

Well-Child Care Visits and Risk of Ambulatory Care–Sensitive Hospitalizations

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Objectives: To determine if poor well-child care (WCC) visit adherence is associated with increased risk for Ambulatory Care–Sensitive Hospitalizations (ACSHs) among young children in an integrated healthcare delivery system.

Study Design: This was a retrospective observational study.

Methods: We used claims and administrative data for children aged 2 months to 3.5 years enrolled at Group Health Cooperative from 1999 to 2006. Our main independent variable was timely WCC visits based on Group Health’s 2000 recommended schedule. We used Cox proportional hazard regression models to determine the association between WCC visit adherence and risk for a child’s first ACSH.

Results: Of the 20,065 children, 797 (4%) had an ACSH. Children with lower WCC visit adherence had increased hazard ratios (HRs) of 1.4–2.0 for ACSH (adherence 0–25%: HR 2.0, 95% confidence interval [CI]: 1.6–2.6, $P < .001$; adherence 26–50%: HR 1.4, 95% CI: 1.1–1.8, $P < .05$). Of the 2196 children with ≥ 1 chronic disease, 189 (9%) had an ACSH. Children with ≥ 1 chronic disease and with lower WCC visit adherence also had increased HRs for ACSH (adherence 0–25%: HR 3.2, 95% CI: 1.8–5.6, $P < .001$; adherence 26–50%: HR 1.9, 95% CI: 1.2–3.2, $P < .05$).

Conclusions: For young children, poor WCC visit adherence was associated with increased risk for ACSH in this integrated healthcare delivery system.

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Children less than 5 years old have higher hospitalization rates than older children.¹ Finding approaches to minimize morbidity for these children (eg, decreasing asthma exacerbations) may reduce hospitalizations. Regular attendance at well-child care (WCC) visits may prevent unnecessary hospitalizations through timely immunizations and/or chronic disease management. WCC visits likely have a higher impact for young children due to the greater frequency of recommended WCC visits in the first 3 years of life (13 visits) compared with older children (1 visit per year through age 18 years).² Prior studies evaluating the association between WCC visit adherence and hospitalizations have been mixed, as 3 studies found that higher WCC visit adherence was associated with decreased ambulatory care–sensitive hospitalizations (ACSHs) while 2 studies found no association.^{3–7} Only 3 of these studies accounted for the timeliness of WCC visits.^{3,5,7} No study has evaluated this relationship in integrated healthcare delivery systems. Unlike other healthcare systems, integrated healthcare delivery systems have greater control in standardizing and improving the care patients receive (ie, population-based care), which can decrease practice variation.^{8,9} In addition, integrated healthcare delivery systems often place high importance on preventive care and therefore encourage and provide these services at no charge. Evaluating WCC visit adherence and risk of hospitalization in this setting provides a unique opportunity to understand this relationship where all patients receive similar WCC visit content.

The goal of this study was to understand whether parents’ timely adherence to WCC visits was associated with risk of ACSHs among young children enrolled in an integrated healthcare delivery system. ACSHs represent hospitalizations which are potentially preventable with adequate access to and/or provision of outpatient care.¹⁰ We hypothesized that poor WCC visit adherence would be associated with increased risk for ACSHs in this integrated healthcare delivery system.

METHODS

Design and Setting

This was a retrospective cohort study conducted in collaboration with Group Health Cooperative, an integrated healthcare delivery system with ~640,000 members in Washington and Idaho. Claims from both the Group Health delivery system and contracted network physicians were included. This

In this article
Take-Away Points / p355
www.ajmc.com
Full text and PDF

study was approved by both the Seattle Children's Research Institute and Group Health Research Institute's Institutional Review Boards.

Patient Population

We focused on children younger than 3.5 years because this age group is at higher risk for hospitalizations than older children,¹¹ because they have higher contact rates with healthcare providers, and because Group Health encourages 1 WCC visit between the ages of 2 and 3.5 years. Children were eligible for the study if they were enrolled by 2 months of age at Group Health between January 1, 1999, and December 31, 2006. Participants entered the study on either January 1, 1999 (ie, already a plan member), or on their first day of enrollment during the study period. When determining a child's complete enrollment information, we considered gaps in enrollment of <45 days as continuous enrollment based on the Healthcare Effectiveness and Data Information Set definition.¹² In addition, children needed to be enrolled on or prior to a recommended WCC visit and through at least 1 of the subsequent recommended WCC visits in order to calculate adherence and minimize misclassification (**Figure**).

