

Economic Impact of Health-e-Access
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I. INTRODUCTION

Nature of the research problem

Tremendous socioeconomic disparities in childhood morbidity burden persist. Our own research in Rochester comparing hospitalization rates for impoverished, inner city, children with those of their more affluent suburban counterparts documents striking differences.^{1,2} Treatment which is delayed or less appropriate also is likely to be an important etiologic factor.^{3,4,5,6} Less effective treatment is closely tied to difficulties in access to care. Inner city children not only endure a greater burden of morbidity, but their families have less social, material and financial resources to address this burden. Based on the US Census, for example, 42% of Rochester's inner city households had no automobile and 13% lacked a phone. These figures compared with 4.6% (no automobile) and 0.7% (no phone) for suburban households. Inner city families are served by health centers and hospital-based clinics whose strained resources can provide only limited continuity of care and limited evening office hours. Use of hospital emergency departments to address problems that could often be managed by phone, telehealth or office visits is a frequent consequence.

Acute illness in children remains a major morbidity, social and economic burden across the socioeconomic spectrum. Children under 15 years in the United States make an estimated 71 million office visits annually for acute illness.⁷ These visits account for 48.8% of all office visits for children and 30.0% of office visits for individuals of any age. In addition, children under 19 years make an estimated 29 million emergency department (ED) visits annually (estimate based on 2002 NHAMCS data),⁸ a number that represents 27% of all ED visits. Approximately 20% of children make at least one ED visit yearly, and 7% make two or more. Many costly ED visits occur because of barriers in access to more appropriate settings. Estimates for the proportion of children's ED visits that are non-urgent have ranged between 20% and 70%.^{9,10,11,12}

To address these problems, we designed and developed a telemedicine network. We chose Health-e-Access (HeA) as the name for this intervention, reflecting its essential nature as communications infrastructure facilitating access to health services. The HeA mission is *to enable healthcare when and where you need it, by people you know and trust*. Accordingly, the organizational and technical design of HeA focuses on: (1) establishing and sustaining access sites in convenient community locations (e.g., childcare, schools, retail settings, group homes, fire stations, rescue squad stations, community centers, assisted living and skilled nursing facilities); (2) using information technology to enhance communication with clinicians (physicians, nurse practitioners, physician assistants) in a remote location; and enabling connection with clinicians from the patient's own primary care medical home. Neither place nor time constrain clinician or patient participation in telemedicine transactions. Assumptions about these dimensions of communication are so fundamental to expectations about daily activities that many people fail to envision telemedicine's transformational potential. As a novel intervention designed to improve healthcare, fundamental research questions included feasibility, acceptability, quality, effectiveness and cost.

Purpose and scope of the investigation

As stated in our funded proposal, this program of research was designed to assess 3 hypotheses, as follows:

- (1) Integration of telemedicine services in primary care practice sites is feasible and acceptable to clinicians.
- (2) Healthcare utilization and costs associated with acute medical problems for children in Rochester childcare centers and elementary school will be reduced following the introduction of Health-e-Access services.
- (3) Economic benefits of Health-e-Access will accrue to parents and employers.

Additional funding, beyond that obtained from MCHB, enabled us to substantially extend the depth and breadth to which we assessed these hypotheses. This funding that was obtained from multiple sources including local and national foundations, federal agencies and New York State agencies. It is neither useful nor possible to distinguish achievements that are attributable to a specific source of funding. All funding was necessary, no source alone was sufficient.

II. REVIEW OF THE LITERATURE

Care outside the home has become the norm for pre-school children in the United States. Already in 1995, 60% of children from birth to 5 years of age participated in a non-parental childcare or early education program.¹³ With continuation of the trend for young mothers to join the work force and the advent of welfare-to-work programs throughout the US, this proportion is undoubtedly larger today. Acute, generally infectious illness is a very common and difficult problem for all involved in childcare centers. Higher incidence and greater severity of illness among children in childcare than among children in home care is well documented.^{14, 15, 16, 17} Economic burden of illness in day care is also substantial.^{18, 19, 20}

Childcare centers have the difficult responsibility of determining whether to exclude a child from the center due to illness. Almost all childcare programs in Rochester adhere to recommendations of the American Academy of Pediatrics (AAP)²¹ and the American Public Health Association (APHA).²² We believe the AAP/APHA recommendations have been thoughtfully crafted to reduce the spread of serious infectious disease and to ensure that children who have treatable conditions are brought to medical attention. Nevertheless, exclusion policies are subject to judgment, and the decision to exclude a child because of illness is often a source of great tension between childcare staff and parents. Prevailing policies often require an office visit for a physician to certify readiness for return to childcare.

