of multidisciplinary approach created an opportunity to implement new services, which is also interrelated to the availability of CPs:

> Many young people with chronic illnesses such as arthritis are seen in hospital outpatient rather than inpatient wards. The pharmacist is not traditionally involved in these clinics beyond the dispensing task, but there was openness to include them.[25]

Clinical pharmacist's self-efficacy

Training in the highly specialised areas

One of the core skill identified which was fundamental to the service implementation was the expert knowledge of pharmacotherapy that CPs possess for this specific population. Examples from the literature have showed the need of skill development in areas such as neonatology and managing children with chronic illnesses.[21 25] Appropriate training was perceived as a necessity from service users prior to service implementation:

> However, clinical pharmacists are currently not involved in general in the medication treatment at the Danish NICUs and should

Table 3 Characteristics of the included studies (n=6) for the systematic review

Reference	Main author	Year of publication	Country	Site information	Study design	Participants	Study objectives	Data analysis	CPS involved	Quality rating
23	Chen	2013	Singapore	A 830 bed hospital that provides specialised paediatric and women's healthcare services	Quantitative (survey)	Caregivers who accompanied epileptic patients on neurology follow-up visits	To evaluate the utility of tailored educational pharmacist counselling in improving knowledge and self-reported confidence in patient care by caregivers of children with epilepsy.	Descriptive statistics	Medication counselling	4 (Moderate)
24	Flannery	2014	USA	A 180-bed tertiary care academic paediatric hospital	Quantitative (survey)	Physicians including paediatric fellows and advanced practice nurses	To assess prescribers attitudes about the Antibiotic Stewardship Programme, aimed to identify perceived strengths and weaknesses of the service, with the ultimate goal of maximising its effect on future prescribing behaviours.	Descriptive statistics	Antibiotic Stewardship Programme	4 (Moderate)
25	Grey	2017	UK	Nationwide	Mixed methods (focus groups, semistructured interviews and survey)	two pharmacy policy makers, three service commissioners, two pharmacy staff, five rheumatology professionals and three lay advocates	There were three phases of the study. The objective of the stakeholder interviews (phase 2) was to share ideas of practicing pharmacists about their current and future roles in the support of young people who take medication for chronic illness with stakeholders to devise a list of roles for prioritisation.	A 'middle-ordered' thematic approach	Pharmaceutical care	4 (Moderate)
26	Moadebi	2013	Canada	Lions Gate Hospital, a 335-bed acute care community teaching hospital	Quantitative (survey)	All nurses working in the site's Emergency Department	To measure the impact of the interprofessional collaboration and educational sessions conducted by the clinical pharmacist on ED nurses' level of comfort and satisfaction with intranasal fentanyl for children.	Descriptive statistics	Education sessions	3 (Moderate)
21	Rishoej	2018	Denmark	Three largest tertiary NICUs	Qualitative (focus groups)	Physicians and nurses who practiced at NICUs	To explore current and potential future practices to prevent medication errors experienced by physicians and nurses.	Qualitative content analysis	Clinical pharmacy services	5 (High)
22	Rosenfeld	2018	Australia	A major Australian paediatric teaching hospital	Qualitative (ethnographic study, focus groups and semistructured interviews)	Pharmacists, registered nurses and doctors from diverse clinical wards	To examine interdisciplinary medication decision making by pharmacists in paediatric hospital settings.	Thematic analysis according to the 'framework' approach	Ward service, medication decision making	5 (High)

Table 4 Themes used for this systematic review

Overarching themes	Operational definition
Acceptability	The perception among implementation stakeholders that CPS is agreeable, palatable or satisfactory.
Appropriateness	The extent to which CPS is suitable, fitting or proper for the hospital.
Feasibility	The extent to which CPS can be successfully used or carried out within the hospital.
Fidelity	The degree to which CPS is implemented and provided as it was described.
Implementation costs	Cost impact of CPS implementation effort.
Penetration	Level of integration of CPS within the hospital and its subsystems.
Service Implementation Efficiency (self-efficacy)	The degree to which clinical pharmacist improves his/her skills and abilities to provide it

CPS, clinical pharmacy service.

