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Caregiver's attitudes, beliefs, and experiences for influenza vaccination in Australian children with medical comorbidities

Daniel A. Norman [a,b], Margie Danchin [c,d,e], Paul Van Buynder [f,g], Hannah C. Moore [a], Christopher C. Blyth [a,b,h,i], Holly Seale [j,*]

[a] Wesfarmers Centre of Vaccines and Infectious Diseases, Telethon Kids Institute, University of Western Australia, WA, Australia
[b] School of Medicine, University of Western Australia, WA, Australia
[c] Department of General Medicine, The Royal Children's Hospital, VIC, Australia
[d] Department of Paediatrics, University of Melbourne, VIC, Australia
[e] Vaccine and Immunisation Research Group, Murdoch Children's Research Institute, VIC, Australia
[f] Griffith University, Southport, QLD, Australia
[g] Gold Coast Hospital and Health Service, Australia
[h] Department of Infectious Diseases, Perth Children's Hospital, WA, Australia
[i] Department of Microbiology, PathWest Laboratory Medicine, WA, Australia
[j] School of Public Health and Community Medicine, University of New South Wales, NSW, Australia

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ABSTRACT

Background: Influenza vaccination is recommended and funded for Australian children with medical comorbidities that increase their risk of severe influenza. Despite this, influenza vaccine coverage remains low within this population. We examined caregivers' attitudes and practices for influenza vaccination in children with medical comorbidities.

Methods: Cross-sectional surveys were conducted with caregivers of children (6 months to <18 years old) with medical comorbidities attending sub-speciality paediatric outpatient clinics at the Royal Children's Hospital (Melbourne), Princess Margaret Hospital (Perth), and Leading Steps private paediatric clinic (Gold Coast). Multivariate linear regression was used to identify surveys responses predictive of receipt of influenza vaccination in 2017.

Results: From the 611 surveys collected, 556 were suitable for analysis. Caregiver reported 2017 influenza vaccine coverage was 52.2% in children with medical comorbidities. Caregivers who believed influenza vaccines to be ≥50% effective were more likely to vaccinate their children (adjusted Odds Ratio [aOR]:3.79 (2.41; 5.96). Those who expressed concerns about vaccine side effects were less likely to vaccinate their children (aOR: 0.49 [95% CI: 0.30; 0.80]). Influenza vaccine uptake was significantly more likely for children who had been previously recommended influenza vaccination by their hospital-based physician (aOR: 4.33 [95% CI: 2.58; 7.27]) and had previously received a hospital-based vaccination (aOR: 3.11 [95% CI 1.79; 5.40]). Hospital-based physicians were also caregivers' most commonly reported source of trusted vaccination information (63.5%). Whilst only 29.3% of caregivers reported their child had been recommended influenza vaccination during a previous admission, 80.1% of caregivers stated they were receptive to their child receiving potential future influenza vaccinations during hospitalisations.

Conclusions: Reported influenza vaccination coverage in children with medical comorbidities remains inadequate. An important finding of this study is that influenza vaccination recommendation by children's hospital physicians and previous vaccine receipt in hospital was associated with vaccine uptake. Opportunities for vaccination, especially during hospitalisation, must be examined.

1. Introduction

Influenza vaccination is currently the most effective influenza prevention strategy [1]. As such, the Australian government funds

Abbreviations: aOR, adjusted odds ratio; WA, Western Australia; NIP, National immunisation program; GP, General practitioner.

* Corresponding author at: School of Public Health and Community Medicine, University of New South Wales, Samuels Avenue, Kensington, NSW 2033, Australia.
E-mail address: h.seale@unsw.edu.au (H. Seale).

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influenza vaccination on the National Immunisation Program (NIP) for high-risk groups including children with specific medical comorbidities [2]. These comorbidities include, cardiac conditions, respiratory conditions, neurologic conditions, immunodeficiency, malignancy, and metabolic conditions. Children with medical comorbidities are at greater risk of severe influenza infection and influenza-associated morbidity including hospitalisation [3]. As such all Australian hospitals promote influenza vaccination however vaccine delivery does vary between hospitals and clinics. At Australian paediatric hospitals, influenza vaccines are generally delivered on wards or at centrally located immunisation clinics. During the 2017 influenza season, 1268 children were admitted to Australian's hospitals for confirmed influenza of which 45.1% had known medical comorbidities [4].

