Burden of paediatric hospitalisations to the health care system, child and family: a systematic review of Australian studies (1990–2022)

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Summary

Background Paediatric hospitalisations represent a significant cost to the health system and cause significant burden to children and their families. Understanding trends in hospitalisation costs can assist with health planning and support strategies across stakeholders. The objective of this systematic review is to examine the trends in costs and burden of paediatric hospitalisations in Australia to help inform policy and promote the well-being of children and their families.

Methods Electronic data sources (Embase, Medline, Web of Science, PSYCH-Info, CINAHL and Scopus) were searched from 1990 until December 2022. Any quantitative or qualitative studies conducted in Australian tertiary hospitals were included in the review. Eligible studies were those that included paediatric (<18 years) hospitalisations and reported on economic and/or non-economic costs for the child, family unit and/or health system. Study quality and risk of bias for each study were assessed with the Joanna Briggs Critical Appraisal Tools. We present a summary of the findings of the hospitalisation burden across major diagnostic admission categories and for the child and family unit. The systematic review was registered with Prospero (ID: CRD42021276202).

Findings The review summarises a total of 88 studies published between 1990 and December 2022. Overall, the studies identified that paediatric hospitalisations incur significant financial costs, which have not shown significant reductions over time. In-patient direct hospital costs varied depending on the type of treatment and diagnostic condition. The costs per-case were found to range from just below AUD$2000 to AUD$20,000 or more. The financial burden on the family unit included loss of productivity, transport and travel costs. Some studies reported estimates of these costs upward of AUD$500 per day. Studies evaluating 'hospital in the home' options identified significant benefits in reducing hospitalisations and costs without compromising care.

Interpretation Increasing focus on alternative models of care may help alleviate the significant costs associated with paediatric hospitalisation.

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Keywords: Child; Adolescent; Caregiver; Hospitalisation; Burden of disease

Introduction

The burden of paediatric hospitalisation has been noted internationally. Annual hospital costs for admissions with medical complexity are estimated at around AUD$2 billion in Australian hospitals[1] while admission costs in the USA for common paediatric admissions were in excess of US$9 billion.[2] In the Australian context in the last five years to 2021–22, there has been minimal change in overall hospital costs for acute care across child and adult admissions.[3] Therefore, changes

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Research in context

Evidence before this study

Several Australian studies have reviewed hospital costs for discrete admission categories, including sports injuries or respiratory conditions, over ten-year periods. However, there has been no systematic review that has synthesised both direct and indirect costs for the child and family. Additionally, there are currently no systematic reviews or meta-analyses available that have synthesised evidence of healthcare costs based on paediatric hospitalisations across various conditions using Australian data.

Added value of this study

This systematic review provides a synthesis of hospitalisation costs incurred by the health care system across different diagnostic classifications. Additionally, it provides a summary of existing evidence on costs incurred by hospitalised children and their families, which are often not addressed in studies of healthcare costs.

Implications of all the available evidence

The review provides cumulative evidence indicating overall stability in hospital costs and admissions rates across diagnostic classifications. Despite population-based preventive programs for certain conditions such as respiratory and trauma, the studies found that hospital costs and admission rates remain stable across these diagnostic categories. Disparities in health outcomes exist for several subgroups including Indigenous children, those residing in rural or remote areas and children with co-morbid conditions. The presence of these disparities emphasises the importance of targeted delivery of both in-patient and outpatient health support programs to address the needs of these populations. The available evidence provides a framework that identifies populations at risk and moderators of health outcomes (e.g., socioeconomic status, Indigenous status) that can inform health policy and practice and when addressed may lead to improved health outcomes.

in costs over time may be more easily observed when examining admissions for specific diagnostic categories and associated moderating factors. These factors can be broadly grouped as hospital specific, e.g., hospital systems/processes, novel care programs[4] and non-hospital specific, e.g., sociodemographic factors; disease related factors including severity of the condition; or other non-hospital factors such as community health initiatives. The influence of these factors on the direct and indirect costs of hospitalisation is somewhat unclear and may vary between studies based on the cost metric reported.

With respect to hospital specific factors, models of care can change over time and there is growing evidence that novel hospital-based interventions can impact costs to the healthcare system. For example, the introduction of '*clinical pathways*' (structured medical models of care tailored for specific conditions) and *'hospital in the home'* (HITH) care models have been associated with improvements across key hospital metrics. These included length of hospital stay (LoS), re-admission rates and healthcare costs.[5] However, the evidence supporting these models and systems is still in its early stages. Research has not extensively evaluated whether the decreased costs resulting from these systems outweigh the development and implementation costs associated with such systems.[6]

Non-hospital specific factors primarily reflect the child's reason for admission and the cumulative influence of sociodemographic characteristics (such as age, sex and socioeconomic status–SES). A recent study of Australian paediatric admissions, noted that age, disadvantaged background and distance from hospital moderated LoS a key metric of direct hospitalisation costs.[7] Similar findings for the younger age group (0–4 years) representing nearly half of admissions were reported in a US study.[8] In contrast, a UK study did not find any sociodemographic association other than medical complexity on LoS.[9] Although the above findings point to likely moderators of direct hospital costs, there has not been a systematic evaluation in the Australian context of how these characteristics may moderate costs for different admission reasons.

