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Interventions in primary and community care to reduce urgent paediatric hospital admissions: systematic review.

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ABSTRACT

Background. There has been a rise in urgent paediatric hospital admissions and interventions to address this are required.

Objective. To systemically review the literature describing community (or non-hospital) -based interventions designed to reduce ED visits or urgent hospital admissions.

Data sources. MEDLINE, Embase, OVIS SP, Psych Info, Science Citation Index Expanded/ISI Web of Science (1981-present), The Cochrane library database and the Database of Abstracts of Reviews of Effectiveness (DARE).

Study eligibility criteria. Randomised Controlled Trials (RCTs) and before and after studies.

Participants. Individuals aged <16 years.

Study appraisal and synthesis methods. Papers were independently reviewed by two researchers. Data extraction and the Critical Appraisals Skills Programme checklist was completed (for risk of bias assessment).

Results. Seven studies were identified. Three studies were RCT's, three were a comparison between non-randomised groups and one was a before and after study. Interventions were reconfiguration of staff roles (two papers), telemedicine (three papers), pathways of urgent care (one paper) and point of care testing (one paper). Reconfiguration of staff roles resulted in reduction in ED visits in one study (with a commensurate increase in GP visits) but increased hospital admissions from ED in a second. Telemedicine was associated with a reduction in rate of children's admissions and reduced ED admissions in two further studies. Interventions with pathways of care and point of care testing did not impact either ED visits or urgent admissions.

Conclusions and implications.

New out of hospital models of urgent care for children need to be introduced and evaluated without delay.

PROSPERO registration: CRD42021274374.

Key words: child, patient admission, emergency medical services, community health care

Funding-none

INTRODUCTION

The number of urgent paediatric hospital admissions across the UK has risen since 2010.(1,2) Evidence-based interventions are required to slow this rise(3,4) but literature in this area is scarce. A recent review found limited data from observational studies that urgent admissions might be reduced by hospital-based interventions such as redesign of hospital buildings, reassigning staff, condition-specific care pathways and telemedicine.(5)

The potential for community, or non-hospital based, interventions to reduce urgent admissions remains unclear. The National Audit Office(6) has suggested that 20% of urgent admissions could be managed in the community, and in children this proportion may be as high as 50%.(7) There is evidence that community-based interventions may reduce short stay urgent admissions due to common conditions(8), but there is no systematic review of this literature. Our earlier systematic review of hospital-based interventions (5) used a previously published search strategy which we realised was not identifying community-based interventions. (9,10). Hence the premise of this systematic review, which used a different search strategy.

Here we present a systematic review of the literature describing community-based interventions (as opposed to hospital-based interventions) designed to reduce urgent ED visits or hospital admissions for children. We defined community-based interventions as those usually delivered outside a hospital by staff without specialist paediatric training who do not usually work in a hospital; this definition includes non-healthcare settings, for example neighbourhoods, schools and work sites.

METHODS

Protocol and registration

The methodology of the Centre of Reviews and Dissemination (CRD) was used for the study protocol. The study was registered with PROSPERO (Reg. No. CRD42021274374; https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=274374). An amendment was made to include ED attendance as an outcome measure.

Eligibility criteria

Full text peer-reviewed papers published in English language since 2000 were eligible if they: were either randomised controlled trials (RCTs) or before-and-after studies; reported on participants aged<18 years; were carried out in primary care, community care or at the interface of either with secondary care; and had urgent hospital admissions or ED attendance as an outcome. Ineligible studies included those that had primary care attendance as an outcome and where an intervention was delivered in a scheduled/ elective care setting with the aim of preventing or managing hospital admissions, e.g. school based asthma management interventions. Conference proceedings and letters were not eligible.

Information sources

We searched the following databases on 6th October 2021: MEDLINE/ OVID (1950-present), EMBASE/OVID SP (1980-present), Psych INFO/OVID SP (1987-present), Science Citation Index Expanded/ISI Web of Science (1981-present), The Cochrane library database and the database of Abstracts of Reviews of Effectiveness. Reference lists of included papers were hand searched for relevant articles (PRISMA Flow Chart). Papers identified in our previous study(5) were included if they met our inclusion criteria.

Search

We adapted the search strategy used in our earlier published review(5) by adding primary care, community care and integrated care services as keywords (see online supplemental file).

Study selection process

The COVIDENCE(11)software for systematic review management was used. After deduplication each abstract was reviewed by two of the three researchers (SD, CMR, CMF). All papers were

independently reviewed by two researchers and differences of opinion were resolved by discussion with all the authors.

Data collection process

Data were extracted from studies using the Cochrane Collaboration's forms for data extraction for RCTs and non-RCTs (https://dplp.cochrane.org/data-extraction-forms), with adaptations described in our previous review.(5) We contacted authors for clarification or missing data.

Data items

After the final selection, data were extracted for pre agreed outcome variables: study design, type of intervention, participant characteristics, study setting - primary/community/ interface of primary and secondary care, period of data collection and outcomes measured i.e. hospital admission, emergency department (ED) visits.

Quality assessment

The included papers were assessed for quality independently by two reviewers (CMR and CMF) using the Critical Appraisals Skills Programme checklists (CASP CHECKLISTS - CASP - Critical Appraisal Skills Programme (casp-uk.net)); papers were categorised as high, medium or low quality.(12) Where there was a minor difference of opinion, the lower of the two categories was adopted. Where a paper was categorised as high and low quality a final decision was made after discussion with all the authors.