Comprehensive national influenza vaccine coverage data do not exist in Australia. Accessing Australian influenza vaccination coverage is complicated by multiple factors. From the small number of studies conducted to date, it appears that there is low influenza vaccine coverage in Australian children both overall and amongst those with medical comorbidities [5,6]. Studies have shown wide variation in uptake for Australian children with medical comorbidities ranging from 2.5% to 41% [3,7]. Comparatively, extensive active surveillance by National Immunization Survey influenza vaccination coverage for all children in the United States for 2016–17 northern hemisphere influenza season was estimated at 59% (95% CI: 58.3%; 59.7%) [8].

Parents of children attending Australian paediatric hospital outpatient clinics were previously identified to be more likely to vaccinate their child if they believed influenza vaccines were safe and effective and they had received a recommendation from a healthcare provider [7]. Understanding these factors and potential differences is critical to informing message framing and development of interventions to improve vaccine coverage in children with medical comorbidities. Therefore, we aimed to: (1) identify influencing factors for influenza vaccination in children with medical comorbidities and (2) explore caregiver's attitudes for influenza vaccination in children with medical comorbidities. This study represents the first attempt to evaluate influenza vaccination in children with medical comorbidities over multiple hospital sites and one private clinic across several Australian states.

2. Methods

2.1. Study population

Caregivers of children attending subspecialty outpatient clinics at two major Australian tertiary paediatric hospitals, Royal Children's Hospital, (Melbourne) and Princess Margaret Hospital, (Perth) were invited to participate during their child's outpatient visit. Additionally, caregivers of children attending a private paediatric practice (Gold Coast) were sent an online survey after their child's appointment. Surveys were completed between July and December 2017, during and following the peak of Australia's influenza season. During recruitment, the Melbourne and Perth sites were located with major metropolitan centres serving state-wide populations of nearly 6.3 and 2.6 million people respective with 18.8% of populations aged less than 15 years old [9]. Whereas the Gold Coast site served a population of approximately 540,000 [10].

Participants were eligible to complete the survey if they had a child aged 6 months to <18 years old attending any of the study's clinics with one or more previously diagnosed medical condition/s known to increase severe influenza risks, classified by the Australian Immunisation Handbook 10th edition [2]. Participants were required to be able to comprehend all questions in English without assistance. Consent was obtained at the Perth and Melbourne sites with return of completed surveys. For the Gold Coast site, consent was given during commencement of the online survey. Ethics approval was obtained from the ethics committees of Child and Adolescent Health Service Western Australia (WA) Health, Royal Children's Hospital Human Research Ethics Committee Melbourne, and Gold Coast Hospital and Health Service Human Research Ethics Committee.

2.2. Data collection

An anonymous cross-sectional survey of 21 multiple choice questions and 8 optional open response questions was developed, based on previous a similar survey (H Seale, unpublished) and the WHO SAGE Working Group on Vaccine Hesitancy's guidelines [11]. Information collected through the surveys included children's reported influenza vaccination status for 2016 and 2017, sources of children's influenza vaccination recommendations, reminders, and caregivers' vaccine related beliefs. Influenza vaccination status was defined as receiving at least one influenza vaccine during the respective influenza season. General sociodemographic characteristics of caregivers, children's hospitalisation history and medical comorbidity status were also collected. Caregivers' attitudes and beliefs about influenza infection and vaccine side effect were measured on four-point Likert scales. Caregivers' understanding of influenza vaccine effectiveness was gauged on a five-point scale of 0%, 25%, 50%, 75%, and 90–100%. Surveys were acceptable for analysis if children met age requirements, had one or more medical comorbidities, and at least 75% of survey questions were completed.