We used a previously validated list of *International Classification of Disease, Ninth Revision (ICD-9)* codes to identify children with chronic disease.¹³ Children were classified as having at least 1 chronic disease (ie, "≥1 chronic disease") if they had 1 or more claims matching an ICD-9 diagnosis included in the validated list. Children were classified as "healthy" otherwise. Since diagnosing asthma in children less than 4 years old can be challenging,¹⁴ 2 or more claims for asthma (ICD-9 493.00-493.99)¹¹ were required for a child to be classified as having asthma. The top 5 chronic disease categories for our study were: asthma (38%), congenital heart disease (15%), congenital musculoskeletal anomalies (14%), failure to thrive (7%), and hereditary and acquired hemolytic anemias (6%).

WCC Visit Adherence

A WCC visit was identified if an outpatient claim billed by a primary care provider (pediatrician, family physician, general practitioner, osteopath, or nurse practitioner) contained the standard WCC visit ICD-9 codes (eg, V20.2) in any diagnosis field. Adherence was based on Group Health's 2000 WCC visit schedule, which was identical to the AAP's schedule for the first 6 months and then differed from this schedule by requiring the following WCC visits

Take-Away Points

Resources should continue to be directed at encouraging attendance at well-child care visits, especially among children with chronic disease.

- Prior literature has not evaluated this relationship in integrated healthcare delivery systems.
- This supports healthcare reform policies that provide preventive services free of costs.
- Well-child care visit adherence may be a useful marker to identify children that might benefit from a case management intervention.

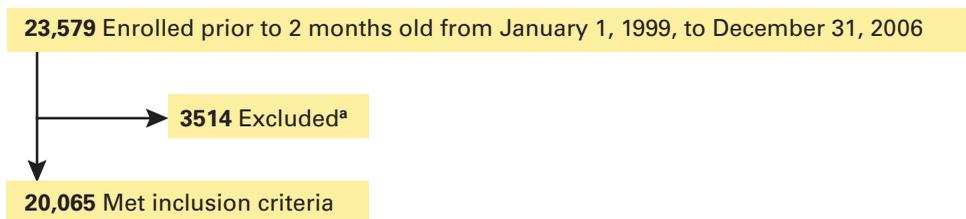
through 3.5 years old: 10 months, 15 months, 2 years, 3.5 years (ie, the AAP's 9-month, 12-month, 18-month, and 3-year visits are not required). WCC visits were included in the adherence calculation (numerator) if the WCC visit was "timely." For example, a "4-month WCC visit" was allowed to occur on or after a child turned 4 months old and up to less than 6 months old (ie, the "4-to-6 month" WCC interval). To allow for an appropriate window of acceptability for when WCC visits might reasonably occur, we counted a "duplicate WCC visit" in 1 interval as the WCC visit for the following interval if the duplicate visit was ≤14 days (visits before 15 months of age) or ≤30 days (visits after 15 months of age) prior to the start of a WCC visit interval where no visit had occurred. Otherwise only the first WCC visit was counted for WCC visit intervals with multiple WCC visits.

WCC visit adherence (range 0% to 100%) was a time-varying variable that was updated at the end of each WCC interval. For WCC intervals that overlapped completely with a child's study period enrollment, WCC visit adherence was calculated by dividing a child's total number of "timely" WCC visits by the total number of recommended WCC visits from start of enrollment through the end of each age-specific WCC interval (ie, a child enrolled for "X" number of WCC visit intervals would have "X" number of WCC visit adherence values for our regression analysis). We examined WCC visit adherence using a priori categories to facilitate interpretation and comparison with our prior study as follows: 0% to 25%, 26% to 50%, 51% to 74%, and 75% to 100% (referent).

