A New Model of Well-Child Care: Implications for Resource Costs and Dissemination

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Abstract

Objective: Current pediatric well-child care (WCC) may be inefficient and inadequate with respect to primary care physicians' abilities to deliver prescribed preventive and developmental services. New Internet-related technologies may improve the efficiency and effectiveness of WCC. This article examines the potential resource cost implications associated with a change in the delivery model of WCC in a capitated, integrated managed care system.

Study Design: Decision analyses and Monte Carlo simulations were used to estimate the variation in resource costs between the current WCC model and a high-performance WCC model, stratifying by age, risk level, and the proportion of pediatric members that may not seek WCC.

Methods: Demographic and health care utilization data associated with 14,910 pediatric enrollees, ages newborn to 5 years, enrolled at Kaiser Permanente Colorado were used to simulate the change in costs attributable to a change in the model of WCC.

Results: Simulation models and sensitivity analyses suggest that the implementation of the high-performance WCC model is likely to be relatively resource cost neutral in a managed care system.

Conclusions: Preliminary findings suggest that implementation of innovative changes in WCC may allow for efficient reallocation of resources to higher-risk children in a relatively cost neutral manner. However, innovative changes that involve the use of unreimbursed non-face-to-face encounters and nonphysician health care professionals may present challenges with respect to implementation of a new model of WCC in a fee-for-service environment.

Introduction

Current pediatric practice, especially the provision of developmental and preventive care services, is inefficient and out of step with the expectations and needs of many families with young children.[1] In our current system, well-child care (WCC) is the primary way for providing these services to children. It comprises almost 25% of pediatric visits, and over 50% of all visits in the first year of life. In spite of this considerable allocation of time and resources, many children do not receive the care they need.[2]

Much of this unmet need stems from a lack of time and resources on the part of the primary care physician (PCP) to deliver the prescribed preventive and developmental services during WCC visits.[3-5] Some of these time constraints could be lessened if the PCP was able to collect screening information and parental concerns before the visit. This would allow for the visit to be tailored to the specific needs of the patient and family and would improve the efficiency and effectiveness of the encounter. Current research has shown that the adoption of new technologies that allow for patient transactions outside the primary care office can significantly affect the effectiveness, patient-centeredness, timeliness, and efficiency of child development and health promotion practice.[6-10] The potential benefits of this type of technology for WCC are considerable. If developmental and psychosocial screening can be accomplished through non-face-to-face transactions over the Internet and communicated to the PCP before the visit, the PCP can ensure that the specific needs of the family are met during the WCC visit in an efficient and effective manner. In spite of the potential benefits, adoption of new technologies to deliver WCC has been slow. One of the perceived barriers to more widespread adoption is the lack of perceived return on investment for Web-based transactions between families and clinicians. PCPs are

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The new model … was designed to improve the efficiency and effectiveness of well-child care by engaging families in Web-based transactions before the visit …

reluctant to embrace a new way of delivering care if it potentially will add to time and resources needed to deliver care. However, adoption of these new technologies may lead to increased efficiencies that save money or keep costs neutral and be of greater value to the patients and their families.

The uncertainty surrounding the impact of adopting new technologies in WCC makes it difficult for health care organizations to "take risks ahead of the data" and proceed with the development of redesigned systems of care. To help reduce this uncertainty we sought to model the potential economic impact of a new system for WCC at Kaiser Permanente Colorado (KPCO) that was designed to deliver enhanced and tailored care during the WCC encounter.

The new KPCO model of WCC, high-performing WCC (HPWCC) was designed to improve the efficiency and effectiveness of WCC by engaging families in Web-based transactions before the visit and using this information to tailor the WCC visit to best meet the needs of parents. To better understand the economic impact of implementing HPWCC, we estimated the resource costs associated with current American Academy of Pediatrics-recommended WCC service schedules (www.aap.org/research/pedmedcostmodel.cfm), as modified by KPCO, as compared to HPWCC, for pediatric patients, ages newborn to 5 years.