Parents find themselves in an even more difficult situation. They are frequently called at their jobs to pick up ill children. One study found that a child's illness accounted for 40% of missed work for childcare parents. Another study, based on a nationally representative sample of working women, found that only 39% had someone they could call on to help with childcare the next time their child is sick.²³ Most women reported either that they would need to miss work (49%) or that they would not know what to do (7%) when this occurs. Work absence to care for a sick child means loss of pay for most women of lower socioeconomic status. Inner city parents may jeopardize employment by leaving work as demanded. Other parents, anxious to keep jobs that they cannot afford to lose, try to delay pick-up and hasten the return of ill children to childcare. Compared to a professional and middle class parent, the typical inner city parent draws on far fewer resources when confronting the challenge of childhood illness. The inner-city parent is less likely to have flexible work hours or a spouse with flexible work hours.

III. STUDY DESIGN AND METHODS

Study designs, population studied, sample selection, instruments and analytic approach varied by hypothesis and thus are described separately for each of the three hypotheses.

Study designs

(1) Feasibility and acceptability of integrating telemedicine services in primary care practices was assessed in a descriptive, observational study of primary care practices and primary care clinicians serving children in the Rochester area.

(2) The impact of HeA of utilization and costs was assessed through a prospective cohort study based on analysis of insurance claims files (secondary data analysis) and comparing utilization for the intervention group (children with access to telemedicine in childcare or school) versus that of a matched control group (children without telemedicine access).

(3) Economic impact on parents and employers was assessed based on surveys of a convenience sample of parents whose children had access to healthcare via HeA.

Populations studied

(1) Ten primary care practices that care for children in the Rochester, NY area participated, of which 5 were located in eastern suburbs and 5 were located in the city of Rochester. After all these practices began providing telemedicine visits, participating practices located in the city provided primary care to children making 70.5% of telemed visits from city childcare and city elementary school telemedicine access points. Participating practices located in the suburbs provided primary care to children making 19.1% of telemed visits from suburban childcare and city elementary school telemedicine access points.

(2) To reduce extraneous influences on utilization, children participating in Health-e-Access were eligible for inclusion in analysis only if they were served for at least 6 consecutive months with simultaneous insurance coverage and telemedicine program participation. We also restricted analysis to observations in children younger than 13 years because mostly younger children attend elementary school or childcare. Given that utilization histories differed in length, we chose child-months as the unit of analysis. In defining child-months, we divided years into 13 equal 28-day periods. Insurance company claims data captured utilization for 80 months (using the 28-day definition), or 6.2 years, from May 2001 when telemedicine service began, through August 12, 2007, the last date for which billing claims were obtained. Use of child-months as the unit of analysis provided a standardized unit for length of observation and enabled adjustment for the effect of age on utilization. Capacity for the latter, which would have been lost with aggregation by child, was especially important given multiple years of observation in early childhood, a period when utilization rates vary widely.

During the 6.2-year study period, multiple events beyond investigator control determined availability of utilization data. As expected, many children enrolled in a different childcare program or school later in the study period. Some subsequent child sites participated in Health-e-Access, whereas others did not. A child contributed child-months to the intervention group when, concurrently, (1) she attended at a child site participating in Health-e-Access, (2) her parents had consented for participation, (3) she had insurance coverage, and (4) this insurance organization provided claims data. One major local insurance organization, which provided coverage for telemedicine visits and had originally agreed to provide billing claims data, was acquired during the study period by another insurance organization outside the Rochester area and ultimately failed to honor its commitment to provide claims data.

We selected control children from insurance company enrollment files to match intervention children on age, sex and postal zip code of residence. As with intervention children, a child needed at least 6 continuous months of insurance coverage to be contribute eligible control child-months. The computer matching algorithm matched periods of sequential child-months (of at least 6-months duration), which we termed *segments*. We matched segments rather than children because the unit of analysis was child-month, because segments for intervention children varied in length, and because some intervention children provided multiple segments. Segments ended when any of the four conditions, listed above, were no longer met.