Ambulatory Care–Sensitive Hospitalizations

As defined by the Agency for Healthcare Research and Quality, a hospitalization was classified as an ACSH if the primary diagnosis was one of those included in the predetermined list of ACSH diagnoses. The only exceptions to this were for the diagnoses of dehydration or iron deficiency anemia where the ACSH diagnosis could be either primary or secondary.¹⁰ Similar to other investigators,⁶ we excluded "adult" conditions (chronic obstructive pulmonary disease,

■ **Figure.** Patient Eligibility



^aChild was not continuously enrolled for ≥ 1 entire well-child care interval.

congestive heart failure, hypertension, pelvic inflammatory disease, skin grafts with cellulitis, and angina). We also excluded “congenital syphilis” as these hospitalizations are unlikely to be affected by WCC visits due to the fact that these infections begin in utero or at birth. Additional hospitalization diagnoses were included based on their clinical importance to children less than 3½ years old (“pneumococcal meningitis” [ICD-9 320.1], “streptococcal meningitis” [ICD-9 320.2], and “septicemia due to H. influenza” [ICD-9 038.41]). Hospitalizations prior to the age of 2 months were excluded. Children could only have 1 ACSH for analysis since we were interested in whether WCC visit adherence was associated with the time to the child’s first ACSH.

Statistical Analysis

Bivariate analyses consisted of Student’s *t* test for comparisons of continuous variables and the Pearson’s χ^2 test for categorical variables. We used a time-varying Cox proportional hazards regression model to determine the association between WCC visit adherence and time from enrollment to the first ACSH. Children were censored when they had their first ACSH, reached the end of the study (December 31, 2006), disenrolled, or turned 3.5 years old, whichever came first. Potential confounders were included a priori in multivariate analyses based on the existing literature: patient age at start of enrollment,⁶ gender,^{4,6} chronic disease (any vs none),⁵ and Medicaid enrollment (yes/no).¹¹ Age at start of enrollment was modeled as a continuous variable. The reference categories were male (vs female), no chronic disease, and never on Medicaid for our categorical variables of gender, chronic disease, and Medicaid enrollment, respectively. The proportional hazard assumption was examined using STATA10. Statistical significance was determined at the $P < .05$ level.

We also conducted 2 sensitivity analyses. First, we used propensity scores in an attempt to control for self-selection bias (eg, children at greatest risk for ACSH may also be

less likely to attend WCC visits).^{15,16} We predicted WCC visit adherence (categorical) propensity score probabilities with multinomial logistic regression using age at start of enrollment, chronic disease status, and whether the child was ever enrolled in Medicaid. This sensitivity analysis (data not shown) did not change our results or conclusions. Second, although we could not adjust for an appropriate measure of continuity of care for this healthcare setting (ie, “clinic level”), we adjusted for continuity of care (COC) at the “provider level” based on the importance of this potential confounder from prior studies.^{7,11} We used Bice and Boxerman’s COC index (range 0 to 1) to measure how often children saw the same provider.¹⁷ We analyzed COC as a time-varying categorical variable that was updated at the end of each age-specific WCC interval. The magnitude of associations and confidence intervals (CIs) were similar to our primary findings (data not shown).

RESULTS

Of the 23,579 children that enrolled in the health plan prior to age 2 months, 20,065 (85%) children were eligible for analyses (Figure). Nearly a quarter of our population was on Medicaid and children with ≥ 1 chronic disease accounted for approximately 11% of our study population (Table 1). Based on when children exited the study, approximately three-fourths of children fell into the highest WCC visit adherence category (75-100%, Table 1). WCC visit adherence was calculated based on at least 4 recommended WCC visits for 69% of children (median 5, interquartile range: 3-6).