Background

The HPWCC model was developed in collaboration with staff and parents of pediatric KPCO members in 2007. Bergman et al and Beck et al describe this model in detail.[11,12] In brief, this system incorporates three improvements to the WCC visit: 1) the use of a Web-based, previsit assessment completed by the family that allows the practitioner to tailor the visit to the family needs; 2) the use of different visit types, eg, brief visits or e-visits that allow the clinician to modify resources and personnel based on the needs of the child; and 3) an extended visit for children with special health care needs. A key component of the HPWCC model is the Web-based tool, the Child Health and Development Interactive System (CHADIS) (www.childhealthcare.org/chadis). This Web-based system captures parental responses to validated developmental and behavioral surveys and allows parents to articulate their child's challenges and strengths as well as any questions they may have for the upcoming visit. The CHADIS assessment is completed before the visit and the results are presented in a one-page summary that is accessed and reviewed by the clinician before the visit. The clinician uses this information to tailor the content and length of the visit and to involve other health care staff as necessary to meet the identified needs of the family.

Methods

Several data sources were used for this analysis including the demographic and health care utilization data associated with the 2006 KPCO pediatric population, ages newborn to 5 years; American Academy of Pediatrics visit schedules; and other published research related to the proportion the pediatric population with special needs.[13] We estimated the age and risk stratification of the 2006 KPCO pediatric population. We then used decision analysis models and Monte Carlo simulations to estimate the variation in WCC cost stratified by age, risk level, and care approach (current WCC vs HPWCC). We also performed sensitivity analyses to adjust for the proportion of pediatric members that may not seek WCC and for the distribution of high-risk patients. This study was reviewed by KPCO's institutional review board and was considered exempt as a quality-improvement project.

Age, Risk Stratification, and Users of Well-Child Care Services

We identified children born between January 2, 2000, and January 1, 2005, (ie, age 0 to 5 years as of January 1, 2005) who were members of KPCO continuously between January 1, 2005, and December 31, 2006. These data were used to estimate the age distribution of pediatric members by the following age categories: age <1 year, age 1 to 2 years, and age 3 to 5 years. We examined total office visits and then divided them into two different subsets: 1) WCC visits versus other and 2) primary care versus specialty or ancillary care (radiology, lab, etc). These analyses also allowed us to identify the proportion of the KPCO pediatric population (age <5 years) who were nonusers of WCC. Colorado-specific data from the National Survey for Children with Special Health Care Needs[13] along with a validated pharmacy-based risk adjustment system, called RxRisk,[14-17] were used to assign the proportion of pediatric members by age category that were likely to have been "high risk" in 2006.

Allocation of Resources and Costs Based on Current Well-Child Care versus High-Performing Well-Child Care

We used WCC visit schedules described in Table 1, which note the visit schedule by age, visit description, and clinician. A description

Table 1. Well-child care visit schedules for current practice, high-performing well-child care, and high-risk children with special health care needs

Visit	Current pediatric WCC with augmented developmental and behavioral screening Description/provider	Visit schedule for HPWCC Description/provider	Visit schedule for HPWCC for high-risk children with special health care needs Description/provider
Perinatal	Home visit/PA or NP	Home visit/PA or NP	Home visit/PA or NP
2 week	Pediatrician visit/MD	Pediatrician visit/MD	Pediatrician visit/MD
2 month	Pediatrician visit; partner violence screening/MD	Pediatrician visit; CHADIS partner violence screening/MD	Care coordinator phone call 20 minutes; pediatrician visit 20 minutes; meeting with family and care coordinator 20 minutes; partner violence screen/MD or care coordinator
4 month	Pediatrician visit; maternal depression screening/MD	21st century WCC visit[a]; CHADIS maternal depression screening/MD	Care coordinator phone call 20 minutes; pediatrician visit 20 minutes; meeting with family and care coordinator 20 minutes; maternal depression screening; partner violence screening/MD or care coordinator
6 month	Pediatrician visit; developmental screening/MD	Pediatrician visit; CHADIS developmental screening/MD	Care coordinator phone call 20 minutes; pediatrician visit 20 minutes; meeting with family and care coordinator 20 minutes; developmental screening/MD or care coordinator
9 month	No 9 month visit	e-Visit[b]; CHADIS developmental screening/MD/RN/ developmental specialist	
12 month	Pediatrician visit; maternal depression screening; developmental screening/MD	Pediatrician visit; CHADIS, maternal depression screening/MD	Care coordinator phone call 20 minutes; pediatrician visit 20 minutes; meeting with family and care coordinator 20 minutes; maternal depression screening/MD or care coordinator
18 month	Pediatrician visit; M-CHAT, developmental screening/MD	21st century WCC visit; CHADIS developmental, M-CHAT; partner violence screening/MD	Care coordinator phone call 20 minutes; pediatrician visit 20 minutes; meeting with family and care coordinator 20 minutes; developmental, M-CHAT; partner violence screening/MD or care coordinator
2 years	Pediatrician visit; M-CHAT, developmental screening/MD	21st century WCC visit; M-CHAT/MD	Care coordinator phone call 20 minutes; pediatrician visit; meeting with family and care coordinator 20 minutes; M-CHAT/MD or care coordinator
3 years	Pediatrician visit; developmental screening; partner violence screening/MD	21st century WCC visit; CHADIS developmental screening/MD	Care coordinator phone call 20 minutes; meeting with family and care coordinator 20 minutes; developmental screening/MD or care coordinator
4 years	Pediatrician visit; developmental screening; pediatric symptom checklist/MD	Pediatrician visit; CHADIS preschool check; developmental screening; pediatric symptom checklist/MD	Pediatrician visit 20 minutes; meeting with family and care coordinator 20 minutes; developmental screening; pediatric symptom checklist/MD or care coordinator
5 years	Pediatrician visit; developmental screening; pediatric symptom checklist/MD	21st century WCC visit; developmental screening; pediatric symptom checklist/MD	Pediatrician visit; developmental screening; pediatric symptom checklist/MD or care coordinator