In relation to costs to the child and family, the universally available publicly funded hospital system in Australia ensures there are no direct hospital fees incurred by the family. Perhaps as a consequence of this, indirect costs incurred by the child and family, including loss of school days, loss of wages, travel, parking and accommodation costs, have not been extensively evaluated. There is growing evidence however of the economic hardships that families experience as a result of their child's admission in hospital.[10]

The above indicate that factors influencing direct and non-direct hospitalisation costs are complex and difficult to disentangle. As such, reviews and evaluations of paediatric hospitalisation costs would benefit from considering numerous factors and how they may interact to contribute to costs incurred by both the hospital system and, the child and family unit. Understanding the factors that moderate hospital presentations can be valuable in informing healthcare policy and has potential to lead to a reduction in hospital based costs, LoS, and the negative impact of hospitalisation on the families.

To date, research has examined this burden primarily in terms of direct costs to the healthcare system, for costs incurred for hospital services.[11] Indirect costs

of hospitalisation, including economic and non-economic costs to the child and family unit, have received less attention. The Australian hospital context, which offers free universal access to public hospital care, provides a unique opportunity to evaluate paediatric hospital costs across various admissions and to appraise the financial and non-financial burden experienced by the child and family. Despite extensive research on paediatric admissions in Australian hospitals, there has been no single systematic evaluation of costs to the hospital system, child and family unit. To address this gap and inform further research and policy in this area, we collated Australian studies over the past 30 years and systematically reviewed direct and indirect costs to the hospital system, child and family unit.

Methods

A detailed methodology is presented in Supplementary Materials. We completed a systematic review of all Australian studies reporting costs of hospitalisation and report findings as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P and PRISMA). The protocol has been registered with PROSPERO (ID: CRD42021276202).

Search strategy and selection criteria, study quality and data synthesis

Both quantitative and qualitative studies were considered for the review. The initial data search across the five databases (Embase, Medline, PsychInfo, CINAHL and Scopus) identified 8333 records. Following removal of duplicates (n = 1225), a total of 7108 studies were screened (title and abstract screening) with 88 studies included in the final review (refer eFigure 1, Supplementary Materials). Study quality and risk of bias for each study was assessed using the Joanna Briggs Critical Appraisal Tools. Study quality ratings were completed by an independent reviewer (SB) and the first author (EAD). Ratings for each criterion were assigned apriori: 0–if the study does not meet the criterion, 2—if the study meets the criterion. Conflicts were resolved following discussion with a final overall agreed rating (graded as poor, fair, or good) assigned to the study. Data synthesis as summarised in the results section, presents a summary of findings for (a) directs costs to the health care system and (b) indirect costs for the child and family unit.

Inclusion/exclusion criteria

The primary inclusion criterion was studies of inpatient paediatric hospitalisations that reported on the burden of hospitalisation or direct and indirect costs for the hospital, child and/or family unit. Direct costs are defined as the economic costs to the hospital system to deliver health care services to inpatient children. Indirect costs refer to the additional monetary expenditure incurred by the family (e.g., travel, parking, food, accommodation) and to hidden costs of hospitalisation including caregiver loss of productivity and loss of school days. Specific definitions are as follows:

Direct costs for the health care system: hospitalisation costs quantified in monetary values as reported in the literature.
Indirect costs for the child and family unit:
Economic burden costs for the child and family unit: financial burden as a result of the child's hospitalisation as reported in the literature. These include but are not limited to loss of income, loss of days' work, loss of productivity, financial costs associated with caregiver accommodation, meals, parking.
Non-economic burden for the child and family unit: resource, social and educational costs due to child hospitalisation—not quantified in monetary values—as reported in the literature. These include but are not limited to quality-of-life (e.g., subjective self-report and/or objective disability adjusted years) measures, loss of school days, educational attainment.

PICO (Participants—Interventions—Comparators–Outcomes) criteria

Participants were classified as hospitalised children under the age of 18 and/or parent/caregivers of in-patient child admissions; *Interventions* included any study that reported on costs data pre and post intervention in a hospitalised paediatric cohort; *Comparators* included any study that reported cost data across hospitalised paediatric diagnostic groups, and *Outcomes* included economic cost of hospitalisation and/or economic or non-economic cost to the child, primary caregiver and/or family unit.