During the study period, 797 (4%) children had at least 1 ACSH (Table 1). The median age at time of hospitalization was 13 months (interquartile range [IQR] 8-20 months) and 70% of all ACSHs were accounted for by the top 4 diagnoses (Table 2). For healthy children, the top 5 ACSHs accounted for 65% of their ACSHs (17% pneumonia, 15% dehydration, 14% asthma, 10% gastroenteritis, and 9% urinary tract infections). For children with ≥ 1 chronic disease, the top 5 ACSHs accounted for 79% of their ACSHs (31%

Well-Child Care Visits and Hospitalizations

Table 1. Patient Characteristics^a

	All N = 20,065	Healthy N = 17,869	≥1 Chronic Disease N = 2196
Gender			
Female	9685 (48)	8834 (49)	851 (39)
Male	10,380 (52)	9035 (51)	1345 (61)
Ever on Medicaid^b	4842 (24)	4342 (24)	500 (23)
Time in study, months^c	20 [9-40]	19 [9-40]	30 [16-41]
Age at start, months^c	0.3 [0-1]	0.3 [0-1]	0.3 [0-0.9]
WCC visit adherence^d			
0-25%	1562 (8)	1488 (8)	74 (3)
26-50%	1451 (7)	1322 (7)	129 (6)
51-74%	1826 (9)	1614 (9)	212 (10)
75-100%	15,226 (76)	13,445 (75)	1781 (81)
Children with ACSHs	797 (4)	608 (3)	189 (9)

ACSH indicates ambulatory care–sensitive hospitalization; IQR, interquartile range; WCC, well-child care.

^aN (%) of eligible children except where indicated. Percentages may not add up to 100% due to rounding.

^bIndicates whether the child was ever on Medicaid during the study period.

^cMedian [IQR].

^dWCC visit schedule was based on Group Health’s recommended schedule in 2000. WCC visit adherence corresponds to the child’s adherence when the child exited the study (ie, at an ACSH or when censored).

Table 2. Diagnoses for Leading Causes of ACSHs^a

Diagnosis ^c	ICD-9 Codes	N (%) ^b
		Total = 797
Bacterial pneumonia	481.xx, 482.2x, 482.3x, 482.9x, 483.xx, 485.xx, 486.xx	165 (21)
Asthma	493.xx	153 (19)
Gastroenteritis	558.9x	127 (16)
Dehydration	276.5x	109 (14)
Urinary tract infections	590.xx, 599.0x, 599.9x	65 (8)
Seizure	345.xx, 780.3x	63 (8)
Severe ear, nose, throat infections	382.xx, 462.xx, 463.xx, 465.xx, 472.1x	50 (6)
Cellulitis	681.xx, 682.xx, 683.xx, 686.xx	29 (4)
Failure to thrive	783.4x	15 (2)
Remaining ACSHs	N/A	21 (3)

ACSH indicates ambulatory care–sensitive hospitalization; ICD-9, *International Classification of Diseases, Ninth Revision*.

^aICD-9 codes were evaluated to the 2nd decimal point.

^bDoes not equal 100% due to rounding.

^cFor healthy children, the top 5 ACSHs accounted for 65% of their ACSHs (17% pneumonia, 15% dehydration, 14% asthma, 10% gastroenteritis, and 9% urinary tract infections). For children with ≥1 chronic disease, the top 5 ACSHs accounted for 79% of their ACSHs (31% asthma, 15% pneumonia, 12% seizures, 11% gastroenteritis, and 10% dehydration).

asthma, 15% pneumonia, 12% seizures, 11% gastroenteritis, and 10% dehydration). The median time from enrollment until first ACSH increased with increasing WCC visit adherence categories (Table 3). The unadjusted rates of ACSH for children with one of our top 5 chronic disease categories were 9% for asthma, 11% for congenital heart disease, 8% for congenital musculoskeletal anomalies, 8% for failure to thrive, and 8% for hereditary and acquired

hemolytic anemias. Lower WCC visit adherence was significantly associated with increased hazards for ACSH after controlling for presence of chronic disease, gender, enrollment in Medicaid, and age at start of enrollment (Table 4). Compared with children with higher WCC visit adherence (75-100%), children who missed half or more of the recommended WCC visits were at 1.4 to 2 times the hazard for an ACSH (adherence 0-25%: hazard ratio (HR) 2, 95% CI:

■ **Table 3.** Time From Enrollment (Months) to First ACSH^a

	All Children		Healthy		≥1 Chronic Disease	
	Median [IQR]	N	Median [IQR]	N	Median [IQR]	N
WCC visit adherence^b						
0-25%	8 [5-18]	75	8 [5-18]	61	7 [4-14]	14
26-50%	10 [8-17]	67	10 [8-15]	50	10 [8-21]	17
51-74%	13 [10-17]	75	12 [10-15]	58	14 [13-23]	17
75-100%	14 [8-21]	580	14 [8-21]	439	16 [10-23]	141

ACSH indicates ambulatory care-sensitive hospitalization; IQR, interquartile range; WCC, well-child care.