Eligible control segments were supplied by a child with the same sex and zip code as those of matched intervention segments. Zip code served to define socioeconomic area, as discussed below. Age match requirements, based on age (in months) at the time the intervention segment began, were as follows: < 12, within 1 month; 12 through 24, within 2 months; 24 through 35, within 4 months; 36 or over, within 6 months. Attempts to match an intervention segment proceeded in chronological order, from first to last enrolled in Health-e-Access. If multiple segments met control criteria, the one selected was that which overlapped with the largest proportion of sequential intervention child-months (usually 100%) and matched most closely on age.

(3) Parent surveys were administered and successfully completed in person or via telephone following enrollment, but prior to the first telemed visit, for 578 children. We attempted phone contact at various times of day, including evenings and weekends, until the child had a telemed visit and thus became ineligible for a pre-telemed survey, until a parent completed the survey, a parent refused, or until 3 unsuccessful attempts to contact were unsuccessful. Almost identical surveys were completed by 335 parents after their child had at least one telemedicine visit. A major objective in analyzing surveys was to compare parent impressions and family circumstances pre- vs. post-telemed experience. We continued attempts to complete post-telemed surveys until 100 surveys were completed by parents who had already completed a pre-telemed survey.

The intervention

Development of the intervention. The Health-e-Access telemedicine model was designed to enable diagnosis and treatment decisions for acute problems that commonly arise in childcare and elementary school settings. Participants in telemedicine encounters include a child with a health problem, a telemedicine assistant and sometimes a parent, all at the child site, plus a telemedicine clinician at a remote site. The clinician site may be located anywhere with broadband internet access and modest personal computer equipment. Clinical, organizational and technical features of the system in use are described elsewhere.^{24,25} Health-e-Access commenced operation in May 2001, with 6 inner-city childcare programs starting participation in stepwise intervals of 6 to 8 months to offer care via telemedicine over the first 3.5 years by 3 clinicians who were primary care providers with the Pediatric Practice of the Golisano Children's Hospital in the University of Rochester Medical Center (URMC).

Beginning in January 2005, child sites were gradually added to the network, including additional inner city elementary schools as well as suburban childcare and elementary schools, bringing the total to 22 neighborhood telemedicine access points. Beginning in May 2005, provider sites expanded to include 9 *additional* city and suburban practices, bringing the total to 5 city and 5 suburban practices.

Sample selection, instruments and measures

(1) Acceptability to clinicians providing primary care for children was assessed through an online survey. Requests to complete this survey were sent to all clinicians who had completed a telemed visit as of February 15, 2007. Acceptability of the HeA model was also indexed by the response of participating primary care practices to requests to perform telemed visits and by their ability to complete telemed visits that they were requested to do. A completed telemed visit was defined as one for which the clinician made diagnosis and management decisions and treatment was instituted based entirely on telemedicine, i.e., no subsequent in-person care, including laboratory or imaging, was required for evaluation or treatment.

(2) Enrollment and comparability of intervention and control groups. During the 6.2 year study period 4,701 children were enrolled at any time in one of the Health-e-Access childcare or elementary school programs. Among these, 2,255 (48.0%) were covered by insurance that provided claims data. Insurance types for the 2,255 we were able to study included Medicaid Managed Care (60.2%), commercial insurance (31.2%) and Child Health Plus (8.6%). Insurance types for the 2,446 we were not able to study included fee-for-service Medicaid (41.9%), Medicaid Managed Care (19.5%), commercial insurance (24.2%) and uninsured/missing insurance information (7.5%). After excluding 758 children because they failed to meet the upper age limit criterion (at least 6 consecutive months of observation prior to the 13th birthday) and 281 more children because a control segment lasting at least 6 consecutive matching child months in duration was not available, 1,216 met all criteria for analysis.

These 1,216 intervention children contributed 19,652 child-months of observation, each matched by a control child-month. Mean (SD) ages of these children at the end of the first and last child-months observed were 6.15 (3.2) and 7.4 (3.1) years, respectively. The number of child-months observed per child ranged from 6 to 81 months, and the mean (SD) was 16.2 (9.4). Children first enrolled in Health-e-Access in city childcare, 566 (46.5%); city elementary schools, 499 (41.0%); suburban childcare, 34 (2.8%); and suburban elementary schools, 117 (9.6%).