2.3. Data analysis

Statistical analysis was performed using STATA 15.1 (StataCorp. College Station, Texas). With children's influenza vaccination status in 2017 as the primary dependent variable and survey responses as independent variables; adjusted odds ratios and 95% confidence intervals were estimated from logistic regression models. Analyses were adjusted for study site, child age, hospitalisation in past 12 months, previous influenza-related hospitalisations, caregivers' tertiary education, caregivers' employment status, high risk medical comorbidities and multiple comorbidities. For analysis, the four-point Likert-type scales of influenza infection and vaccine side effects concerns were collapsed into binary values with 'very concerned' and 'somewhat concerned' forming 'concerned'; additionally, 'not too concerned' and 'not at all concerned' formed 'not concerned'. The five-point scale of vaccine effectiveness belief was similarly collapsed to the binary values of either <50% or ≥50% effective. This was done to include influenza infection concerns, vaccine side effect concerns and vaccine effectiveness belief within the linear regression model. Answers of 'unsure' and 'don't know' for these questions were removed for analysis. Open questions were used to expand on specific vaccine issues including specific vaccine side effect concerns, factors influencing vaccination decisions, and alternative influenza prevention methods.

3. Results

Between July and December 2017, 611 surveys were collected of which 556 were included in the analysis. Of the 55 surveys excluded: 51 did not indicate the child's chronic medical condition/s, 3 were <75% completed, and one respondent's child was 18 years old. From the 556 surveys analysed, 474 surveys were paper based and completed at outpatient departments with the remaining 82 (14.8%) completed online. The median number of high-risk comorbidities per child was 1 (range: 1–5) while 15.8% of children reported having >1 high risk condition. Chronic respiratory diseases were the most commonly reported high-risk condi-

tion (30.8%, Table 1) and children with chronic respiratory diseases had the highest vaccination coverage in 2017 at 60.8%. Immunocompromised children had the second highest coverage at 56.9%, followed by children with cardiac conditions at 53.4% and neurological conditions at 51.1%.

Overall reported influenza vaccine coverage in 2017 was 52.2%. For children, eligible for vaccination for both 2016 and 2017's influenza seasons (i.e. aged ≥2 years in 2017), reported vaccination rates were 52.4% for 2017 and 53.7% in 2016. Reported vaccination status for 2017 varied between sites with Melbourne having the greatest coverage (56.5%) followed by Gold Coast (54.3%) and Perth (41.2%) (Table 1).

3.1. Caregivers' attitudes

Caregivers reported varying degrees of concerns about influenza severity, influenza vaccine side effects and effectiveness. Approximately half had concerns about the severity of influenza infection (very concerned 22.3%; somewhat concerned 23.9%), while only a quarter were concerned about influenza vaccine side effects (very concerned 12.7%; somewhat concerned 13.2%). However, Perth caregivers were almost three times more likely (OR 2.97 [95% CI 1.92; 4.58]) to express concern for vaccine side effects than non-Perth caregivers. Only 22.8% felt that influenza vaccination was effective less than half the time, with 53.8% caregivers believing that it was ≥75% effective (Table 2).

3.2. Factors influencing vaccine uptake

The strongest predictor for reported influenza vaccination in 2017 was having reported influenza vaccine receipt in 2016 for children ≥2 years old (aOR: 20.77 [95% CI 12.66; 34.07]). Whilst higher vaccine coverage was observed in children with multiple medical comorbidities (62.5% vs 50.1%), this factor was not statistically associated with increased influenza vaccination likelihood after adjustment for potential confounders (aOR: 1.03 [95% CI 0.52; 2.05]). After adjustment, only chronic respiratory conditions were statistically associated with increased influenza vaccination likelihood (aOR: 2.71 [95% CI 1.57; 4.73]).