[a] An HPWCC visit will use the Internet-based CHADIS program to shift a portion of the care involved with a WCC visit to before the office visit. Specifically parents will have opportunity to assess their child's development, articulate their concerns, and relate the good parts and the challenges of parenting. The physician will be able to respond by e-mail to parents' questions and concerns before the visit. This will hopefully allow more efficient visits with the physicians, which should take 10 minutes instead of the usual 20 minutes per visit. If the previsit assessment identifies concerns the physician can allot more time for the visit. Parents always have the option of declining the HPWCC visit for a standard visit.

[b] An e-visit is similar to an HPWCC visit except in the case that the child's development is normal and there are no parental concerns that can't be addressed through e-mail or a phone call, there is no office visit required. Parents always have the option of declining the HPWCC e-visit for a standard office visit.

CHADIS = Child Health and Development Interactive System; HPWCC = high-performing well-child care; M-CHAT = modified checklist for autism in toddlers; MD = physician; NP = nurse practitioner; PA = physician assistant; WCC = well-child care

of the associated Common Procedure Terminology (CPT4) codes and associated WCC procedures for each visit is available online at: www.thepermanentejournal.org/images/Spring2011/WellChildCareCPTCodes.jpg. Table 1 contains the current KPCO WCC schedule for visits and developmental and behavioral screening. It also describes the content and visit schedule associated with the HPWCC model[11] that was developed at KPCO.

Managed Care Costs

KPCO's Decision Support System (DSS) was used to estimate 2007 resource costs for WCC, using the visit schedules noted in Table 1. The DSS allocates health care costs for all internal services provided directly by KPCO based on the personnel and other resources used in the delivery of health care services. Internal costs are allocated by CPT4-specific resource intensity weights (by service department and procedure) using KPCO's general ledger.[18,19] Specifically, the numerator in the DSS system is the total costs associated with the delivery of all health care at KPCO (excluding insurance and marketing costs), and the denominator is all activity as captured resource value units (RVU) that are derived from CPT4 and Evaluation and Management codes, etc, associated with delivery of care. This allows for estimation of cost per RVU, which can then be translated to costs per CPT4 code or type of visit. If DSS-based cost estimates were not available for a particular CPT4 code, we imputed CPT4 level costs by mapping comparable RVU estimates from other CPT4 codes that were captured in the DSS system in order to estimate a comparable cost metric.