Control child-months, provided by 1,410 different control children, matched the 19,652 intervention child-months. By virtue of the matching process, child-months from intervention and control children matched on sex, zip code and insurance type, whereas matching within specified age ranges allowed minor differences in age to occur. Child-months from children dwelling in inner city, rest of city, and suburban zips comprised 60.2%, 28.6% and 11.2% of months, respectively, for both the intervention and control groups. Females contributed 51.2% of child-months for both study groups. Child-months from children covered by Medicaid Managed Care and commercial or Child Health Plus insurance comprised 78.4% and 21.6% of months, respectively, for both study groups. Mean age at the end of each child-month was 6.72 years for the intervention group and 6.71 years for the control group.

(3) A convenience sample was used to address Aim #3 as discussed in the section above on Population Studied.

Analysis

(1) As appropriate for the study design, descriptive statistics (e.g., frequencies, proportions, means) were used to characterize findings on indicators of feasibility, acceptability and integration into primary care practice.

(2) For primary analysis, visits were counted and utilization was expressed as the average number of visits per 100 child-years. Average visits per child-year may be interpreted as the expected number of visits during a typical year for an average study child. Utilization rates for

intervention and control children were compared first in bivariate analysis, then in multivariate analysis. As subjects were not randomly sampled nor randomly assigned to intervention or control groups, significant tests were not relevant unless one regards our study population as a cluster of cases.

Because each subject contributed multiple child-months, and each child-month had a corresponding matched control, we have multilevel data with repeatedly measured outcomes clustered within a subject. Analysis for such data needs to take into account for both within-subject and within-matched pair correlations. Within children, months may not be independent of each other unless one considers acute illness episodes as random events within a child. Generalized estimating equations (GEE)²⁶ with two levels of clustering were used to estimate the effect of telemedicine on numbers of visits of a particular type (e.g., ED visits, overall illness utilization) by fitting marginal Poisson regression models.²⁷ Sandwich estimators were calculated to generate robust estimation of standard errors. The advantage of GEE is that it provides consistent estimation even with a miss-specified correlation structure, and it is computationally feasible with the large numbers of observations and clusters. Multivariate analyses were performed with SAS.²⁸

Recognized determinants of utilization include child age, season of the year, sex, insurance type, and socioeconomic status. Effects of season, sex and insurance type were eliminated from the present analysis by matching, and the effect of age was minimized by matching within narrow limits. Matching on zip code of residence for Rochester-area children reduces the potential for effects of socioeconomic status, transportation, race and ethnicity because of the high correlations between zip code and these attributes.

After minimizing potential effects of several sources of variation by matching, we used multivariate analysis to adjust for sources when matching was not perfect, such as age. The GEE method with a log link and Poisson errors were repeated adjusting for potentially confounding variables. To address the possibility that reduction was attributable to season despite matching, we included in regression models an indicator variable for each month of the year. Models also included indicator variables for insurance type.

(3) As appropriate for the study design, descriptive statistics were used to characterize findings on indicators of burden related due to child illness, especially with regard to work loss and the possibility that telemedicine might reduce this burden.

IV. DETAILED FINDINGS

(1) Feasibility and acceptability of telemedicine in primary care of children.

Over the 7 years between May 1, 2001 and April 30, 2008, 6,511 telemedicine visits were attempted. Stages in the development of HeA were as follows. The *Pre-Expansion Stage* began with the first telemedicine visits and continued until the *Expansion Stage*, which commenced with funding for expansion from AHRQ and MCHB, received 10/1/04. The first phase of the Expansion Stage was Technology Development Phase, in which a new software and hardware system was designed to create a functionally reliable, user friendly system that both telemed assistants and busy primary care clinicians could readily learn, dependably use and fully integrate in their day-to-day activities. The PCP Installation/Training Phase began when new integrated software/hardware system was first available for deployment, 5/13/06. We defined the PCP Ramp-Up Phase as beginning when all 10 PCP sites had completed installation and training and had completed their first visit. PCP Ramp-Up began 04/21/06. Visits addressed in

this report included Pre-Expansion, 1871, 28.7% and Expansion, 4640, 71.3%. Within the Expansion Stage, phases included Technology Development, 843,13.0%; PCP Installation/Training 1243, 19.1%; and PCP Ramp-Up, 2554, 39.2.