Influenza vaccine receipt was positively correlated with caregivers' belief that influenza vaccines are ≥50% effective (aOR: 3.81 [95% CI 2.44; 5.94]), a previous vaccine recommendation from their child's hospital physician (aOR: 4.65 [95% CI 2.80; 7.73]), and the child previously receiving a 'hospital-based' vaccination either as an inpatient or during an outpatient appointment (aOR: 3.06 [95% CI 1.78; 5.25]). Unvaccinated children more frequently received no vaccine recommendation (aOR: 0.30 [95% CI 0.17; 0.54]), received their previous vaccinations in community clinics (aOR: 0.45 [0.23 – 0.87]) and had caregivers expressing concerns for influenza vaccine side effects (Table 3).

Only 29.3% of caregivers reported their child being recommended for influenza vaccination during a previous hospitalisation. Of those children who received a recommendation, only 33.7% were reported to have been vaccinated during these respective hospitalisations. However, amongst all participants surveyed, 80.1% stated they were happy for their child to receive influenza vaccination during a potential future hospitalisation.

While 44.2% recalled previously receiving an influenza vaccination reminder, receiving any form of reminder was not associated with influenza vaccine uptake (aOR: 0.99 [95% CI 0.70; 1.41). However, most caregivers (68.4%) agreed to potentially registering their mobile phone number to receive SMS reminders for influenza vaccinations in the future. Willingness of caregivers to register their mobile was additionally associated with vaccine uptake (aOR: 1.87 [95% CI 1.27; 2.75]).

Table 1
Demographics, site, comorbidities, vaccination status and hospitalisations.

	Paediatric outpatients (n = 556)
Demographics	
Average child age (years) [std.]	8.17 (4.65)
Child male gender (%)	275 (49.5%)
English spoken at home (%)	538 (96.8%)
Australian born caregiver (%)	432 (77.7%)
Caregiver tertiary education (%)	454 (82.1%)
Employed caregiver (%)	366 (65.8%)
Site	
Melbourne: public paediatric hospital outpatient clinics (%)	336 (60.4%)
Perth: public paediatric hospital outpatient clinics (%)	138 (24.8%)
Gold Coast: private paediatric clinic (%)	82 (14.8%)
Comorbidities	
Median number of comorbidities [range]	1 [1 –5]
Multiple disease conditions (%)	88 (15.8%)
Chronic cardiac condition (%)	103 (18.5%)
Chronic respiratory condition (%)	171 (30.8%)
Chronic neurological condition (%)	94 (16.9%)
Immunocompromising condition (%)	116 (20.9%)
Preterm birth (%)	51 (9.2%)
Down syndrome (%)	23 (4.1%)
Other disease conditions* (%)	122 (21.5%)
Influenza vaccination status	
Vaccinated in 2017 (%)	290 (52.2%)
Vaccinated in 2016 and 2017 [children ≥ 2 years old; n = 498] (%)	219 (44.0%)
Previous hospitalisation	
Previous influenza hospitalisation (%)	65 (11.7%)
Previous hospitalisation in the past 12 months (%)	285 (51.3%)

* Other comorbidities include: long-term aspirin use, liver disease, diabetes, and all other high-risk conditions. Multiple comorbidities were defined as more than one concurrent comorbidity types being selected on respondent surveys.

Table 2
Likert scale responses to caregivers influenza attitudes and belief questions.

Attitude and belief question responses No. (% of total n)	Vaccinated 2017 No. (% of group)
Degree of caregiver concern for influenza (n = 552)	
Very Concerned (n = 123, 22.3%)	72 (58.5%)
Somewhat Concerned (n = 127, 23.0%)	70 (55.1%)
Not too Concerned (n = 193, 35.0%)	101 (52.3%)
Not at all Concerned (n = 95, 17.2%)	39 (41.1%)
Not sure (n = 14, 2.5%)	6 (42.9%)
Degree of caregiver concern for influenza vaccine side effect (n = 553)	
Very Concerned (n = 70, 12.7%)	16 (22.9%)
Somewhat Concerned (n = 73, 13.2%)	28 (38.4%)
Not too Concerned (n = 166, 30.0%)	88 (53.0%)
Not at all Concerned (n = 232, 42.0%)	152 (65.5%)
Not sure (n = 12, 2.2%)	5 (41.7%)
Caregiver influenza vaccine effectiveness belief (n = 528)	
Not effective: 0% of the time (n = 21, 4.0%)	5 (23.8%)
Somewhat effective: 25% of the time (n = 88, 16.7%)	32 (36.4%)
Effective: 50% of the time (n = 114, 21.6%)	61 (53.5%)
Very effective: 75% of the time (n = 202, 38.3%)	129 (63.9%)
Extremely effective: 90–100% of the time (n = 58, 11.0%)	43 (74.1%)
Don't know (n = 45, 8.5%)	17 (37.8%)