> receive training before involvement, as these units are highly specialised.[21]

The attainment of the required knowledge in these specialised areas facilitates the acceptability of CPS, and the following quote illustrate how these factors were interrelated:

> Pharmacists were viewed by staff as primary authorities about medication issues, particularly in making complex (medication) decisions…[22]

Development of communication skills

Evidence showed that good communication between CP and nurses helped to develop a strong relationship, thus enabling the use of the service;[22] however, similar findings cannot be identified between physicians and CPs. CPs were often found to work as a bridge between doctors and nurses for resolving pharmaceutical issues:

> Communication informing medication decisions were principally dyadic… The ease with which nurses communicated with ward pharmacists and junior doctors, however, seemed more a matter of propinquity than hierarchy…[22]

Our review has also revealed that pharmacist's face-to-face interaction with parents or caregivers has increased their confidence in managing children's conditions.[23] This experience extended to adolescents who seek help from pharmacists directly, as data suggested adolescents were more likely than other age groups to consider pharmacist a trustworthy source of information, thus showing how communication enables CPS implementation from their point of view.[25]

DISCUSSION

With only six studies included in this review, the lack of research in this area seemed apparent. Heterogeneity of the service provided was shown across the inclusive studies. The difference in the characters of each service might have variable factors which influence the implementation. However, due to the limited evidence available, analysis of individual service was not possible; as a result, the data were analysed collectively as a whole.

The year of publications for the included studies suggested a recent growth of interest in this area, which is comparable with a recent systematic review in the adult setting.[29] The majority of publications were countries with relatively high health expenditure,[30] reflecting the gap exposed in research in countries with lower health expenditure in this area.

Healthcare professionals' attitude can be a facilitator for the implementation of paediatric CPS. Its value in CPS implementation was supported by research which advocated that positive attitudes between healthcare professionals nurtured teamwork and trust, which improves the quality and safety of patient care as a result.[31] Unfortunately, we were unable to identify factors which demonstrate how patients, parents or caregivers' attitudes

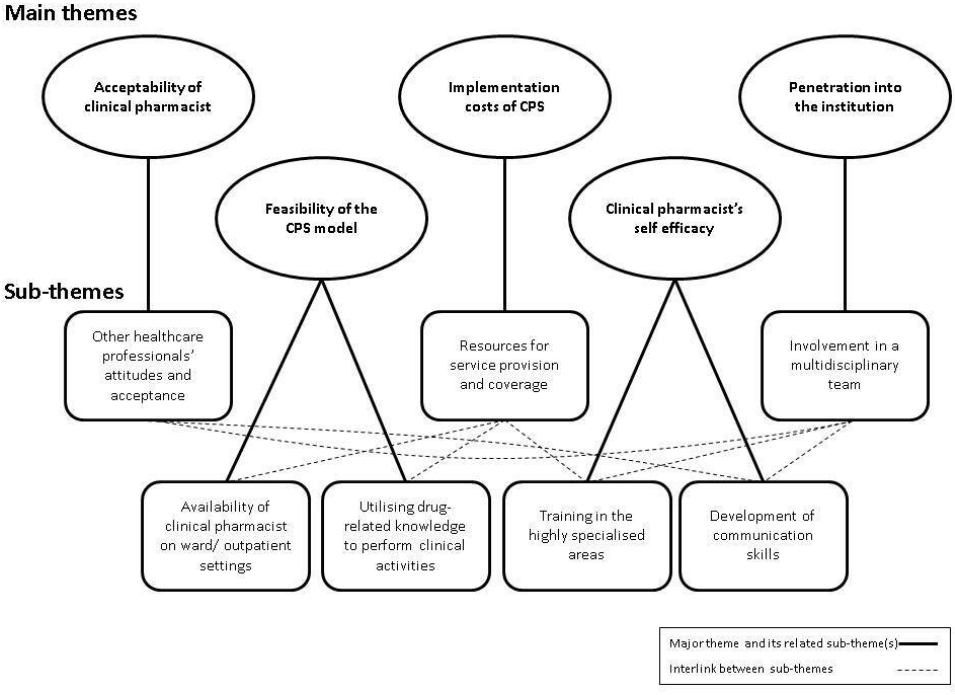

Figure 2 Thematic map showing the factors which influence the implementation of paediatric CPS in hospitals. The overarching themes were adopted from Garcia-Cardenas *et al*, with their subsequent subthemes derived from the data collected using thematic analysis. The broken lines illustrate the interrelationship between the subthemes identified from the analysis. CPS, clinical pharmacy service.