Simulation Models

We employed TreeAge Pro 2008 (TreeAge Software, Inc; Williamstown, MA) to develop decision models along with Monte Carlo simulations to estimate the variation in WCC costs between the two models of care. This type of analysis has frequently been used within the field of pediatric research as an analytic tool to better understand the range of predicted costs associated with implementation of an intervention, or a new model of care.[20-23] This technique can be used to address variations in the inputs (in this case visit types) within the models while capturing the effects of uncertainty. This Monte Carlo simulation used cohorts of simulated pediatric patients as they pass through a year of WCC. In this analysis, our Monte Carlo simulation was based on parameters derived from the 2006 KPCO pediatric patient population (described above) including age, risk category, user status, and CPT4 level DSS cost estimates. As the subjects pass through the model, they are randomly assigned within the decision tree model to the current WCC model versus the HPWCC model.

Sensitivity Analyses

In the sensitivity analyses, we examined the variation in risk stratification of the pediatric members, and the proportion of members that potentially would, or would not use (or come to clinic for) WCC. Monte Carlo simulations were also run separately for both high-risk and normal-risk groups and by age category. Mean, minimum, and maximum total annual costs were estimated using the entire pediatric population as well as excluding nonusers of WCC (the estimate of the proportion of children who do not come in for WCC). Values were estimated based on 500 repeated randomized samples from a normal probability distribution function. Monte Carlo is a mathematical simulation model that relies on random sampling when it is not feasible to compute results based on the deterministic algorithms. Since results for both intervention and control groups were not actual observation, but rather computer generated numbers, it is not possible to calculate statistics such as p values.

Results

The baseline estimate for the high-risk cohort was estimated at

Table 2. Number of Kaiser Permanente Colorado 2006 pediatric enrollees using well-child care services, distribution by user status and risk category[a]

	2006 pediatric population		2006 pediatric population minus nonusers of WCC[b]	
Age group	Normal risk	High risk (12% age <2 years, 15% age 3 to 5 years)	Normal risk	High risk (12% age <2 years, 15% age 3 to 5 years)
<1	2454	335	2037	278
1-2	2668	364	2215	302
3-5	7726	1363	5254	927
Total	12,848	2062	9506	1507

[a] High-risk cohort estimated at 12% for age <2 years, and 15% age 3 to 5 years

[b] Data from 2006 demonstrated that the distribution of nonusers of WCC was 17% of patients age <2 years and 32% for patients age 3 to 5 years.

WCC = well-child care

an average of 12% for age <2 years and 15% for ages 3 to 5 years. This estimate was based on evidence described in Blumberg et al.[13] Results derived via the implementation of the RxRisk model using pharmacy dispense data associated with the 2006 KPCO pediatric population suggested that the high-risk cohort could range from 12% to 16% for age <2 years and from 14% to 18% for ages 3 to 5 years. These parameters were then used in the decision analysis.

The distribution of nonusers of WCC for pediatric enrollees age <2 years and age 3 to 5 years was 17% and 32%, respectively. Table 2 describes the distribution of the 2006 KPCO pediatric population by age category, estimated risk stratification, and user status WCC.

Managed Care Resource Costs

Figures 1 through 3 describe the variation in annual total cost estimates derived from the Monte Carlo models where we evaluated WCC now, relative to the HPWCC Model, employing KPCO specific resource costs based on CPT4 codes. Figure 1 includes estimated annual total costs, along with the estimates of the range total costs, for all normal-risk (not high-risk) pediatric patients, newborn through age 5 years, stratified by age categories noted above. The annual total costs for 12,848 normal-risk pediatric patients using the current WCC model are estimated to range from $4,122,335 to $7,655,766 (depending on use of services, etc) with an average annual total cost of $5,889,051. The HPWCC model average annual total cost estimate was $6,167,199 (range from $4,317,039 to $8,017,359). Little variation is noted in the range of estimated costs for normal risk pediatric patients, with the exception of infants less than age one year, where the estimated costs for the HPWCC model are higher.

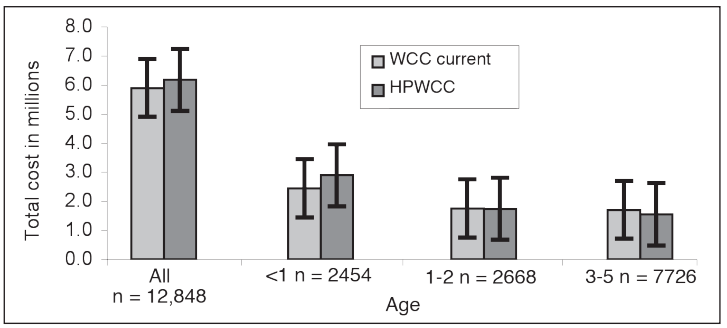

Figure 1. Kaiser Permanente Colorado total resource cost estimates of current WCC vs normal-risk HPWCC.