4. Discussion

Overall, we observed higher reported influenza vaccine coverage than previous evaluations in Australian children with medical comorbidities, with over half of children reported to have received

Table 3
Predictors of high-risk children's influenza vaccination in 2017.

2017 Vaccination Predictor	n	Crude odds ratio (95% CI)	Adjusted odds ratio** (95% CI)
Influenza Vaccination History			
Received influenza vaccine in 2016. (Children ≥ 2 years old)	225	16.40 (10.54– 25.53)	20.77 (12.66 – 34.07)
Caregiver Beliefs & Concerns			
Influenza vaccine believed to be effective (≥50%).	374	3.64 (2.50 – 5.31)	3.81 (2.44 – 5.94)
Concerned about influenza infection.	250	1.40 (1.00 – 1.96)	1.20 (0.81 – 1.78)
Concerned about influenza vaccine side effects.	143	0.30 (0.20 – 0.45)	0.43 (0.27 – 0.69)
Believe in other better ways to protect children from flu.	112	0.70 (0.47 – 1.07)	1.45 (0.86 – 2.45)
Previous Influenza Vaccine Recommendation Sources			
Child's Hospital Physician	215	8.01 (5.33 – 12.03)	4.65 (2.80 – 7.73)
Child's GP	185	2.82 (1.94 – 4.10)	1.43 (0.87 – 2.34)
No Recommendation	169	0.14 (0.09 – 0.21)	0.30 (0.17 – 0.54)
Hospital Nurse	69	2.90 (1.65 – 5.12)	1.35 (0.68 – 2.69)
Family Members/Friends	39	1.06 (0.55 – 2.04)	0.81 (0.37 – 1.74)
Community Nurse	19	1.01 (0.40 – 2.52)	0.75 (0.26 – 2.17)
Primary Location of Previous Childhood Vaccinations			
GP's Clinic	354	0.69 (0.49 – 0.98)	0.98 (0.60 – 1.61)
Paediatrician's Clinic	176	1.82 (1.26 – 2.63)	1.27 (0.80 – 2.01)
Hospital	140	3.64 (2.37 – 5.60)	3.06 (1.78 – 5.25)
Community vaccine clinic	62	0.39 (0.22 – 0.68)	0.45 (0.23 – 0.87)
School	53	0.49 (0.27 – 0.88)	0.60 (0.30 – 1.18)
Specialist's clinic	25	2.00 (0.84 – 4.68)	1.72 (0.67 – 4.41)

** Adjusted for site, child age. hospitalisation in the past 12 months, influenza hospitalisation history, caregiver tertiary education, caregiver employments status, Australian born caregivers, Down syndrome status, chronic respiratory disease status, chronic neurological disease status, immunocompromised status, pre-term status, other diseases conditions group, and multiple disease conditions.

influenza vaccination in 2017 [6,7,12]. The relationship between influenza vaccine coverage and caregivers' view of influenza vaccine effectiveness and of vaccine safety concerns is consistent with previous Australian findings [7,13]. However, our findings identified the importance of hospital-based factors in influencing influenza vaccination coverage in children with medical comorbidities. We found that a recommendation by the child's hospital specialist, and previous hospital-based vaccinations were strong predictors of children reportedly receiving influenza vaccination in 2017. Furthermore, the hospital setting's importance is highlighted by the insignificance of general practitioners' (GP) influenza vaccine recommendations and previous vaccinations at GPs' or paediatricians' clinics on influenza vaccine uptake in these children. With 80.1% of caregivers agreeing to potential influenza vaccine delivery for their children during a future hospitalisation there is strong potential for acceptance of hospital-based influenza vaccination in children with medical comorbidities.