Summary measures

The outcome was proportion of children attending ED or admitted to the hospital (either per unit time or per capita).

Synthesis of results

Extracted data were tabulated to show Population, Intervention, Comparator and Outcome elements for each included study (Table 1) according to the Preferred Reporting items for the Systematic Reviews and Meta-Analyses (PRISMA) reporting items checklist (http://www.prisma-statement.org/documents/PRISMA_2020_checklist.pdf). Studies were grouped by intervention type.

RESULTS

Study selection

The search yielded 11,296 titles from which 257 were considered potentially eligible, and seven papers were included in the final review, Figure 1 PRISMA flowchart. The majority of potentially eligible studies which were subsequently eliminated (96%) described interventions to prevent urgent admissions in children with chronic conditions such as asthma, diabetes and epilepsy which were delivered in a scheduled context when the child was well. Five papers were identified in the search(9,10,13-15); and two papers identified in our previous systematic review (5) but not in the search for the present review were added.(16,17) Meta analysis was not possible due to the heterogeneity within the identified papers in relation to the study design and settings, types of interventions, population age groups included and risk of bias. The review is reported as a narrative synthesis following the Synthesis Without Meta-Analysis guidelines.(18)

Study characteristics

Four studies were from Europe(13-15,17) two from North America(10,16) and one from New Zealand(9) (Table 1). Three studies were randomised controlled trials (9,14,15) three were a comparison between non-randomised groups of children,(10,13,16) (10)before and after design(17) The period of assessment varied between eight months(13) and 14.3 years.(16) The earliest study was conducted in 2000(15) and the latest were published in 2017.(16,17)

Outcome measures

Hospital admissions or ED attendance was the outcome measure in all the studies. (9,10,13-17) Some studies also measured costs and savings due to prevented emergency admissions(15), referral to primary care(13) and number of CRP tests performed.(14). The outcomes were expressed as odds ratios(17) percentage change,(9,13,14) (13)or rate ratios(16) (10,16) and cost savings and rate of admissions/1000 calls.(15)

Quality assessment

Included studies were categorised as medium quality,(9,10,13-15,17) or low quality.(16) Reasons for studies not being high quality included limited information on factors such as recruitment of the cohort, confounding factors and poor generalisability of the results (Table2).

Categories of intervention

Details of the interventions for each study are described in Table S1 (online supplemental file).

Reconfiguration of staff roles

A before and after study from Belgium described the impact of starting General Practitioner Cooperatives (GPC, analogous to the UKs Out-Of-Hours GP service) in two centres. The authors were able to stratify results by age. In one centre there was an increase in attendance of 0–5-year-olds at the GPC (odds ratio 2.1 [1.6, 2.8]) with a reduction in Emergency Department (ED) attendance (magnitude of reduction not stated).(17)

O'Keeffe *et al*.(13) compared the proportion of children (<16y) presenting with minor illnesses to minor injury units, urgent care centres and GP out of hours who were discharged home or admitted to paediatrics by Emergency Care Practitioners (ECP, non-medical staff including paramedics, paediatric nurses) against the proportion discharged by non-ECPs (e.g. doctors). . Compared to non ECPs, ECPs discharged significantly fewer patients (mean difference 7% [95% CI 0, 14]), and referred

more to hospital (mean difference 5% [95% CI 3, 12]) and to primary care providers (mean difference 3 [95% CI 4, 10]).

Telemedicine

Interventions using of telephone/ telemedicine were described in three papers.(10,15,16) One RCT from the UK(15) randomised patients who contacted the primary care Out-Of-Hours (OOH) service to receive nurse telephone consultation using decision support software or to receive usual care. Within the subgroup of children, admissions to hospital within three days of receiving the intervention (event rate/1000calls) were lower compared to those who received usual care (Control n=2780, rate 35.6, 95% CI 29 to 43; Intervention n=2690, rate 26.4 95% CI 20 to 33; rate difference -9.2 95% CI -0.004 to -1.84; p=0.049). The intervention had a potential saving of approximately £8,000 (by 2000 National Health Service costings).

Two articles based on the same intervention used data collected at different times to evaluate the impact of offering telemedicine to staff in child-care and primary school settings, as part of a child's health insurance. (10,16) The telemedicine assessment included electrical stethoscope and real time videoconferencing. Matched controls were identified from insurance company records. The first study (10) published in 2009 using data collected between 2001 and 2007, used a case-control design and described a significant 22% decrease in ED visits (p=0.036) but a non-significant (3.3%) reduction in visits to the office paediatrician. The second paper (16)published in 2016 using data collected between 1993 and 2007, applied a before and after design to determine whether the introduction of telemedicine led to increased healthcare utilisation among impoverished inner-city children compared to more affluent suburban children. Before telemedicine was introduced, impoverished inner city children were 75% less likely to see an office paediatrician or attend the ED for an urgent illness visit compared to more affluent suburban children ($p < 0.0001$). The introduction of telemedicine increased use of all combined urgent healthcare resources (i.e. telemedicine, office paediatrician and ED attendance) for all participants. Compared to more

affluent suburban children before telemedicine (449 visits/100 child years), healthcare use became similar among impoverished inner-city children after telemedicine was introduced (519 visits/100 child years); this change was mostly explained by use of telemedicine.

Pathway of urgent care

One RCT(9) evaluated the implementation of an asthma clinical pathway in the community; general practices were randomised to receive the intervention or not, and there was a third group of practices not involved in the trial. The intervention involved a two-hour group education session including the assessment and management of urgent asthma. In the 18 months post intervention there were reduced ED presentations and hospital admissions due to asthma which were similar for children from both the intervention and control practices, and also from practices not involved in the RCT.