affect the implementation of CPS. Effort should be made in exploring how this can influence implementation, as evidence were apparent in other healthcare settings.[32–34]

Studies have shown that the hierarchical structure within healthcare discourages interprofessional communication and collaboration.[35] Our findings suggested that CPs can help to mitigate this barrier, especially when they were available in real time situations such as ward round or impromptu conversations, acting as a bridge between physicians and nurses to solve any pharmaceutical-related issues.[22 25] The benefits of having CPs available in the outpatient settings were also observed from patients' perspectives.[36] The benefits of such implementation were that long-term relationships could be developed which leads pharmacists to make individualistic, personalised interventions.[36] Our data suggested that similar perception was found in paediatric CPS.

The employment of CPs' expertise in performing clinical duties helped other healthcare professionals to focus on their non-drug-related duties, and the belief of improved quality of patient care was also observed. This appealing factor could lead to successful implementation of CPs, but study found that this was highly variable which depends on individual's perception and experience towards CPS.[37]

Studies have pointed out that a multidisciplinary team supports high-quality care, patient and staff engagement and organisational efficiency.[38] The impact of the involvement of CP in multidisciplinary team on patient outcomes was evidential.[39 40] This was found to be a strong implementation facilitator and its importance was reflected by the principle of the 'medication optimisation' paradigm endorsed by National Institute for Health and Care Excellence (NICE).[41]

The lack of resources was found to be a barrier to implement paediatric CPS. Shortages of CPs prevent proper collaboration such that understaffed pharmacists were overloaded with responsibilities, thus affecting the quality of CPS.[42] Previous studies have found that the initiation of CPS by healthcare bodies or government was a facilitator to implementation.[27] However, we did not find any governmental or institutional policies in place to provide funding to advocate the implementation of paediatric CPS within the included studies. The support could be hindered by the scarce human and technological resources, pressure on cost containment as well as the lack of a motivational professional and career pathway development.[43] Research into the impact of CPS on patient outcomes and health economic data could perhaps help to ascertain its value.

In an economic evaluation of CPS in USA, training was found to be an important factor within the CPS structure which renders a cost-effective pharmacy programme.[44] Apparently, strategies such as clinical training for pharmacists could help to enhance the pharmacists' confidence and motivation to implement CPS in hospitals;[29] however, this was hindered with the fiscal restraint as shown from the included studies.

Researchers showed that the identification of implementation factors is one of the most important strategies to implement change.[45] Although our review has identified number of factors which could influence paediatric CPS implementation, a large knowledge gap in this area was also identified. Researchers should therefore focus on conducting implementation studies to allow policy makers to appreciate the multifactorial considerations for paediatric CPS implementation in hospitals.

This is a first systematic review to identify the factors which influence the implementation of paediatric CPS in hospital settings. We have used robust and recognised methods to integrate qualitative and quantitative data, and reported the synthesis against the ENTREQ. Nevertheless, there are limitations to this review. First, some studies included both paediatric and adult patients in their study design and we were not able to separate the data; therefore, these studies had to be excluded. Second, the limited number of studies and majority of studies being single-site limited their transferability and generalisability to other healthcare systems. Third, since grey literature was not considered, it is not clear how this can influence the review. Last, since there was no consensus on the literature to exclude studies based on quality assessment, the majority of included studies were moderate in quality; therefore, study designs which produce high quality evidence is warranted.

CONCLUSION

This systematic review has found six studies, with seven factors identified which either facilitate or hinder the implementation of paediatric CPS in hospitals. These factors were: healthcare professionals' attitude and acceptance; the availability of CP; resources for service provision; involvement in a multidisciplinary team; using expert knowledge to perform drug-related activities; training in the specialised areas and the development of communication skills. There was very little research on how to implement paediatric CPS in hospitals and an extensive knowledge gap within this area has been identified. Nevertheless, this review has lent insight into some factors which influence the implementation of paediatric CPS in hospital settings. Due to the heterogeneity of different CPS activities provided in the included studies, further research should focus on identifying the factors that influence each individual service. Further research should also focus on how the characteristics of the individual CP affect implementation. With the enriched content available, analysis can be performed to highlight the factors which affect the implementation of each CPS activity, thus providing a strong foundation for strategic planning for paediatrics CPS implementation and development including the required personal training and development.