Cost measures

Monetary costs reported in each study were converted to 2022 Australian dollar values using the Reserve Bank of Australia inflation calculator, a comparable approach was also used in other studies.[12] The introduction of activity based funding in Australian hospitals in 2011[13] altered the funding composition to reflect the number and mix of patients treated while taking into account medical complexity and other weight factors. This adds additional variability in comparing costs across the 30 years of the review period.

Role of the funding source

This research was supported by Hospitals United for Sick Kids (formerly Curing Homesickness). The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

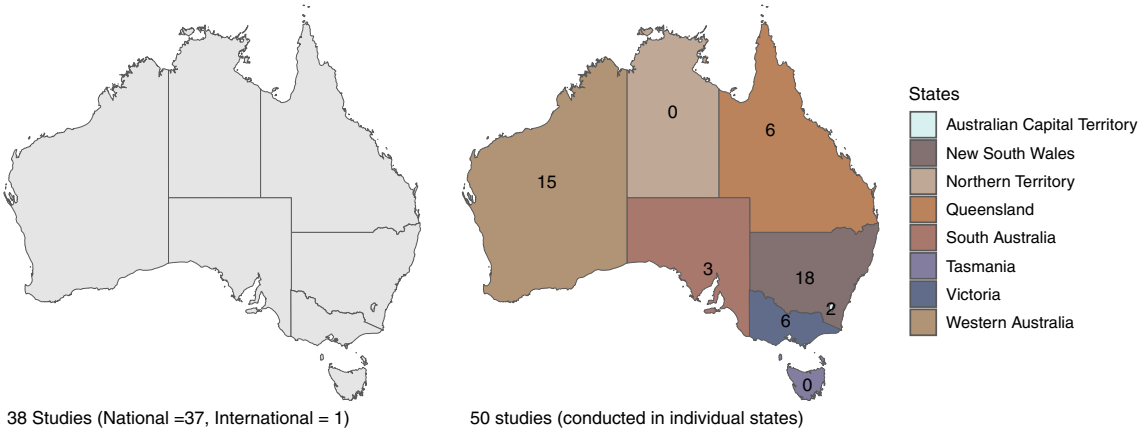

Fig. 1: Geographical distribution of studies.

Results

Eighty-eight quantitative studies were included in the review. Fig. 1 summarises the distribution of studies by geographic location. A detailed summary of study outcomes is presented in Supplementary Materials (Attachment 3). Fig. 2 summarises studies across each diagnostic category. Most studies (76%) were appraised to be of moderate to good quality. Studies reporting on direct costs to the health care system are summarised in eTables 3a–f while studies reporting on costs to the child and family are summarised ineTable 3g.

Direct costs to the healthcare system

Costs to the health care system are summarised based on reported data from: shorter term studies and studies reviewing five or 10 year trends, and specific metrics on hospitalisation costs. Findings on moderators and intervention programs are also reported.

Transdiagnostic and medical complexity related conditions (eTable 3a)

Sixteen studies reported across diagnostic conditions for medically complex hospital admissions. When considering costs in 2022 inflation values across the review period, costs per admission were comparable (AUD$2500-AUD$3,5000) for asthma, epilepsy, non-obese children[12] and those with infectious conditions[14] Higher admission costs were reported for children with intellectual disability–ID[15] or obesity,[12] (approximately AUD$10,000 and AUD$5000 respectively).

Five studies examined five- or ten-year trends across different admissions, including pre-term infants, infectious diseases and chronic conditions. The earlier study on pre-terms infants (1983–1994) reported increased survival rates for preterm infants due to improved treatment options and increased resource allocation for this group.[16] A later study (2001–2011)[17] reported that children born pre-term had higher re-admission rates and hospitalisation costs in the first six years of life compared to full term infants. For chronic conditions, increasing admission rates were reported for respiratory and neurological conditions (2002–2013). These were associated with longer LoS and contributed to nearly half of all hospital costs.[11] A comparison between acute respiratory and gastroenteritis conditions (2009–2018) noted higher admission numbers for respiratory conditions.[14] The introduction of the rotavirus vaccine (2007) and associated reduction in gastroenteritis admissions contributed to this finding. Ten-year trend data (1990–2000) for hospitalisation of Indigenous infants (0–2-year-old) showed higher re-admission rates and higher mortality compared to non-Indigenous infants.[18] The most common causes were for mainly preventable infectious conditions (respiratory and gastroenteritis).[18]

Overall, economic costs to the health system varied as a function of patient factors, with co-morbidity, medical complexity and younger age predicting higher costs and greater LoS.[1,11,12] For example, hospital costs for children with comorbid obesity were double those of healthy weight children.[12] While only 13.9% of admissions represented medical complexity, they accounted for nearly one third of total hospital costs.[1] Population-level data revealed that younger children (0–14 years) had the second highest ranking for high-resource inpatient admission costs.[19] Similarly, younger children (0–14) diagnosed with cancer had a significantly higher median annual cost for the first year of treatment compared to children diagnosed when older (15–17).[20]

There was limited research evaluating the efficacy of intervention-based programs for children with complex medical needs. Two studies reported on the implementation of a post-discharge care co-ordination program implemented by tertiary care nursing staff.[21,22] A significant decrease in hospital admissions and hospital bed-days was noted. An annual saving of AUD$2.1 million[21] and bi-annual savings of over AUD$5.6 million[22] were reported in the two studies.