Point of care testing

A cluster randomised trial evaluated whether the decision to admit to hospital was influenced by point of care testing in primary care of children with an urgent illness for C-reactive protein (a plasma protein whose concentrations can be elevated in sepsis) (14). Forty-five practices were randomised to have testing available to all children with an urgent illness and there were an additional 45 practices randomised to test only children at clinical risk (as defined by a clinical risk score). There was no difference in the proportion of children referred to hospital when trial arms were compared. When the subgroup of 20% of children at clinical risk were considered, there was no difference in the proportions referred.

DISCUSSION

This systematic review of out of hospital (or community-based) interventions finds a limited number of studies examining designed to reduce ED attendance or hospital admission. Drawing conclusions about the benefits and risks associated with these interventions is limited by the small number of studies included. Reconfiguration of staffing roles showed no evidence of change to rates of urgent

admissions, however there was some evidence that use of telemedicine reduced both the number of acute admissions within three days of the intervention and the costs associated with hospital admission and a reduction in number of ED attendances was achieved in two studies where alternative pathways of care were provided.

This study should be interpreted in the context of several limitations of the literature. The studies included were restricted to high-income countries with well-established healthcare systems meaning the results have limited international generalisability. Additionally, differences between healthcare system in the nations where studies were identified may limit the generalisability of findings between high-income countries. Only a small number of studies were identified in the search; nevertheless, this highlights the importance of research in this area where there is limited evidence but an increasing clinical need for effective interventions. A further limitation of the literature is that many out of hospital models of care which are designed to prevent admissions are not described in the peer reviewed literature. For example the Health London Partnership identified ten out of hospital models. (19) A review of the "grey literature" is likely to have identified more models of care relevant to our aim. A final limitation is that we were unable to carry out meta-analysis due to the heterogeneity in study design, setting, cohort age, type of intervention, outcomes, statistical measures, and risk of bias.

A potential limitation of our study methodology is that two eligible papers identified in an earlier search were not identified in the search used in this paper, and our search may have missed other papers; this is a limitation for all systematic reviews when large numbers of papers are reviewed. Our earlier work ensured that these papers were included. A second consideration is that we excluded numerous studies which delivered preventative interventions in a scheduled setting and designed to reduce unscheduled admissions; there is an extensive literature describing interventions delivered in the scheduled setting aimed at preventing hospital admissions.(20) We included one

study delivered in the scheduled context,(9) since this provided training to health care professionals to support them in providing clinical care for children urgently unwell with asthma, and we believed was within our inclusion criteria.

In our work for the present and our earlier review (5) we have not identified interventions at the interface between community and hospital, and this context may have an impact on safely reducing admissions since interventions in the hospital setting may only reduce admissions in the context of provision in the community surrounding the hospital. For example when a short stay paediatric assessment unit (SSPAU) is opened in a hospital, admissions may fall but also may rise(21) and this divergence of results may reflect different referral pathways into hospital from the community between different centres. A second example is that after a paediatric ward is partly or fully closed, admissions to the neighbouring hospital, where inpatient services are maintained, depend on what contingencies are placed in the community where closure takes place.(22) Interventions which include both primary care/community and secondary care/hospital may therefore be more effective in reducing unscheduled admissions than interventions delivered either in primary or secondary care.

Factors other than child's illness may be important to decision making leading to admission, and these factors might be considered when designing studies aimed at reducing hospital admissions. One systematic review(23) identified non-clinical factors that influenced GPs' decisions about referrals. These were linked to patients (parents'/ caregivers' perceptions of illness severity), GPs (appraisal of parents ability to cope, aversion to risk) and health system (access to diagnostics, distance from hospital).(24)A second systematic review found parental factors such as race, ethnicity, socio economic status and parental perception of child's illness as some of the factors that influenced decision making of parents and families in seeking urgent care for their child.(24) One study from the US has suggested that using in person patient care navigators can be useful in both in

primary and secondary care interventions to reduce paediatric hospital admissions and thereby overcome some of these barriers.(25)

Conclusion

We found very few interventions in the community which were designed to reduce urgent ED attendance and hospital admissions. We identified four categories of interventions, of which telemedicine (which has gained even more importance after the COVID 19 pandemic) seemed to have the greatest impact on reducing ED attendances and hospital admissions especially for interventions that included. Out of hospital models of care identified here and described elsewhere (26) need to be introduced and evaluated without delay to provide realistic pathways of urgent care for children. Such models might also be applicable to adult care.

Declaration of interests

We declare no competing interests.

Contributorship statement

ST conceived the study. SD designed the search strategy and carried out the literature searches. SD, CM and CMc screened the titles, abstracts and full texts. ST and PW resolved any conflicts around the selection process. SD, CM and CMc carried out the data extraction and quality assessment. ST and SD wrote the first draft, and all authors were involved in the interpretation of data and provided valuable contribution towards reviewing, editing and completion of the final draft. All authors had access to all the data in the study and the responsibility for the decision to submit for publication.

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What is already known on this topic

- The continued rise in urgent paediatric hospital admissions is unsustainable and therefore a need for interventions to tackle this.
- There is evidence suggesting that community based interventions can reduce short satay admissions.
- There is no published systematic review on this topic.

What this study adds

- This is the first systematic review examining literature around primary care and community based interventions designed to reduce urgent paediatric admissions.
- The available evidence is very limited and inconclusive towards efficacy in reducing hospital admissions but does suggest a reduction in presentations to the emergency department.