Contributors CM-HS wrote the manuscript. CM-HS and DD conducted the study selection process and CH reviewed for the appropriateness of the included studies. CM-HS, DD and CH participated in the critical appraisal process. IDM and CH supervised the project and contributed to the final version of the manuscript.

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Appendix 1

SEARCH STRATEGY

MEDLINE & Cochrane Library

(Pharmaceutical Services) OR (Pharmacists) OR (Pharmacy Service, Hospital)

AND

(Adolescent) OR (Child) OR (Infant) OR (Pediatrics)

AND

(Attitude) OR ("Attitude of Health Personnel")

EMBASE, CINAHL, Web of Science (Core Collection) & Scopus

(exp clinical pharmac*/) OR OR (exp hospital pharmac*/)

AND

(exp adolescent*/) OR (exp child*/) OR (exp infant*/) OR (exp p$ediatric*/)

AND

(exp attitude*/) OR (exp belief*/) OR (exp experience*/) OR (exp opinion*/) OR (exp satisfaction*/)

Reference ID	Main Author	Year	Study location	Aim	Study design	Methods	Site information	Study population	Recruitment method
21	Chen C (Department of Pharmacy, Kandang Kerbau Women's and Children's Hospital)	2013	Singapore	To evaluate the utility of tailored educational pharmacist counselling in improving knowledge and self-reported confidence in patient care by caregivers of children with epilepsy	Pharmacists worked with neurologists to individualise counselling for patients, using the handbook and hardcopy presentation slides during counselling. Pharmacists arranged follow-up sessions over the telephone 2 weeks after the counselling session, discussing the frequency and changes in characteristics of seizures and enquiring on the compliance with therapy and presence of side effects. Caregivers were provided with a self-administered questionnaire pre- and post-counselling session, with another questionnaire administered over the telephone.	Quantitative	An 830 bed hospital that provides specialised paediatric and women's healthcare services.	Caregivers who accompanied epileptic patients on neurology follow-up visits. (n=27)	Not specified.
22	Flannery DD (Alfred I du Pont Hospital for Children)	2014	USA	To assess prescribers attitudes about the Antibiotic Stewardship Programme, aimed to identify perceived strengths and weaknesses of the service, with the ultimate goal of maximising its effect on future prescribing.	A 10-question survey questionnaire was designed by a paediatric resident, 2 ID attending physicians and the ID pharmacist using Survey Monkey.	Quantitative	A 180-bed tertiary care academic paediatric hospital	93/153 (61%) of respondents participated: 67% (48/72) of resident physicians, 91% (10/11) of hospitalists, 41% (9/22) of PEM attending. 38% (8/21) of paediatric fellows and 67% (18/27) of APN/PAs.	Not specified.
23	Gray NJ (Green Line Consulting Limited)	2017	UK	There were 3 phases of the study. The objective of the stakeholder interviews (phase 2) was to share ideas of practicing pharmacists about their current and future roles in the support of young people (10-24yrs) who take medication for chronic illness with stakeholders to devise a list of roles for prioritization.	The first 2 phases – pharmacists FGs and stakeholder telephone interviews, reflecting the dearth of literature in this area and the need to capture and record ideas about current and future roles. The final phase –multidisciplinary discussion groups was quantitative, encouraging pharmacists and rheumatology professionals to discriminate between ideas and to priortise roles to be developed or enhanced.	Mixed-methods (triangulation)	Nationwide	2 pharmacy policy makers, 3 service commissioners, 2 pharmacy staff, 5 rheumatology professionals and 3 lay advocates	Stakeholders for interviews were generated by advisory group members and the project team.