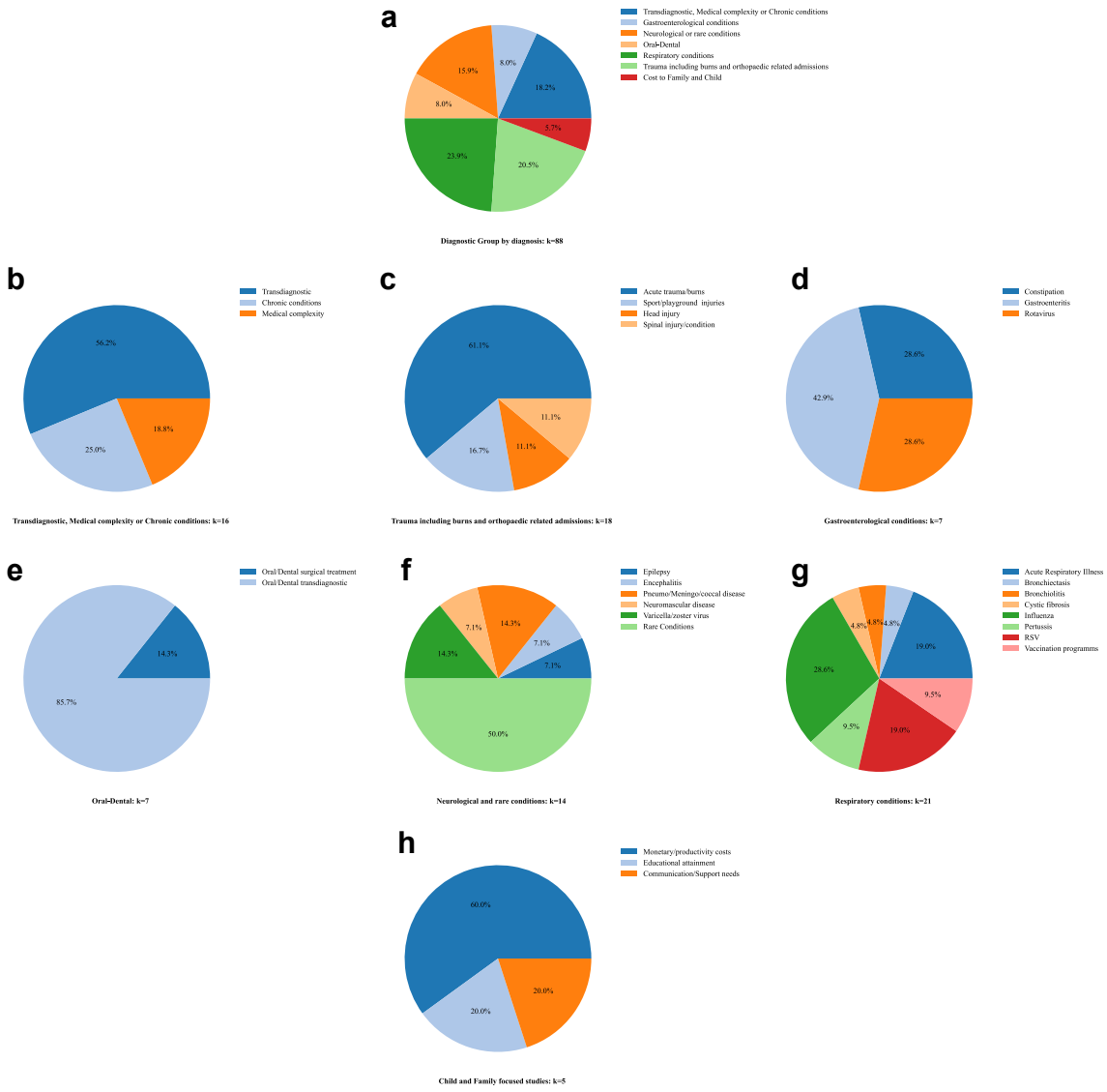

Fig. 2: Percentage of studies by diagnostic category.