How this study might affect research, practice or policy

- Encourage researchers to design novel interventions addressing both the clinical and non-clinical factors.

- Good quality interventions integrating all the strata of health and social care will help to safely reduce urgent admissions.

REFERENCES

(1) Ruzangi J, Blair M, Cecil E, Greenfield G, Bottle A, Hargreaves DS, et al. Trends in healthcare use in children aged less than 15 years: a population-based cohort study in England from 2007 to 2017. BMJ Open 2020 May 05;10(5):e033761-2019.

(2) Al-Mahtot M, Barwise-Munro R, Wilson P, Turner S. Changing characteristics of hospital admissions but not the children admitted-a whole population study between 2000 and 2013. Eur J Pediatr 2018 March 01;177(3):381-388.

(3) The King's Fund. Community health services explained. 2019; Available at: https://www.kingsfund.org.uk/publications/community-health-services-explained. Accessed 07/14, 2021.

(4) The Nuffield Trust. Focus on emergency care for children and young people, 2017. 2017; Available at: https://www.nuffieldtrust.org.uk/research/focus-on-emergency-hospital-care-for-children-and-young-people. Accessed June, 2021.

(5) Dick S, MacRae C, McFaul C, Rasul U, Wilson P, Turner SW. Interventions to reduce acute paediatric hospital admissions: a systematic review. Arch Dis Child 2021 July 31:archdischild-2021.

(6) National Audit Office. Emergency admissions to hospital: managing the demand. 2013.

(7) Steele L, Coote N, Klaber R, Watson M, Coren M. Understanding case mix across three paediatric services: could integration of primary and secondary general paediatrics alter walk-in emergency attendances? Arch Dis Child 2019 May 01;104(5):432.

(8) Busby J, Purdy S, Hollingworth W. Opportunities for primary care to reduce hospital admissions: a cross-sectional study of geographical variation. Br J Gen Pract 2017 January 01;67(654):e20-e28.

(9) Mitchell E, Didsbury P, Kruithof N, Robinson E, Milmine M, Barry M, et al. A randomized controlled trial of an asthma clinical pathway for children in general practice. Acta Paediatrica 2005 February 01;94(2):226-233.

(10) McConnochie KM, Wood NE, Herendeen NE, Ng PK, Noyes K, Wang H, et al. Acute Illness Care Patterns Change With Use of Telemedicine. Pediatrics 2009 June 01;123(6):E989-E995.

(11) COVIDENCE. Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org. 2022.

(12) Crandon S, Elbaz MSM, Westenberg JJM, van der Geest, R J, Plein S, Garg P. Clinical applications of intra-cardiac four-dimensional flow cardiovascular magnetic resonance: A systematic review. Int J Cardiol 2017 December 15;249:486-493.

(13) O'Keeffe C, Mason S, Bradburn M, Iheozor-Ejiofor Z. A community intervention trial to evaluate emergency care practitioners in the management of children. Arch Dis Child 2011 July 01;96(7):658-663.

(14) Verbakel J Y, Lemiengre M B, De Burghgraeve T, De Sutter A, Aertgeerts B, Bullens D M A, et al. Point-of-care C reactive protein to identify serious infection in acutely ill children presenting to hospital: Prospective cohort study. Arch Dis Child 2018 May 01;103(5):420-426.

(15) Lattimer V, Sassi F, George S, Moore M, Turnbull J, Mullee M, et al. Cost analysis of nurse telephone consultation in out of hours primary care: evidence from a randomised controlled trial. BMJ 2000 April 15;320(7241):1053-1057.

(16) Ronis SD, McConnochie KM, Wang H, Wood NE. Urban Telemedicine Enables Equity in Access to Acute Illness Care. Telemedicine Journal & E-Health 2017;23(2):105-112.

(17) Colliers A, Remmen R, Streffer ML, Michiels B, Bartholomeeusen S, Monsieurs KG, et al. Implementation of a general practitioner cooperative adjacent to the emergency department of a hospital increases the caseload for the GPC but not for the emergency department. Acta Clin Belg 2017 February 01;72(1):49-54.

(18) Campbell M, McKenzie JE, Sowden A, Katikireddi SV, Brennan SE, Ellis S, et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline. BMJ 2020 January 16;368:l6890.

(19) Healthy London Partnership. Compendium: New models of care for acutely unwell children and young people. 2016; Available at: https://www.healthylondon.org/wp-content/uploads/2017/11/Compendium-Out-of-hospital-care-for-acutely-unwell-children-and-young-people.pdf. Accessed 17th Jan 2023.

(20) Harris K, Kneale D, Lasserson TJ, McDonald VM, Grigg J, Thomas J. School-based self-management interventions for asthma in children and adolescents: a mixed methods systematic review. Cochrane Database Syst Rev 2019 January 28;1(1):CD011651.

(21) Turner S, Raja EA. The association between opening a short stay paediatric assessment unit and trends in short stay hospital admissions. BMC Health Serv Res 2021 May 29;21(1):523-021.

(22) Martin J, Raja EA, Turner S. Does admission prevalence change after reconfiguration of inpatient services? An interrupted time series analysis of the impact of reconfiguration in five centres. BMC Health Serv Res 2021 January 21;21(1):75-021.