Ref	*Inclusion/ exclusion criteria*	*Data collection*	*Analysis*	*Study findings*
21	Patients were aged below 18 years and must have been seeing a neurologist at the institution. They could have been either newly diagnosed or have existing epilepsy. These patients were either commencing treatment with a new AED, changing an AED or were non-compliant to AEDs. They were excluded if they were not contactable by telephone on 3 separate occasions for 2 weeks post counselling.	3 sets of questionnaires (Set A-C) were used with set A & C being knowledge-based. Both questionnaires were the same administered randomly pre and post counselling. Set B was the perception questionnaire. It was adapted from the validated instrument developed by Larson et al. For set A&C, scoring followed by negative grading system. Set B, "excellent" ratings were assigned 5 points, followed by "very good", "good", "satisfactory" and "poor".	The confidence scores before and after counselling and after telephone follow-up were compared using Wilcoxon signed ranks test. Statistical significance was defined as $p<0.05$.	The mean caregiver knowledge score for set C was significantly higher than that of set A (14.7±4.6 v 10.4±3.4, $p<0.05$). The confidence of caregivers in administering the AEDs improved after counselling (from 3.60 to 3.94). In regards to the patient satisfaction survey, scores between four and five suggested that the caregivers felt that that particular aspect of service was either very good or excellent. The caregivers were most satisfied with knowledge that the pharmacist displayed during the counseling and the courtesy shown to the caregivers (average score = 4.70 out of 5). This may reflect that the training of the pharmacists is adequate. Study results also suggested that the caregivers may not be satisfied with the time allocated for each counseling session (average score = 4.44). As the nature of the question on the original instrument was not specific to the appropriateness of the duration of the session, more detailed questioning may be needed to elicit such information.
22	Participants were selected based on frequency of prescribing antimicrobial medications, which included residents, paediatric fellows and PEM attending physicians. Certain inpatient advanced practitioner nurses and physician assistants were also invited.	Survey was sent to participants using institutional email addresses. A reminder email was sent out 2 weeks after the original email.	The data obtained by Survey Monkey were analysed in Stata v11. Descriptive analyses were performed, and statistical tests utilised included the Kruskal-Wallis test and Mann Whitney U test. A P value of 0.05 was used as representative of statistical significance.	The effectiveness of an ASP relies heavily on behaviour change by prescribing clinicians. This study found that interventions such as real-time feedback and other educational interventions were well received. Respondents reported positive experiences with specific aspects of the ASP, including prospective audit and real-time feedback, required pre-authorisation and indication for Rx of antimicrobials, CPOE order sets and ID pharmacist.
23	Participation at a senior level in a pharmacy or rheumatology organisation.	Stakeholders were sent a briefing note prior to the telephone interview. It combined “Arthriting” blog quotes, innovative pharmacist case studies, and an interim analysis of phase 1 FGs (with pharmacists).	A framework approach was used for telephone interview analysis. Each respondent had chosen his priority pharmacy roles. The responses were summarised by one of the interviewers and were independently reviewed by the project manager. Consistency within and between phases was monitored to assess the trustworthiness of the findings.	The development of generic healthcare skills among young people was a strong theme across the phases, reflected by rheumatologist. Many young people with chronic illnesses are seen in hospital outpatient clinics rather than inpatient wards; pharmacists are not traditionally involved in these clinics but there was openness to include them. Other rheumatologists described innovation with pharmacists. One centre had a pharmacist prescribing methotrexate in clinic. Another team had a dedicated pharmacist attached to their group, who answered the team’s queries but did not attend clinic.

Reference ID	*Main Author*	*Year*	*Study location*	*Aim*	*Study design*	*Methods*	*Site information*	*Study population*	*Recruitment method*
24	Moadebi SM (University of British Columbia)	2013	Canada	To measure the impact of the interprofessional collaboration and educational sessions conducted by the clinical pharmacist on ED nurses' level of comfort and satisfaction with intranasal fentanyl for children.	A protocol for administering intranasal fentanyl for children age 1–15 years with acute pain was introduced to the ED Nursing staff by an educational session conducted by a clinical pharmacist. Nurses' level of satisfaction and comfort was surveyed prior to and following IPE. Compliance with patient monitoring was determined by chart review .	Multi-methods	Lions Gate Hospital, a 335-bed acute care community teaching hospital. Paediatric visits contribute to approximately 20% of all visits.	All nurses working in the site's ED. The ED Clinical Nurse Educator assigned staff nurses to attend the education classes who were employed full time at our 24 acute bed and minor care ED. A total of 71 nurses were included in the study. The majority of the nurses who responded to the practice assessment had over 5 years of nursing experience.	Not specified.
25	Rishoej RM (Department of Public Health, University of Southern Denmark)	2018	Denmark	To explore current and potential future practices to prevent medication errors experienced by physicians and nurses.	2 FGs, one including physicians and one including nurses were conducted at each NICU (total: 6 FGs). A min of 3 participants to a max of 6 per FG.	Qualitative	3 largest tertiary NICUs. All units were involved in the complex treatment of extremely premature neonates and other newborns with severe complications.	3 nurses FGs with 3, 3 and 6 participants; 3 physicians FGs with 3,4 and 4 participants.	Local project managers emailed information about the study prior to FGs.
26	Rosenfeld MPH (University of Melbourne)	2018	Australia	To examine interdisciplinary medication decision making by pharmacists in paediatric hospital settings.	An ethnographic design comprising observation, SSIs and FGs.	Qualitative	A major Australian paediatric teaching hospital.	Pharmacists, registered nurses and doctors from diverse clinical wards.	Not specified.