Trauma - and orthopaedic- related conditions (eTable 3b)

A total of 18 studies reported on trauma- and orthopaedic-related conditions, most (k = 12) focused on acute injury and burns. The reviewed studies indicated that trauma-related hospitalisations add a significant economic burden to the health care system. Ten year trends for head and general trauma injuries (2002–2012) reported total costs of AUD$630 million[23] and annual costs of AUD$267 million[24] respectively with no downward trend. Other ten-year trends indicated that high costs are maintained for childhood injuries[24] despite education efforts on safety standards.[25] Sports-related and spinal injuries incurred one of the highest hospitalisation costs, with estimates of up to AUD$12,500 per child admission.[26] Ten year trends on assaults and self-harm in children[27] noted costs per case between AUD$4500 and AUD$5500. Notably, poor health-related quality of life outcomes were reported for seriously injured children, two years post discharge.[28]

Demographic factors, child sex, age, Indigenous background and SES, moderated some study outcomes depending also on type of admission. While comparable costs per admission were reported for head injuries for males and females,[23] males had significantly higher admission rates leading to higher overall costs. Similar gender findings were noted for burns and fall related admissions.[25,29] Playground injuries were associated with higher costs in older 10–14 year old children

compared to younger children (AUD$3700 and AUD$3000)[25] while younger children were more likely to incur increased hospital costs associated with burns and falls.[25,29,30] Indigenous children[30] had a threefold higher admission rates for falls compared to non-Indigenous children,[30] while SES moderated hospitalisation across a range of injuries.[31]

One study evaluated the cost-effectiveness of an enhanced recovery pathway (ERP) program for spinal fusion surgery. Significantly lower LoS and post-operative costs were reported for the ERP program and estimated to be nearly half (AUD$9900) of treatment as usual (AUD$19,900).[32]

Gastroenterological conditions (eTable 3c)

Five studies reported on gastroenteritis related infections and two studies on paediatric constipation. Two studies reporting on five (2007–2012) and 10-year (2000–2010) trends for gastroenteritis, noted reduction for rotavirus related infections[33] while shiga-toxin related infections remained stable.[34] The introduction of the rotavirus vaccination program in 2007 likely contributed to these findings.[35] A cost-effectiveness evaluation of the rotavirus vaccination program (2007–2012), estimated cost savings of AUD$81.91 million and significant improvement in quality-of-life-adjusted-years (QALYs).[33] Studies reporting on data prior to the introduction of the rotavirus program, noted an average annual admission rate of 21.9 per 100,000 population[36] and a higher burden of childhood gastroenteritis on Indigenous children (mean LoS 5.5 compared to 2.3).[37] Significant economic burden was noted for paediatric constipation estimated at AUD$5773 per admission. Predictors of readmission included older age (10–18 years), male gender, rural residence and severe SES disadvantage.[38,39]

Oral-dental conditions (eTable 3d)

Seven studies reported on hospital admissions for oral/dental conditions. Direct hospital costs for oral treatment for the period 2000 to 2009 were AUD$125.4 million.[40] Indirect costs (estimated for travel, accommodation, loss of productivity, absence from work and patients' absence from school) contributed a further 50% for a total cost of AUD$188.1 million. Indigenous children and those living in remote areas showed substantial increases in hospitalisations over the period.[41,42] Several studies noted that some admissions could be preventable with better access to primary care.[43,44]

Neurological conditions and rare infectious or hereditary conditions (eTable 3e)

Fourteen studies reported across neurological and rare conditions with a detailed summary provided in eTable 3e. A moderate impact on hospitalisation rates was noted in an evaluation of the varicella vaccination program[45] for the period 2008–2015. Examination of 10-year trends (2002–2013) for invasive infections[46] noted higher ICU admission rates (47.6 vs 15.9 per 100,000/year) and mortality rates (2.67 vs 1.04) for Indigenous compared to non-Indigenous children. Two studies reported on the cost-effectiveness of HITH programs. A HITH program for children with cellulitis was shown to be more cost-effective and of comparable quality to care in hospital[47] while a home mechanical in-exsufflation program for children with neuromascular disease contributed to a reduction in hospital LoS.[48]

Respiratory conditions (eTable 3f)

The 21 reviewed studies identified a significant burden of respiratory disease, particularly among younger children, those with chronic conditions and children of Indigenous status.[49,50]

Three studies reported on 10-year trends[51–53] for a range of respiratory conditions while one study reported on the prevalence of the respiratory syncytial virus (RSV) in a high at-risk population for the period 1996–2017.[54] The latter study noted that RSV was the second most prevalent virus, particularly in children under two years of age admitted with bronchiolitis.[54] Ten year trend data for acute lower respiratory infections (ALRI) noted highest hospitalisation rates (69.9/1000 child years) for infants (0–3 months) which decreased to 21.7 for 1–2 year olds and 7.0 for 2–5 year old children.[52] Indigenous children had the highest incidence for RSV hospitalisations, while children with bronchopulmonary dysplasia (BPD) the second highest (11.0 and 10.2). Direct costs per case, however, were higher for RSV admissions for children with BPD (AUD$16,900).[52] Influenza related admissions with chronic lung conditions compared to those without, were associated with higher incidence and costs per episode (approximately AUD$26,100 and AUD$6000). Risk factors associated with RSV hospitalisations in the first two years of life included disadvantaged SES, maternal smoking during pregnancy and male sex.[51]