(23) Conlon C, Nicholson E, Rodríguez-Martin B, O'Donovan R, De Brún A, McDonnell T, et al. Factors influencing general practitioners decisions to refer Paediatric patients to the emergency

department: a systematic review and narrative synthesis. BMC Fam Pract 2020 October 16;21(1):210-020.

(24) Nicholson E, McDonnell T, De Brún A, Barrett M, Bury G, Collins C, et al. Factors that influence family and parental preferences and decision making for unscheduled paediatric healthcare - systematic review. BMC Health Serv Res 2020 July 17;20(1):663-020.

(25) Pantell MS, Hessler D, Long D, Alqassari M, Schudel C, Laves E, et al. Effects of In-Person Navigation to Address Family Social Needs on Child Health Care Utilization: A Randomized Clinical Trial. JAMA Netw Open 2020 June 01;3(6):e206445.

(26) Viner RM, Blackburn F, White F*, et al* The impact of out-of-hospital models of care on paediatric emergency department presentations *Arch Dis Child* 2018;103(2)**:**128-136.

Table 1. Characteristics of studies included in this systematic review.

Category of intervention	Study	Country	Study population	Study period	Study design	Number of presentations	Study outcome	Significant results
Reconfigure staff roles	Colliers *et al.* (2017)	Belgium	Community dwelling children 0-15 years	2006 – 2007 – GPC distant from ED 2011 – 2012 – GPC adjacent to ED	Before and after study	Turnhout study GPC Intervention n=1945, Control n=1593; ED intervention n=795, Control n=missing Antwerp study GPC Intervention n=1889, Control n=3041; ED Intervention n=2850, Control n=3479	ED attendances - odds ratios and 95% confidence interval	In the intervention region in the Antwerp study there was a significant increase of patients using the General practitioner cooperatives (GPCs) in the age category of 0–5 years old (OR: 2074; CI: 1561–2755). There was also a reduction in the emergency department (ED) attendance in the age-category 0–5 year decreased.
	O'Keeffe *et al*. (2011)	UK	Community dwelling children 0-15 years presenting to unscheduled primary care services	January-August 2007	Comparison between non - randomised groups	Paediatric urgent episodes Intervention n=415, Control n=748	Referral to secondary care paediatrics teams - percentage difference and 95% confidence interval	ECPs discharged significantly fewer patients (mean difference 7% [95% CI 0, 14]), and referred more to hospital (mean difference 5% [95% CI 3, 12]) and to primary care providers (mean difference 3 [95% CI 4, 10])
Telemedicine	Lattimer *et al*. (2000)	UK	Children <16 years	1997-1998	Randomized controlled trial	Intervention n=2690, Control n=2780	Rate of admissions expressed as event rate/1000calls;	Rate of admissions (event rate/1000calls) was significantly higher in the control group compared to the intervention group (Control n=2780, rate 35.6, 95% CI 29 to 43; Intervention n=2690, rate 26.4

							Costs associated with emergency hospital admissions in GBP sterling with 95% confidence intervals	95% CI 20 to 33; rate difference -9.2, 95% CI -0.004 to -1.84; p=0.049). Savings from reduced child admissions of £29 268 per annum were reduced to £21 572 (£86 to £36 692) by the costs of additional admission through accident and emergency (13 cases at £296 in the trial year totalling saving of £7696 per annum).
	McConnochie *et al*. (2009)	USA	Community dwelling children aged 0-12 years	2001 - 2007	Comparison between non - randomised groups	Intervention n=1216, Control n=1216	Emergency department attendance -	Higher overall utilization for intervention children attributable to telemedicine visits (rate ratio 1.235; 23.5% increase; P< 0.001) but there was a significant decrease in ED visits among intervention children (rate ratio 0.778; 22.9% decrease; P=0.036).
	Ronis *et al*. (2017)	USA	Community dwelling children < 6years of age	1993 – 2007 (includes 8 years of historical control group data capture)	Comparison between non - randomised groups	Intervention n=1217, Control n=1217	Emergency department attendance -	When both suburban and inner-city children lacked telemedicine access, overall urgent illness visits were 75% greater among suburban than inner-city children (suburban : inner-city rate ratio 1.75, p < 0.0001). After telemedicine became available to inner-city children, their overall urgent visits approximated those of suburban children (suburban : inner-city rate ratio 0.80, p = 0.07), whereas urgent visits among suburban children remained at least (worst-case comparison) 56% greater than inner-city children without telemedicine (rate ratio 1.56, p < 0.0001).

Pathway of care	Mitchell *et al*. (2005)	New Zealand	Children 0-14 years	January 1999 to December 2000	Randomized controlled trial	270 General Practitioners randomised to 22 cell groups	Admissions to hospital for asthma and attendance at the children's emergency department	Admissions for asthma dropped in the intervention group (40%) compared to the control group (33%) this difference was not significant (p=0.7). Results for ED attendances were similar and non-significant (intervention 25% reduction, control 30% reduction, P=0.3)
Point of care (POC) testing	Verbakel *et al*. (2016)	Belgium	Children 1 month to 16 years of age	February 15 2013 to February 28 2014	Cluster randomized controlled trial	CRP testing Intervention Children at clinical risk n=1417 episodes, all children n=1730 episodes	Hospital admission (> 24 hours) for a serious infection within five days after initial presentation	There was no significant difference in the proportion of children with serious infection referred to hospital (CRP all children 0.16% vs CRP at risk children 0.14%, p=0.88).

Table 2. Quality control of the papers included.