HPWCC = high-performing well-child care; WCC = well-child care

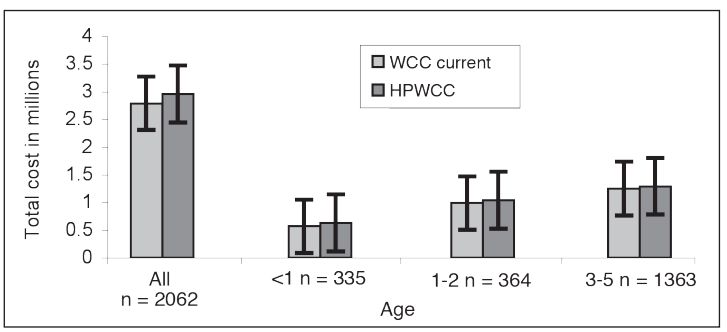

Figure 2. Kaiser Permanente Colorado total resource cost estimates of current WCC vs high-risk HPWCC.

HPWCC = high-performing well-child care; WCC = well-child care

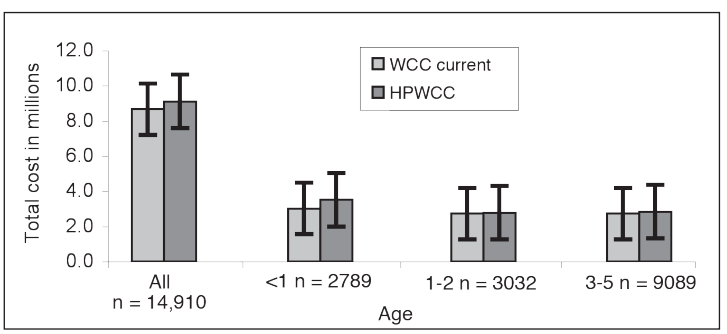

Figure 3. Kaiser Permanente Colorado total resource cost estimates of current WCC vs HPWCC combination: normal and high risk.

HPWCC = high-performing well-child care; WCC = well-child care

Figure 2 describes the estimated annual total costs for both models of care for the 2062 high-risk pediatric patients, in total, and stratified by age category. The range of total annual costs for all high-risk pediatric patients in the current WCC model versus the HPWCC model was $1,955,169 to $3,631,029, and $2,069,726 to $3,843,776, respectively. The HPWCC models generated slightly higher ranges of cost estimates across all age categories.

Figure 3 describes the estimated ranges of KPCO annual total costs between both WCC models for

all pediatric patients (normal and high risk combined). The range of total annual costs for pediatric patients for current WCC versus HPWCC model was $6,077,504 to $11,286,795 and $6,386,765 to $11,861,135, respectively. Little variation in costs estimates between the two models are noted for the age 1 to 2 years and age 3 to 5 years categories, with a difference in mean estimated costs for ages 1 to 2 years of $51,242, and a difference of $109,065 for ages 3 to 5 years. Consistent with normal risk estimates in Figure 1, most of the overall variation in cost estimates between the two models is driven by the estimated cost differentials for infants less than one year of age.

Discussion

With the exception the category of infants age <1 year, our simulation models and accompanying sensitivity analyses suggest that the implementation of the HPWCC model is likely to be relatively resource cost neutral in an integrated managed care system such as KPCO. Although the HPWCC models generated slightly higher cost estimates, the range of probable cost estimates overlapped by a large degree (Figures 1 to 3). Our results suggest that it may be possible to achieve greater efficiencies, with respect to engaging families before the initial WCC visit without adversely affecting the overall cost of WCC in a managed care environment.