These findings echo Rao et al.'s observations in 1001 surveyed parents of paediatric inpatients at Children's Hospital, Colorado between October 2014 to March 2015 [14]. In their study, only 28% of parents agreed they would prefer their child to receive influenza vaccination from their child's primary care provider. Additionally, the authors found 71% of parents with vaccinated children agreed to potential future inpatient hospital influenza vaccine delivery versus 53% of parents with unvaccinated children [14]. These results align with our findings that strongly support for potential hospital-based vaccine delivery in children with medical comorbidities.

Rao et al. additionally identified through surveying of inpatient clinical providers, 80% agreed they believed parents would refuse influenza vaccination due to their child's illness, only 32% of parents surveyed agreed to the statement '*My child is too sick to receive flu vaccine*' [14]. This disconnect between providers' and parents' perceptions of children's illness and influenza vaccine acceptance illustrates potential barriers with clinical providers for hospital-based paediatric influenza vaccine delivery.

Future interventions should aim to both increase hospital physicians' awareness of their role with influenza vaccination recommendation to children with medical comorbidities and the promotion of opportunistic hospital-based vaccination for these children. Previously, a multicomponent intervention targeted influenza vaccination in paediatric oncology outpatients through vaccination education and patient eligibility identification by electronic medical record utilisation [15]. Overall, complete influenza vaccination increased from 44.4% to 64.5% post-intervention introduction, with similar increases across malignancies, child ages, and gender groups.

Observed lower vaccine coverage at the Perth site may have been due to previous concerns about vaccine safety [16] and the lower influenza disease burden that was documented in Western Australia (WA) compared to other Australian states in 2017 [17]. Furthermore, the higher incidence of 2017's seasonal influenza in Australia's eastern states potentially led to increased related media coverage and influenza vaccine promotional compared to WA [18]. Secondly, febrile reactions in children during 2010 attributed to *CSL Limited's Fluvax*® and *Fluvax*® *Junior* influenza vaccines were observed in WA [16].

There are several limitations that need to be addressed with our study. Firstly, we were unable to validate children's influenza vaccination status with primary care providers and the Australian Immunisation Registry. Reported vaccine coverage with our surveys may have been falsely elevated due to potential social desirability and recall bias by caregivers. As participants were actively recruited both in person and by email messaging, selection bias is possible with prejudicing our results for caregivers with greater vaccine supporting attitudes and knowledge. As surveys were conducted during the Australian influenza season's peak, this may have impacted behaviour reporting by caregivers as well as difference in vaccination practices between sites. Additionally, while having multiple medical comorbidities was not identified as a predictor for influenza vaccination likelihood, only 15.8% of children surveyed were in this group. As such, inference of our wider results regarding this sub-population should be taken lightly.

5. Conclusion

Overall, we observed higher than expected reported influenza vaccine coverage in children with medical comorbidities in 2017 and identified caregiver and hospital-based factors influencing vaccine uptake. Caregivers were strongly supportive of influenza vac-

cine delivery with their children during subsequent hospitalisation highlighting the potential for hospital-based interventions targeting influenza vaccination of children with medical comorbidities. Critically, a recommendation to vaccinate by the child's hospital-based physician and previous receipt of a vaccine in hospital was associated with vaccine uptake. Therefore, improving the proportions of hospital-based physicians' consistently recommending influenza vaccination to their patients and opportunities for these patients to receive vaccination on site in hospital may result in greater vaccine coverage.

Review of current hospital-based influenza vaccination programs and factors across Australia is needed to inform future development of effective multi-component interventions to improve influenza vaccine uptake specifically in children with medical comorbidities.

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Conflict of interest

Dr. Holly Seale has previously received funding from vaccine manufactures for investigator driven research and for presenting at workshops. This funding was not associated with this research.

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