Several studies identified Indigenous status as a high-risk factor for respiratory conditions[52,54] with younger children being more vulnerable.[54] Increased risk of hospitalisation for ALRI was identified in Indigenous infants following pneumococcal vaccination.[55]

Influenza was shown to have a significant disease burden in otherwise healthy children.[56,57] Two studies indicated a significant burden on hospitalisation for respiratory conditions such as bronchiolitis and pertussis, leading to greater use of ICU resources despite an overall reduction in LoS for this condition.[58,59] LoS, younger age and severity of the condition were found to be predictive of higher hospitalisation costs for bronchiectasis. Two studies[60,61] identified factors that predict testing for respiratory viruses in hospital and reported on methodology to improve their estimates in hospitalised children. Predictors included gestational

age, maternal smoking during pregnancy, and geographic region at birth. Utilising linked laboratory and hospital data instead of ICD codes alone, improved ascertainment of ALRI related viruses.

The introduction of the universal funding initiative for influenza vaccinations contributed to a significant decrease in hospitalisations,[49] barriers remain however to universal coverage. These included limited provision of information to families about preventive immunisation programs and lack of understanding of its role in preventing illness and hospitalisations.[62] A HITH program for bronchiectasis contributed to an overall reduction in hospital costs.[63]

Indirect costs for the child and family (eTable 3g)

Indirect costs refer to both monetary and non-monetary burden experienced by the child and family. Three studies[10,64,65] reported on family costs for travel/parking, accommodation/meals. and loss of productivity. They concluded significant financial burden particularly for single-parent families and those of low income.[10,64,65] The first study (2004),[64] reported weekly costs of around AUD$315, while the second study (2010)[10] identified costs between AUD$400 to over AUD$530 per week (for budget and average meals respectively). A more recent study (2018)[65] estimated AUD$687 per patient day including loss of productivity. Productivity estimates were based on time off work by caregiver and other family/friends to care for the child in hospital and other dependents. Travel costs were estimated at AUD$104 per day while meals, accommodation and incidental expenses were estimated at AUD$42 per day. Living in a remote area and greater distance travelled correlated with higher family costs. While families report high financial burden associated with their child's hospitalisation, programs such as family-centred care contribute to positive outcomes for the child and family in hospital.[66]

One longitudinal study reported on the adverse longer-term impacts of hospitalisation on educational attainment.[67] Children with higher frequency of re-admissions and greater LoS were two to three times more likely to perform 'below national minimum standards' (BNMS) on national literacy and numeracy tests. At each grade, children hospitalised for mental health and/or behavioural conditions were at the highest risk to perform BNMS.[67]

Some studies reporting on direct costs to the health care system also reported on indirect costs to the family (e.g., loss of productivity and incidental costs such as travel or accommodation)[40,41,47,63] These were estimated on various hospital metrics including LoS.

Discussion

The systematic review summarises 88 Australian studies investigating the direct and indirect costs of paediatric hospitalisation on the healthcare system, the children and their families. Overall trends point to direct hospital costs remaining relatively stable over reported ten-year periods with some admission types reporting increased costs over time. It is noted, however, that the introduction of activity-based funding in 2011[13] altered fund-allocation to tertiary health care. The implications of this funding format to comparisons of cost outcomes and hospital metrics is still under review.[68] While only a very small number of studies addressed indirect costs to children and families, they identified a significant burden with greatest impacts on single-parent families and those of low income.

When considering hospital specific factors, few studies reported on the cost effectiveness of systemic changes such as novel care programs (e.g., ERP) and interventions (e.g., HITH). These studies reported positive outcomes for both direct and indirect costs of hospitalisation. Non-hospital specific factors including demographic characteristics and admission type moderated direct and indirect costs. Children with disadvantaged SES, Indigenous background or children with chronic conditions were identified as particularly at-risk across a range of direct and indirect cost metrics. These included increased LoS, significantly higher hospitalisation rates and poor educational outcomes.