Ref	*Inclusion/ exclusion criteria*	*Data collection*	*Analysis*	*Study findings*
24	The sample group included all Emergency Department staff nurses who completed the educational session.	Participants were recruited in a formal educational presentation by clinical pharmacist. Nurses' experience with intranasal fentanyl was assessed by questionnaire before the educational presentation. Those nurses identified with past experience were asked to rate their satisfaction or comfort level with a five-point Likert scale. An online survey using Survey Monkey was administered post educational intervention to evaluate satisfaction and comfort with administrating intranasal fentanyl. Content validity was established by the expert judging panel (two pharmacists and one nurse) reviewing each survey question as essential items measuring skill or knowledge. Item clarity was assessed in pilot testing and minor changes to wording were addressed.	Statistics on the Likert scale questionnaire items were computed, including means, standard deviations (SDs) and significance values ($p < 0.05$). The significant differences in comfort level between intranasal fentanyl and intravenous morphine in the nursing group based on practice were assessed using a paired student t-test. Confidence intervals were calculated using the GraphPadQuickCalcs. The level of significance was set at $p < 0.05$. The Cronbach's alpha coefficient calculated by Excel setting the benchmark alpha level <0.70.	Nurses reported a high level of understanding of medication dose and monitoring schedule (4.15 ± 0.89; 3.8–4.5) and side effects (3.98 ± 0.90; 3.6–4.2). Most nurses felt very comfortable with intranasal fentanyl administration but there was increased comfort with intravenous morphine (83% versus 98%, $p < 0.05$). Nurses rated high level of satisfaction the written medication handout (80%). This educational intervention was provided by the team of nurse educator and hospital clinical pharmacist to improve nurse practice acceptance with the launch of intranasal fentanyl. The proximity of the pharmacist to the department allows for direct consultation and medication review by the pharmacist. Furthermore, the pharmacist's participation in educational in-services two days per week has helped to alleviate the nurse educator workload allowing more time to implement new educational programs in the ED. Authors expected the availability of a clinical pharmacist in the department would decrease barriers for using intranasal fentanyl.
25	NICU physicians and nurses were eligible to participant if they had at least 1 month of work experience at the NICU and provided direct patient care.	During each FG, participants were asked to express their attitudes towards discussing prevention of MEs. Next, a poster was presented to the participants (with factors influencing ME identified through literature search) and was asked: i) how do you current prevent ME from occurring? ii) how can we become better at preventing MEs?	Using content analysis. 3 coders were involved. 2 coders predefined categories and colour-codes to be used. They met after finalising the analyses and evaluated the identified categories in each transcript. A third coder reviewed the final analyses and discusses possible additions of categories. Feedback on the findings was provided by 3 local project managers.	One theme emerged from the FGs was hospital pharmacy services. Nurses generally considered iv antibiotics prepared by the pharmacy safer than medication preparation conducted by nurses and felt that it decreased nurses' workload and interruptions. However, nurses in one group expressed that they did not feel safe trusting unknown pharmacy staff to prepare medication; furthermore, limited opening hours of pharmacy service raised a concern, as 24-hour service was considered necessary. Physicians in one group considered clinical pharmacists effective at improving medication safety. A clinical pharmacist had previously conducted medication reviews and reviewed medication safety procedures but the service was not implemented. Physicians suggested reinvesting in a clinical pharmacist to strengthen medication safety in the future.
26	Inclusion criteria for the sample involved pharmacists, nurses and doctors who were recruited from diverse wards including. Children cared for by these health professionals therefore had a diverse range of conditions in relation to these various ward settings. Exclusion criteria included nurses who had only completed a one-year course and therefore had no medication responsibilities, and health professionals who were not employees of the hospital.	The study was conducted from March 2014 to February 2016. Participants were recruited following the conduct of information sessions with the pharmacy department and ward managers. Thehealth professionals recruited for the study worked together with other health professionals situated in the same ward. However, health professionals were recruited as individuals.	Data were thematically analyzed according to the 'framework' approach. Through social action, the experiences of individuals are examined and interpreted in terms of the demands, constraints and enablers affecting health care practice. Transcription was undertaken by the researchers who conducted observations. Field notes were consulted for context. Data were repeatedly scrutinisedin an iterative process to identify major themes. Resultswere reviewed by three researchers for concordance. FGs of nurses and pharmacists were then conducted to gain feedback on the themes obtained, to enable further refinement of themes, and to verify that no important information had been omitted.	Three interdisciplinary medication decision themes were identified. These themes were: pharmacists' role in interdisciplinary complex medication decisions; factors facilitating pharmacists' involvement with other health professionals in medication decisions; and challenges impeding pharmacists' ability to make medication decisions. Pharmacists were integral to medication decision making, which included complex medication decision making, involving off-label prescribing, clarifying administration issues when protocols were absent or ambiguous, mediating administration conundrums between patient safety and inflexible protocol adherence, and maintaining heightened vigilance when patients received multiple medications. Facilitators in decision making comprised strong relationships among pharmacists,doctors and nurses, thereby enabling communication, and having a culture that supported open disclosure of medication errors. Challenges in decision making related to the lack of availability of pharmacists in the emergency department, limited after-hours pharmacy staff, and competing responsibilities for the conduct of discharge interviews and dispensing, with case note review.