Study Reference	Did the study address a clearly focussed issue?	Was the cohort recruited in an acceptable way?	Was exposure accurately measured to minimise bias?	Was the outcome accurately measured to minimise bias?	Have the authors identified all important confounding factors?	Confounding factors taken into account in the design and/or analysis?	Was the follow-up of subjects complete enough?	Was the follow up of subjects long enough?	Do you believe the results?	Will the results help locally?	Do the results of this study fit with other available evidence?	Total Score out of 11	Rating*
Colliers *et al.*	Yes	Yes	Can't tell	Yes	Can't tell	Can't tell	Yes	Yes	Yes	Yes	Can't tell	7	MED
McConnochie *et al.*	Yes	Can't tell	Yes	Yes	No	Can't tell	Yes	Yes	Yes	Can't tell	Can't tell	6	MED
O'Keeffe *et al.*	Yes	No	Yes	Yes	Can't tell	Can't tell	Yes	Yes	Yes	No	Can't tell	6	MED
Ronis *et al.*	Can't tell	Can't tell	Can't tell	Yes	Can't tell	Can't tell	Yes	Yes	Can't tell	No	Can't tell	3	LOW
Lattimer *et al.*	Yes	Yes	Can't tell	No	Can't tell	Can't tell	No	No	Can't tell	Yes	Yes	4	MED
Mitchell *et al.*	Yes	Can't tell	Can't tell	No	Can't tell	Yes	Can't tell	Yes	Yes	Yes	Can't tell	5	MED
Verbakel *et al.*	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes	No	7	MED

FIGURE-LEGEND

Figure 1. PRISMA flow diagram showing how the 7 papers included in this systematic review were identified.

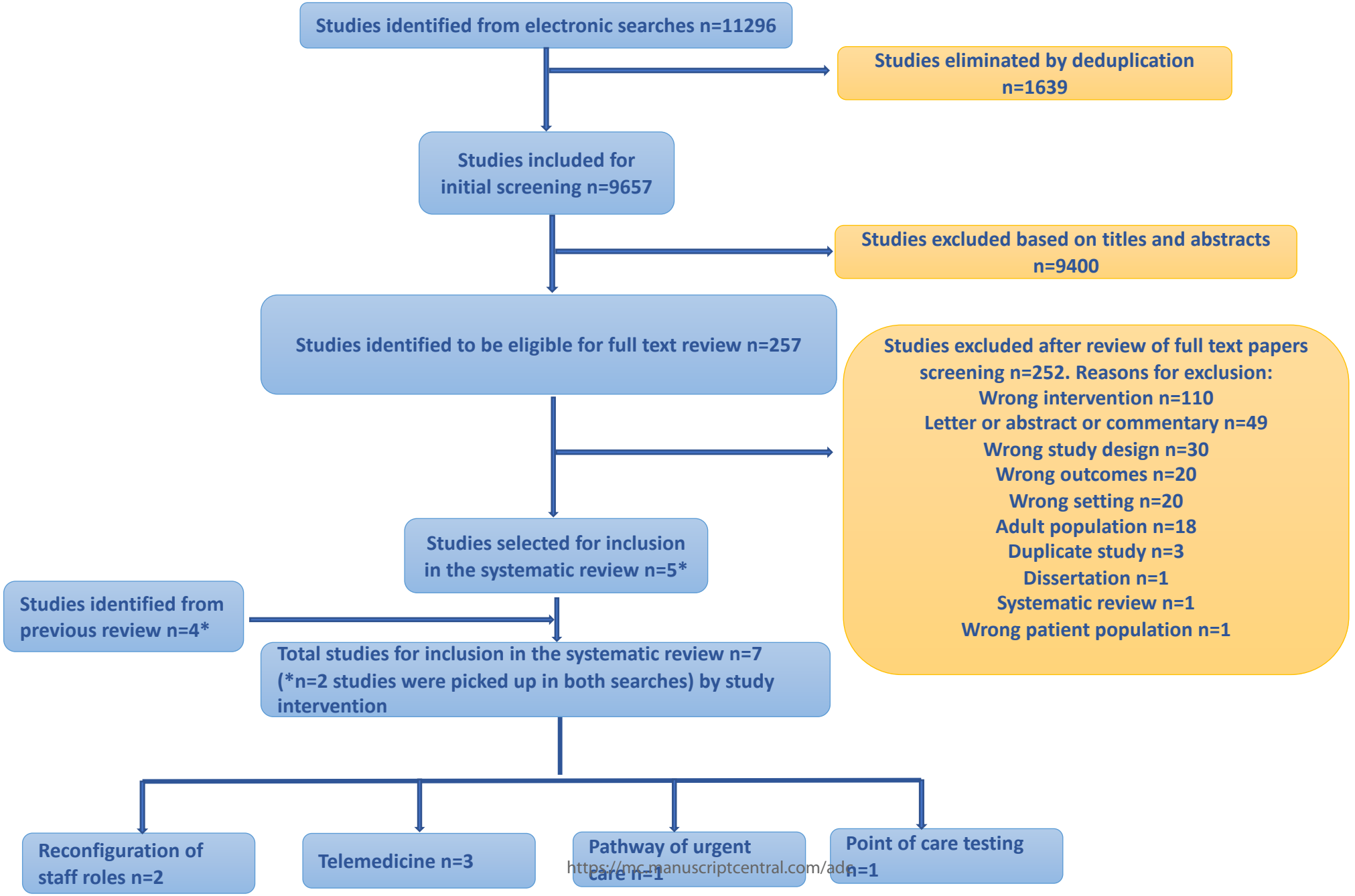

Table S1 Details of interventions in papers included in this review.