… the ability to model resource allocation before the implementation of such services will help organizations manage the risk associated with new innovations …

Although managed care organizations may provide the infrastructure and financing that make innovation more feasible than in fee-for-service settings,[24] these organizations face their own challenges when deciding to adopt innovative practices. Often innovations are required to have a business case that estimates a return on investment to offset implementation costs. Cost offsets are usually estimated from associated reductions in other services (eg, sick visits, Emergency Department visits, admissions to the hospital and/or Neonatal Intensive Care Unit) or from efficiencies gained by implementing the innovation. In the future this challenge will most likely not be confined to managed care organizations. Recent health care legislation suggests new models such as Accountable Care Organizations, which have a global payment to the organization for the health services of a defined population.[25] These new models will then confront the same challenges of current managed care organizations in estimating the return on investment on new and innovative systems.

We plan to conduct additional analyses to determine whether HPWCC is associated with either decreases or increases in the use of other health services, as well as efficiencies in providing WCC. However, decisions to adopt innovations in managed care systems are not always based on cost offsets—they may also be driven by evidence of significant improvements in quality of care and/or patient satisfaction justifying investment in the innovation. This is particularly true for the development of innovative preventive services for children. Whereas these methods allow us to examine the more proximate costs related to resource use, they do not factor in the potential downstream benefits in preventing adult-onset disease and in long-term improvement in quality of life with the concomitant savings in health care costs. This is particularly true for children identified as high risk.[26] The design of systems such as HPWCC that allow for the allocation of appropriate resources to high-risk children through the use of new technologies to accrue efficiencies in the care of normal children will be particularly important in preventing future adverse outcomes in the high-risk group of children. We feel that the ability to model resource allocation before the implementation of such services will help organizations manage the risk associated with new innovations and will facilitate implementation and evaluation of new models of care.

This study has several limitations. It is based on simulation models that were informed by the pediatric population characteristics of those enrolled in KPCO in 2006-2007. Although we ran sensitivity analyses to account for variation in the proportion of high-risk patients, the low-level Medicaid participation rate in KPCO may bias our estimates. We also did not examine or model how the HPWCC model will affect non-WCC services. It is possible that significant cost off-sets may be found for this age group for non-WCC services given the more intensive use of development screenings, etc. Our cost estimates were based on the perspective of the health plan. We also did not include other changes in societal costs, including the time costs of the parent. Although the previsit screen does require parent time to complete, anecdotal findings from our pilot study suggest that these time costs are recouped by more efficient WCC visits.

In addition, findings from this study may not translate to the fee-for-service, noncapitated or integrated environment including Medicaid. We measured costs using KPCO's cost allocation system, not Medicaid or other fee-for-

service-based estimates. How one defines the measures and the key outcome variables such as costs versus reimbursements (Medicaid or other) may be critical to the study outcome or findings.[27,28] Too often redesigned care calls for new types of health care professionals and the use of non-face-to-face encounters that are not reimbursed in existing fee-for-service systems.[29,30] Although work is underway to develop criteria for reimbursement of e-visits, to date there has not been widespread reimbursement for these services.[31]

Given the issues noted above, the policy implications from this study may depend heavily on where the program is implemented. In an integrated care system like KPCO, where a large majority of the enrollees have access to the Internet, HPWCC may allow greater flexibility for patients and clinicians and for a more efficient allocation of resources for high-risk pediatric patients. However, alternate models of HPWCC that do not rely on the Internet (eg, use of promotoras [a community outreach worker who is responsible for raising awareness of health and educational issues], kiosks in clinic waiting rooms with developmental assessments, etc) may be more likely to achieve such efficiencies in underserved populations.

The strength of this study is that it incorporates actual health services utilization data (and data for nonusers) into simulation models, thereby increasing the accuracy of the cost models. Ultimately these findings need to be confirmed through a study of the implementation and evaluation of the HPWCC model in clinical settings. We are evaluating HPWCC in three intervention clinics at KPCO to validate the cost predictions presented in this study. ❖

Disclosure Statement

This study was funded by the Commonwealth Fund, grant #20080150.

The author(s) have no conflicts of interest to disclose.

Acknowledgments

We would like to thank Jennifer L Ellis and Carol Zager for their assistance in preliminary data analyses, and Alanna Kulchak Rahm for reviewing earlier drafts.

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Civilization

The level of civilization attained by any society
will be determined by the attention
it has paid to the welfare of its children.

— The Children's Bill of Rights, *1968,*
Billy F Andrews, MD, pediatrician and lecturer