Qualitative studies

Main author	Clear research questions?	Data allow to address the research questions?	Approach appropriate to answer the research question?	Comments	Data collection methods adequate to address the research question?	Comments	Are the findings adequately derived from the data?	Comments	Interpretation of results sufficiently substantiated by data?	Comments	Coherence between data sources, collection, analysis and interpretation?	Comments
Rishoej	Yes	Yes	Yes	*The methodology of the study is a qualitative descriptive in the form of focus groups interviews using a semi structured interview guide to facilitate discussion. Qualitative approach is appropriate to address the research question.*	Yes	*Focus groups were used which were adequate but one-to-one semi-structured interviews might be more appropriate as medication error is a sensitive issue; The setup of focus groups was appropriate, including venue, recording methods and pilot tested.*	Yes	*The data analysis is appropriate for the study design. The qualitative data analysis was done after audiotapes were transcribed verbatim and notes were compiled. Analysis of the focus group transcripts was conducted using qualitative content analysis. There were two coders involved to analyse the data individually.*	Yes	*Results were supported by quotes that justified the themes.*	Yes	*There was a clear link between the data collection analysis and interpretation and the data source. They have interviewed physicians and nurses and used their quotes to come up with themes.* **Total score: 5**
Rosenfeld	Yes	Yes	Yes	*The methodology of the study is a qualitative descriptive in the form of ethnographic design including observations, semi structured interviews and focus group. Qualitative approach is appropriate to address the research question.*	Yes	*An ethnography approach was used to describe and interpret behavior which is appropriate; Observations with the use of field notes and audio taping (note: only pharmacists and nurses were shadowed, as authors found that shadowing doctors led to disjointed interactions with patients); Semi-structured interviews: in a room in clinical setting, at the time convenient for participants for approx. 1 hr.; Focus groups: data analysis from interviews provided themes for FGs. (note: doctors' FG did not happen in view of difficulties in organising).*	Yes	*The data analysis is appropriate for the study design. The qualitative data analysis was done after audiotapes were transcribed verbatim thematically analyzed using the framework approach.*	Yes	*The results were supported by the data collected with first-order interpretation quotes.*	Yes	*There was a clear link between the data collection analysis and interpretation and the data source.* **Total score: 5**