Category of intervention	Study	Country	Study design	Intervention
Reconfigure staff roles	Colliers et al. (2017)	Belgium	Before and after	The effect of implementation of General Practitioner Cooperatives (GPC) on the out of hours case load of local ED. One GPC was located adjacent to the ED of general hospital, other was further away from the hospital. This data was compared with the period before implementation of GPC.
	O'Keeffe et al. (2011)	UK	Comparison between non - randomised groups	The effectiveness of Emergency Care practitioners (ECPs) in the acute management of children, focusing on patient pathway and care was compared to control services (non-ECP's).
Telemedicine	Lattimer et al. (2000)	UK	Randomized Controlled Trial (RCT)	Intervention group consisted of nurse telephone consultation using decision support software. Control group was usual GP care.
	McConnochie et al. (2009)	USA	Comparison between non - randomised groups	Intervention consisted of utilization of telemedicine or office or ED care by children with telemedicine access. Control consisted of utilization of care services by children without telemedicine access.
	Ronis et al. (2017)	USA	Comparison between non - randomised groups	Intervention consisted of utilization of telemedicine or office or ED care by children with telemedicine access. Control consisted of utilization of care services by children without telemedicine access.
Pathway of care	Mitchell et al. (2005)	New Zealand	Randomized Controlled Trial (RCT)	The trial group of General Practitioners (GPs) implemented asthma clinical pathway while the control group pf GPs continued with usual asthma medical care management.
Point of care (POC) testing	Verbekel et al. (2016)	Belgium	Cluster Randomized Controlled Trial (RCT)	Intervention group carried out POC CRP testing in only those children assessed as being at a higher risk. The control group performed POC CRP testing in all children.

SEARCH STRATEGIES

OVID MEDLINE 3799

(((General Practice/ or General Practitioners/ OR (Primary care physician* or PCP).ti,ab. OR Family Practice/ or General Practice/ or Family Practice*.mp. or family physician.mp. OR Community Health Nursing/ OR Home Care Services/ OR Nurses, Pediatric/ or Nurses, Community Health/ or Nurses/ or Nurses, Neonatal/OR Health visit*.ti,ab. OR Primary Health Care.mp. or Primary Health Care/ OR Telemedicine/ OR (Guideline* adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR Emergency Medical Services/ or Emergency Medicine/ OR (Checklist adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR (Algorithm adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR Education, Continuing/ or Health Education/ or Education, Medical, Continuing/or Education/ OR Early Intervention, Educational/ or Internet-Based Intervention/ or Early Medical Intervention/ OR school based intervention*.ti,ab. OR Community based intervention*.ti,ab. OR Comprehensive intervention*.ti,ab. OR Integrat* intervention*.ti,ab. OR Evidence based healthcare.ti,ab.)) AND (Child, Hospitalized/ or Child, Preschool/ or Child/ or Child Health/ or Child Health Services/ OR Infant Health/ or Infant/ or Infant, Newborn/ OR (child* or p?ediat*).ti,ab. OR Adolescent Health Services/ or Adolescent/ or Adolescent Health))) AND (Accident adj Emergency).ti,ab. OR A&E.ti,ab. OR patient admission.mp. or patient Admission/ OR hospital admission*.ti,ab. OR health care utili*.ti,ab. OR P?ediatric assessment*.mp.) limit 35 to (english language and yr="2000 -Current")

EMBASE 4199

((General Prac*.ab,ti. OR Primary care physician* or PCP).ab,ti. OR Family Prac*.af. OR Community Health Nurs*.af. OR Home Care Service*.af. OR Nurse*.af. OR Health visit*.ab,ti. OR Primary Health Care.af. OR Telemedicine/ OR (Guideline* NEAR2 (evaluat* or implement* or develop* or approach or assess*)).ab,ti. OR Emergency Medic*.ab,ti. OR (Checklist NEAR2 (evaluat* or implement* or develop* or approach or assess*)).ab,ti. OR (Algorithm NEAR2 (evaluat* or implement* or develop* or approach or assess*)).ab,ti. OR Continuing Medical Education.af. OR Intervent*.af. OR school based intervention*.ab,ti. OR Community based intervention*.ab,ti. OR Comprehensive intervention*.ab,ti. OR Integrat* intervention*.ab,ti. OR Evidence based healthcare.ab,ti.) AND (child/ OR infant/ OR (child* or p?ediat*).ab,ti. OR Adolescent* Health Service*/)) AND (Accident NEAR Emergency).ab,ti. OR A&E.ab,ti. OR patient admission.af. OR hospital admission*.ab,ti. OR health care utili*.ab,ti. OR P?ediatric assessment*.af.) limit 35 to (english language and yr="2000 -Current")

DARE 79

(((General Prac$.af. OR (Primary care physician$ or PCP).af. OR Family Prac$.af. OR Community Health Nurs$.mp. OR Home Care Service$.mp. OR Nurse$.af. OR Health visit$.af. OR Primary Health Care.mp. OR Telemedicine.mp. OR (Guideline$ adj2 (evaluat$ or implement$ or develop$ or approach or assess$)).af. OR Emergency Medic$.af. OR (Checklist adj2 (evaluat$ or implement$ or develop$ or approach or assess$)).af. OR (Algorithm adj2 (evaluat$ or implement$ or develop$ or approach or assess$)).af. OR Continuing Medical Education.mp. OR Intervent$.af. OR school based intervention$.af. OR Community based intervention$.af. OR Comprehensive intervention$.af. OR Integrat$ intervention$.af. OR Evidence based healthcare.af.)) AND *((child.mp. OR (Infant$ or