Demographic characteristics

Age, sex, Indigenous status and SES disadvantage all have predictive value on monetary costs and the burden of hospitalisation and could therefore be the target for preventive programs. Younger age presents a heightened risk for multiple impacts including respiratory conditions (irrespective of the presence of co-morbidities),[53,57,63] and burns.[29] Male sex was also associated with higher admission rates across a range of conditions including burns,[29] respiratory infection (RSV)[52] and injury-related diagnoses.[26,30,69,70] Advantaged SES lessened the likelihood of hospitalisation for influenza[51,52] and for a range of injuries (assault, poisoning, burns and pedestrian collisions).[31] In contrast, obese children had a higher hospitalisation risk if from a disadvantaged SES.[12]

The above findings point to the importance of disease modelling, health education and evaluation of preventive programs particularly in cohorts demonstrating greater disease burden. The discriminating factors that contribute to these findings can then be better determined. Several studies noted for example, that despite national prevention programs, (e.g., playground safety, obesity, vaccinations), there continues to be unmet needs for select demographic cohorts. Integration of programs between primary and tertiary health care and across hospital systems and processes is also important. For example, poor integration between hospital post-discharge services and primary health care professionals, or lower

engagement by primary health professionals in promoting health initiatives can contribute to higher hospitalisation rates and increased costs.[71] Where these relationships have been managed successfully[72] it has led to significant gains for the hospital, child and family.

The health status of Indigenous children remains at a significant disadvantage compared to their peers. This was particularly evident for respiratory,[50,52,54] infectious[36] and oral dental conditions.[43] Comparable findings for respiratory conditions have been reported for Indigenous American[73] and Canadian[74] children. Of particular concern are the observations that more recent studies do not identify significant improvements. For example, a study completed in 2007 showed that Indigenous children had higher risk of multiple admissions and mortality due to meningitis, bronchiolitis and gastroenteritis.[18] A study completed 10 years later continued to show that invasive infections and associated incidence and mortality rates, were higher in Indigenous children.[46] This aligns with broader health findings for Indigenous children and lack of progress to address gaps in health and other outcomes.[75]

Broader systemic factors, also contribute to the observed health disadvantage of Indigenous children. A number of studies identified that the hospital experiences of Indigenous Australians is moderated by additional factors beyond those experienced by other populations[76] and this is also relevant when recruiting Indigenous patients for research studies.[77] This highlights the importance of conducting culturally sensitive and inclusive research in order to best identify and address health disparities.[78] Importantly, broader system changes targeting tertiary education to strengthen the cultural competence of students, with an example in dentistry and oral health,[79] can facilitate positive health outcomes in Indigenous populations.

The impact of demographic factors noted in this review is consistent with findings reported in international studies. Studies conducted across low to high income countries, generally report disadvantaged SES as a significant moderator of hospitalisation burden for discrete conditions, e.g. respiratory, infectious, and across admissions, regardless of type of health care system and insurance status.[80] The increasing impetus on identifying social determinants of health[81] can inform policy at the tertiary level of care and lead to improved outcomes. Universal screening programs in clinical settings[82] can facilitate strategies to identify and support families with particular needs.[83]

High risk cohorts

The review has identified high risk hospital admission cohorts include children with complex/chronic conditions[12] and intellectual disability (ID).[15] Population based studies showed that chronic health conditions account for nearly half of hospital costs[11] and impact the child's immediate (e.g., LoS, readmission rates)[84] and longer term outcomes (e.g., education). Similar findings on hospitalisation rates and costs were reported for children with ID.[15] In both cohorts, barriers in access/availability of targeted primary/community health care services were noted to be contributing factors for hospital admissions. Targeting these cohorts with programs that have demonstrated effective outcomes, for example improved clinical pathways, early interventions and care co-ordination,[72] can lead to reduced costs to the healthcare system and the child/family. For example, the implementation of a targeted care-co-ordination program in high risk cohorts in two Australian hospitals led to less travel and reductions in short term readmissions. Success of the program was in part attributed to sustainable relationship building between primary and tertiary care services and a well-supported clinical care co-ordination program. These are important factors that must be addressed to effectively mitigate systems and policy changes.

Burden of hospitalisation on the child and family

The limited number of studies that directly examined child and family burden identified significant economic[10,64,65] and non-economic costs and unmet needs.[67] Single parent families and those of lower SES were noted as the most disadvantaged. These findings are comparable to international studies that report on family financial hardship,[85] with low-income families and those with children with high-risk conditions been particularly vulnerable.[86] It is noted that financial burden is not limited to particular socioeconomic groups and cohorts but it is identified across the paediatric population.[86] This is of particular importance in countries like Australia with its universal access to healthcare. Indirect family costs may as a result, have received less focus as also evidenced by the small number of studies in this area. This can–and has been addressed at least in some Australian hospitals–by hospital clinical services. Universal support services include free integrated television/Wi-Fi services and sleeping arrangements by the child's bedside. Other services based on family needs, include free accommodation near the hospital and subsidised government support for accommodation and transport. International studies have shown that opportunity to stay with the child facilitates family-centred care and has positive outcomes for both the child and family.[87] Regardless of these options, enhancing awareness on the family burden of hospitalisation, and identifying the populations most at need, can facilitate targeted interventions for these groups.