Quantitative studies

Main author	Clear research questions?	Data allow to address the research questions?	Sampling strategy relevant to address the research question?	Comments	Sample representative of the target population?	Comments	Are the measurements appropriate?	Comments
Chen	Yes	Yes	Yes	*Patients with epilepsy who the neurologist refers to the pharmacists and agreed to be referred to a pharmacist took part and the sample size was small but it does exactly what the aim (which is narrow in terms of evaluating a pharmacist service in neurology in one hospital site in Singapore). But the way the patients (all who were happy to be referred to a pharmacist) were sampled could produce biased results as you would only find the ones that are happy to receive pharmacist counselling and follow up.*	Yes	*There is a clear description of the inclusion and exclusion criteria, however, no clear statement regarding the reason why some participants declined to participate.*	Yes	*The perception questionnaire (Set B) was adapted from a validated instrument (Larson et al); The questionnaire was reviewed several times, incorporating inputs from pharmacists and neurologists; The questionnaires were pilot-tested but Cronbach Alpha not tested.*
Flannery	Yes	Yes	Yes	*A single site with doctors who are likely to prescribe antibiotics were recruited. Involvement of advanced practitioner nurses and physician assistants was also appropriate.*	Yes	*61% (93/153) completion rate showed the samples could represent the target population, which are doctors who prescribe antibiotics at the study site. The analysis would be difficult to be interpreted by other institutions.*	No	*The questionnaire was not reported to have piloted and Cronbach's Alpha was not tested, thus the reliability and validity are questionable; The use of Likert scale was appropriate.*
Moadebi	Yes	Yes	Yes	*The source of sampling is relevant to the targeted population and a clear discussion about the targeted population was stated that is in line with the research question.*	Yes	*There is a clear description of the sample that will be recruited as well as the setting and all approached and recruited participants took part in the study.*	Yes	*The survey framework was guided by an educational intervention assessment used for obstetric nurses reported in the literature. Also a clarity pilot test for the survey was conducted and some amendments were done accordingly.*

Quantitative studies (cont'd)

Main author	Is the risk of nonresponse bias low?	Comments	Statistical analysis appropriate to answer the research question?	Comments
Chen	No	*Bias is possible in that the neurologist were only referring a small number of cases they deem suitable for a pharmacist; in addition, social desirable bias is high as the questionnaire was completed straight after the counselling session and the authors were the pharmacists conducting the sessions. Nonresponse bias is also possible, when 22/55 (40%) of the target population did not participate. Authors did not identify the reasons for not participating.*	Yes	*The survey design (5-point Likert scale) allowed good statistical analysis (i.e. paired sample t test for Set A & C); Confidence scores before and after counselling and after telephone follow-up were compared using Wilcoxon Signed Ranks test which was appropriate.* **Total score: 4**
Flannery	Yes	*High response rate for this survey and clear statement regarding why some eligible participants did not take part.*	Yes	*Descriptive statistics and non-parametric tests such as Kruskal-Wallis and Mann-Whitney U tests to compare two independent variables were appropriate.* **Total score: 4**
Moadebi	N/A	*The response rate for the survey was 56% and the author had to remove 3 of the submitted surveys form the analysis as they were incomplete. There was a clear justification to the low number of participants within the limitation section of the paper.*	No	*Means, SDs and significance values of $p<0.05$ were used; Non-parametric test would be more appropriate for Likert scales where you rank according to discrete values (ordinal data).* **Total score: 3**

Mixed methods studies

Main author	Clear research questions?	Data allow to address the research questions?	Adequate rationale for using a mixed methods design?	Comments	Different components of the study effectively integrated?	Comments	Outputs of the integration of both components adequately interpreted?	Comments
Gray	Yes	Yes	Yes	*The sequential mixed methods study design was adequate – the qualitative part of the study reflected the dearth of literature in this area and recorded idea from interviewees, this provided a framework and themes identified for the quantitative phase.*	Yes	*Results from all phases were integrated using Triangulation approach. At the end of phase two the data of both qualitative phases were compared and to incorporate into phase 3.*	Yes	*There was a clear interpretations derived from integrating qualitative and quantitative findings from all phases which was clearly described in the results.*
			Are divergences and inconsistencies between both results adequately addressed?	**Comments**	**Do the different components adhere to the quality criteria of each tradition of the methods involved?**	**Comments**		
			No	*It was unable to tell if there was inconsistencies between qualitative and quantitative data as these were not explicitly stated or compared and contrasted; However, the study stated that participants recruited across the phases were similar.*	Yes	*No issues with the quantitative phase; However, in the qualitative phases, three pediatric rheumatology centres within the country for whom authors had contact among the project team and/or advisory group members – 1) high risk of bias as centres were not selected randomly; 2) 3 centres (out of 15, as reported) might not represent across the country. In addition, the nonresponse bias is high. Authors did not report the number of potential respondents form the 26 respondents who participated. It is not known that how the facilitators from the 3 centres recruited these respondents.* **Total score: 4**		