Newborn$).mp. [mp=title, full text, keywords] OR (child$ or p?ediat$).af. OR Adolescent$ Health Service$.mp.))) AND ((Accident adj Emergency).af. OR A&E.af. OR patient admission.mp. or patient Admission/ OR hospital admission$.af. OR health care utili$.af. OR P?ediatric assessment$.mp.)) limit 35 to (english language and yr="2000 -Current")

PSYCHINFO 151

(((General Practice/ or General Practitioners/ OR (Primary care physician* or PCP).ti,ab. OR Community Health Nursing/ OR Home Care Services/ OR Nurses, Pediatric/ or Nurses, Community Health/ or Nurses/ or Nurses, Neonatal/ OR Primary Health Care.mp. or Primary Health Care/ OR Telemedicine/ OR (Guideline* adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR Emergency Medical Services/ or Emergency Medicine/ OR (Checklist adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR (Algorithm adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR Education, Continuing/ or Health Education/ or Education, Medical, Continuing/ or Education/ OR Early Intervention, Educational/ or Internet-Based Intervention/ or Early Medical Intervention/ OR school based intervention*.ti,ab. OR Community based intervention*.ti,ab. OR Comprehensive intervention*.ti,ab.)) AND ((Child, Preschool/ or Child Health Services/ or Child/ or Child, Hospitalized/ or Child Health/ OR Infant/ or Infant Health/ or Infant, Newborn/ OR (child* or p?ediat*).ti,ab. OR Adolescent Health Services/ or Adolescent/ or Adolescent Health/))) AND ((Accident adj Emergency).ti,ab. OR A&E.ti,ab. OR hospital admission*.ti,ab. OR health care utili*.ti,ab.)) limit 29 to (english language and yr="2000 -Current"))) limit 30 to (humans and ("all infant (birth to 23 months)" or "all child (0 to 18 years)" or "newborn infant (birth to 1 month)" or "infant (1 to 23 months)" or "preschool child (2 to 5 years)" or "child (6 to 12 years)" or "adolescent (13 to 18 years)") and english)

Cochrane Central Register of Controlled Trials and Cochrane Database of Systematic Reviews 222

(((General Practice/ or General Practitioners/ OR (Primary care physician* or PCP).ti,ab. OR Community Health Nursing/ OR Home Care Services/ OR Nurses, Pediatric/ or Nurses, Community Health/ or Nurses/ or Nurses, Neonatal/ OR Primary Health Care.mp. or Primary Health Care/ OR Telemedicine/ OR (Guideline* adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR Emergency Medical Services/ or Emergency Medicine/ OR (Checklist adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR (Algorithm adj2 (evaluat* or implement* or develop* or approach or assess*)).ti,ab. OR Education, Continuing/ or Health Education/ or Education, Medical, Continuing/ or Education/ OR Early Intervention, Educational/ or Internet-Based Intervention/ or Early Medical Intervention/ OR school based intervention*.ti,ab. OR Community based intervention*.ti,ab. OR Comprehensive intervention*.ti,ab.)) AND (Child, Preschool/ or Child Health Services/ or Child/ or Child, Hospitalized/ or Child Health/ OR Infant/ or Infant Health/ or Infant, Newborn/ OR (child* or p?ediat*).ti,ab. OR Adolescent Health Services/ or Adolescent/ or Adolescent Health/))) AND ((Accident adj Emergency).ti,ab. OR A&E.ti,ab. OR hospital admission*.ti,ab. OR health care utili*.ti,ab.)) limit 29 to (english language and yr="2000 -Current"))) limit 30 to (humans and ("all infant (birth to 23 months)" or "all child (0 to 18 years)" or "newborn infant (birth to 1 month)" or "infant (1 to 23 months)" or "preschool child (2 to 5 years)" or "child (6 to 12 years)" or "adolescent (13 to 18 years)") and english)

Web of Science 2764

((((TS=(((General Practic* or Primary care physician* or PCP or Family Practic* or General Practice or family physician or Community Health Nursing or Home Care Services or Nurse* or Health visit* or Primary Health Care or Telemedicine or (Guideline* adj2 (evaluat* or implement* or develop* or approach or assess*)) or Emergency Medic* or (Checklist adj2 (evaluat* or implement* or develop* or approach or assess*)) or (Algorithm adj2 (evaluat* or implement* or develop* or approach or assess*)) or Continuing medical Education or continuing Health Education or Early educational Intervention* or medical intervention* or Internet based intervention* or school based intervention* or Community based intervention* or Comprehensive intervention* or Integrat* intervention* or Evidence based healthcare))))) AND TS=((child* or infant* or adolescent* or p?ediat*))) AND TS=(((Accident NEAR Emergency) or A&E or patient admission* or hospital admission* or health care utili* or p?ediatric assessment*))) AND LA=(English) and Article or Early Access (Document Types) and Proceeding Paper (Exclude – Document Types) and Pediatrics (Research Areas) and Review Article (Exclude – Document Types) and Pediatrics or Emergency Medicine or Critical Care Medicine (Web of Science Categories) and Pediatrics or Emergency Medicine or General Internal Medicine or Infectious Diseases or Allergy or Respiratory System (Research Areas) and 27TH ANNUAL MEETING OF THE SOCIETY OF MATERNAL FETAL MEDICINE (Exclude – Conference Titles)