Preventative, intervention and novel models of care

Studies reporting on novel care and support models, (ERP, FCC, HITH)[32,47,66] and preventive health programs identified their utility to enhance delivery of care and

reduce costs. Although only a small number of studies were conducted in Australian hospitals, overseas findings point to promising health outcomes.[88] Almost all reported health prevention programs related to immunization initiatives. These generally noted reduction in hospitalisation rates and hospital costs when effectively utilised.[33] The importance of maintaining active surveillance of hospitalisation admissions (e.g., for influenza), to inform policy was quantified in two studies.[89,90] These reported that on-going detailed data collection of the factors associated with infectious diseases, significantly contributes to bridging research gaps and improving health policy response.[89,90] Complementing the above findings, two studies identified that low uptake of vaccination for influenza for children was in part due to insufficient understanding by parents on its importance, and lower engagement in the program by primary health care professionals.[53,71] The studies highlight the importance of communication and engagement between services when delivering prevention programs as well as ensuring that education initiatives target niched as well as broader population groups.

The review's overall findings point to policy implications for the Australian healthcare system. The importance of primary care access and community education was highlighted in many of the studies. For example, costs associated with respiratory admissions would be moderated by the uptake of freely available influenza vaccines. Strengthening parent education efforts to improve vaccination rates could contribute to reduction of respiratory admissions. It is widely reported both on the Australian and international health systems[91,92] that improving primary access to health care leads to reduction of hospital admissions particularly for short-term stays.[7]

Limitations

A number of limitations were identified in this review. These relate to methodological differences between studies including on definitions and reporting of direct and indirect costs (e.g., annualised vs costs per admission or different components for out-of-pocket costs). Methodological differences in definitions of diagnostic conditions, e.g., criteria for trauma,[93] and differences in the reporting criteria of incidence, prevalence and costs, limit opportunity to directly compare between studies. Discrepancies in the definition of diagnostic criteria are of a particular concern. One study showed[94] that a higher number of otherwise preventable hospitalisations would be identified with improved methodology and could contribute to better outcomes on disease burden. In addition, there are significant gaps in the literature that limits this review. For example, there were no studies evaluating the direct and indirect cost of hospitalisation for those with mental health or neurodevelopmental conditions, both of which are known to be associated with increased hospitalisation rates. Further, only a small number of studies examined the burden of hospitalisation on the child and family. It is also of note that there is often significant lag between collection of data and publication of findings. This may negatively influence policy advice and the development of appropriate strategies to reduce disease burden. The 30-year period considered in this review may also be considered a limitation as earlier findings may have been addressed by policy and system changes; however, it allowed us to comprehensively evaluate the state of the literature to date.

Future directions

The systematic review highlights the need for further high quality research to address factors that contribute to the disease burden of paediatric hospitalisations. In particular, high quality research that specifically measures direct and indirect financial costs as well as the costs/impact of psychosocial burden to children and to families should be a priority.

Second, there is a clear need for early identification and preventive approaches for at-risk groups identified in the literature particularly disadvantaged children and their families. The importance of preventive health care strategies to reduce hospitalisation rates and re-admissions, were identified as a priority in a number of studies. Addressing modifiable risk factors through enhanced primary health care models particularly for chronic conditions, would further minimise the burden of disease for both the hospital care system and the family unit. Benefits to the family unit extend to gains in productivity and improved quality of life. Long term benefits (e.g., child educational attainment) would contribute to decreased societal costs.

Third, the review findings support extending evaluations of novel interventions (e.g., HITH, ERP) and expansion of care models such as integrated care-coordination services to a broader range of conditions. These have demonstrated positive outcomes for both direct and indirect costs of paediatric hospitalisations.

Further, particular attention should be placed in identifying determinants of social disadvantage to ensure that families experiencing significant burden can be supported when their child is in hospital.

Conclusion

The reviewed studies confirm the continuing high direct and indirect costs associated with paediatric hospitalisations. Although policy and systems have changed over the 30-year review period, there remain unmet needs and challenges for the health care system, across paediatric admissions and for specific cohorts. These include Indigenous children, families of disadvantaged background and specific high at-risk groups. The review however also points to positive future directions that can build on current findings. Targeting identified cohorts

at-risk, further extending and evaluating novel interventions and health care models can lead to the reduction of direct and indirect costs and ameliorate the psychosocial burden on children and families.

Contributors

EAD. Conceptualisation, data curation, methodology, study design, literature search, data collection, data interpretation, writing original draft, writing review and editing.
KB. Data interpretation, writing–review and editing.
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CS. Data visualisation.
AG. Conceptualisation, supervision, data interpretation, writing–review and editing.

Data sharing statement

The data upon this systematic review was based is available on request.

Editor note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

We declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2023.100878.

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