^aThis table only includes children with an ACSH.

^bWCC visit schedule was based on Group Health's 2000 recommended schedule. WCC visit adherence corresponds to the child's adherence when the child exited the study (ie, at an ACSH or when censored).

■ **Table 4.** Adjusted Hazard Ratios for Rate of ACSHs, Hazard Ratio (95% Confidence Interval)^a

	ACSHs		
	All Children N = 20,065	Healthy N = 17,869	≥1 Chronic Disease N = 2196
WCC visit adherence^b			
0-25%	2.0 (1.6-2.6) ^f	1.8 (1.4-2.4) ^f	3.2 (1.8-5.6) ^f
26-50%	1.4 (1.1-1.8) ^d	1.2 (0.9-1.7)	1.9 (1.2-3.2) ^d
51-74%	1.0 (0.8-1.3)	1.0 (0.7-1.4)	1.0 (0.6-1.8)
75-100%	1.0 (referent)	1.0 (referent)	1.0 (referent)
Chronic disease	2.0 (1.7-2.4) ^f	N/A	N/A
Female	0.9 (0.8-1.0) ^d	0.9 (0.7-1.0)	0.8 (0.6-1.1)
Ever on Medicaid^c	1.8 (1.5-2.1) ^f	1.9 (1.6-2.3) ^f	1.4 (1.0-1.9) ^d
Age at start (months)	0.8 (0.7-0.9) ^f	0.8 (0.7-0.9) ^e	0.7 (0.5-0.9) ^d

ACSH indicates ambulatory care-sensitive hospitalization; WCC, well-child care.

^aReferents: 75-100% WCC visit adherence, no chronic disease, male, never on Medicaid for the categorical variables of WCC visit adherence, chronic disease, female, and ever on Medicaid, respectively. Age at start (months) of enrollment was a continuous variable. All variables were simultaneously included in the model.

^bWCC visit schedule was based on Group Health's 2000 recommended schedule. WCC visit adherence corresponds to the child's adherence when the child exited the study (ie, at an ACSH or when censored).

^cIndicates whether the child was ever on Medicaid during the study period.

^d*P* < .05.

^e*P* < .01.

^f*P* < .001.

1.6-2.6, *P* < .001; adherence 26-50%: HR 1.4, 95% CI: 1.1-1.8, *P* < .05). Children with ≥1 chronic disease who missed half or more of the recommended WCC visits were 1.9 to 3.2 times the hazard for an ACSH (adherence 0-25%: HR 3.2, 95% CI: 1.8-5.6, *P* < .001; adherence 26-50%: HR 1.9, 95% CI: 1.2-3.2, *P* < .05) compared with those in the highest WCC visit adherence category.

COMMENT

In this study evaluating the relationship between parents' timely adherence to WCC visits and hospitalizations in an integrated healthcare delivery system, we found that young children who had lower WCC visit adherence (≤50% adherence) had up to 2 times the hazard for ACSH compared with children with

higher WCC visit adherence (≥75% adherence). This relationship was stronger for children with chronic disease and was surprisingly similar to our prior study in a traditional fee-for-service system.⁷ This study adds to the limited and mixed evidence supporting WCC visit adherence and confirms our Hawaii study.^{3,7,18-20} In Hawaii, children typically are cared for by solo practitioners, which can increase the variability of care between healthcare providers. In comparison, Group Health has greater control of variability through its population-based model of standardizing the care patients receive. Therefore, timely WCC visit adherence still appears to be an important component of reducing hospitalizations even in a system where patients are more likely to receive similar care for the same services.

Timely WCC visits, in theory, can reduce hospitalizations by providing opportunities to administer immunizations to

prevent serious infections, proactively manage a child's chronic disease, or enhance the primary care relationship. Previous studies have found that children with asthma who received better asthma management plans (eg, inhaled corticosteroids or asthma action plans) had lower rates of hospitalizations for asthma.²¹ This may be particularly important since children with asthma have approximately 2.1 hospitalizations for every 100 children.²² Unfortunately, a recent study found that only 46% of children with asthma received appropriate asthma care.²³ It is also possible that low WCC visit adherence may simply be a marker for other factors (eg, poor access, parental healthcare utilization beliefs, sociodemographic characteristics, having a trusting, well-established relationship with their child's PCP) that are associated with increased risk for hospitalizations.^{6,7,11,24-28} For example, parents of children who are less adherent to the WCC visit schedule may also be less adherent to other aspects of healthcare (eg, less likely to follow treatment regimens). If so, then improving WCC visit adherence may not necessarily reduce hospitalizations. However, WCC visit adherence could be used as a marker to identify children who may benefit from a case management intervention. WCC visit adherence is a relatively easy metric to monitor even in systems that only have access to claims data. Besides ensuring that children attend the recommended WCC visits, health plan or primary care team case managers could discuss with parents whether they have the appropriate support for all of their child's healthcare needs (eg, adequate transportation). From a population-based perspective, case managers can help health plans and providers ensure that their patients receive appropriate care.

Given the association found between increased timely WCC adherence and more favorable outcomes in this and prior studies,^{3,7} we should continue encouraging attendance at WCC visits. Similar to our study,⁷ Hakim and Bye found that children up-to-date (vs not up-to-date) with WCC visit adherence had decreased hazards of avoidable hospitalizations.³ The only other study which accounted for timeliness of WCC visit adherence found no association with ACSH, which may be due to the relatively small number of ACSHs (N = 115).⁵ Although not statistically significant, these authors found that more children without an ACSH (63%) were up-to-date with WCC visits than those with an ACSH (53%, $P > .05$).⁵ One way of increasing WCC visit adherence might be to provide preventive services at no cost. Studies have found that adults with copays were less likely to receive recommended preventive care than those without copays.^{29,30} During our study period, the majority of visits for WCC at Group Health did not require a copay. This might explain why WCC visit adherence, particularly for children with chronic disease, was higher in this integrated healthcare delivery system than in

our prior study of children enrolled in a traditional fee-for-service system.

The limitations of this study are that we studied members enrolled in a single integrated healthcare delivery system and that children had high WCC visit adherence and were likely from higher-income families. Therefore our results may not be generalizable to other systems or populations. In this study, we could not adjust for some important potential confounding factors (eg, income, education, race/ethnicity) due to limitations of available data. Future studies should attempt to directly account for these potential confounders. We were also unable to control for continuity of care for this healthcare setting at the clinic level due to the limitations of the available data; during the study period, Group Health encouraged continuity at both the provider and clinic level. Therefore the magnitude of our findings may be biased away from the null. Due to the small number of children with chronic disease, these findings should be interpreted with caution. ACSHs are only "potentially preventable" and therefore may not always be avoidable even with adequate access to and/or provision of outpatient care. In addition, some ACSHs may be related more to ambulatory specialty care (eg, seizures) than primary care. Our study design only suggests associations that cannot be inferred as causal. Although we attempted to control for self-selection bias, our available variables and the size of our study population may have limited our ability to adequately conduct propensity score analysis. Our study excluded 3514 (15%) children, although these children are unlikely representative of Group Health's general population due to their very short duration of enrollment (median 1 month, IQR 1-2).

Conclusions/Policy Implications

In this integrated healthcare system, timely WCC visit adherence was associated with reduced ACSHs. When compared with our prior study, our findings may help support healthcare reform policies that require preventive care free of costs. To better understand if this association could be causal, we recommend that future investigations rely on utilization data that are collected from electronic health records so that data from providers' notes could be extracted. Our study findings could also be enhanced by qualitative data to further explore reasons why parents did not bring their child in for a WCC visit and survey data to collect important confounders (eg, income). In addition, future studies may want to evaluate emergency department visits as a mediator between low WCC visit adherence and hospitalizations or include diagnoses for acute injuries and poisonings, similar to a prior study,³ as these topics are often discussed at WCC visits. Until this association is clarified, poor WCC adherence can only be re-

garded as a potentially important risk factor for hospitalization among young children.

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