Telemed visit completion rate was 97.3% overall and varied little among program development phases, with proportions not completed of 1.3%, 1.9%, 3.9% and 3.5%, respectively, for Pre-Expansion, Technology Development, PCP Installation/Training, and PCP Ramp-Up phases.

For children with a participating PCP office, continuity of care for telemedicine visits was 83.2%. Among the 2554 telemed visits during the PCP Ramp-Up Phase, 1557 were made by children with a participating PCP, and 1296 of these (83.2%) were seen by a clinician from the primary care medical home. Continuity varied substantially among participating practices, ranging from 41.2% to 92.9% among city practices and from 28.1% to 92.3% among suburban practices.

Among the 43 clinicians that had completed at least one telemed visit at the time survey responses were requested, 30 (23 pediatricians, 7 mid-level practitioners) responded. Important findings follow. The time clinicians estimated for decision making via telemed visits averaged 10.3 min per visit. Also, 82.1% of clinicians estimated the time required for medical decision making via telemed was the same (50.0%) or less (32.1%) than that for similar office visits. Clinicians estimated a mean time for completing the entire visit via telemed (including documentation and any contacts with pharmacy, parents and telehealth assistants) of 19.8 min per visit. Total time required probably has diminished since this survey was conducted because software was upgraded in June 2007 to allow easier documentation and navigation, and to allow prescriptions to be faxed directly from the software application to the pharmacy. Faxing prescriptions eliminates the substantial time that clinicians would otherwise spend phoning in prescriptions to the pharmacy. 48.3% of clinicians estimated that the total time required for completing the visit via telemed was the same (31.0%) or less than (17.2%) that for similar office visits (same as, 31.0%; less than, 17.2%). Among the 6 clinicians who had completed 50 or more telemed visits, mean estimates for time involved in decision making and total time were 7.2 and 15 min per visit, respectively.

Among the 30 clinician respondents, the proportion that felt the information conveyed by tympanic membrane images, other fixed images, or electronic stethoscope sounds was as good or better than that obtained in person was 76.7%, 40.0% and 13.3%, respectively. Among the 6 clinicians who had completed 50 or more telemed visits, 100% felt that the information conveyed by tympanic membrane images was better than that obtained in person; and the proportions that felt the information conveyed by other fixed images or electronic stethoscope sounds were as good or better than that obtained in person were 83.3% and 50%, respectively. 86.7% of clinicians expressed no discomfort working with telehealth assistants. Overall 46.3% of clinicians were at least as confident of diagnoses made via telemed as in person. Among the 6 clinicians who had completed 50 or more telemed visits, 83.3% were at least as confident of diagnoses made via telemed as in person.

(2) Impact on healthcare utilization and costs.

Bivariate analysis. Overall illness utilization rates, including both visits to traditional sites (ED, office) and telemed visits were 22.9% greater for intervention than control children (336.4 vs. 273.7 visits per 100 child-years). The higher overall utilization for intervention children was attributable to telemedicine utilization, at a rate of 83.6 per 100 child-years. Rates

among intervention child-months for ED visits and illness office visits, however, were 23.7% less (44.1 vs. 57.7/100) and 3.3% less (208.8 vs. 216.0/100), respectively, than those for control child-months. All these differences were statistically significant at the .001 level or better.

Multivariate analysis. This analysis showed within-subject telemedicine effects adjusting for season, health insurance type, child's age and socioeconomic area. Coefficients in this analysis represent the treatment effect of telemedicine, i.e., difference in the log of the rate ratio between intervention and control groups. In Poisson regression, with season, child age, socioeconomic area and insurance type in statistical models, lower rates associated with telemedicine was not statistically significant for office utilization, but it was for ED utilization (rate ratio = 0.778, $P = .036$). Illness utilization overall increased (rate ratio = 1.235, $P < .0001$). As expected because matching was used to minimize extraneous sources of variation among intervention and control child-months, these results of multivariate analysis were very similar to those of bivariate analysis. The rate ratio for overall illness utilization is equivalent to 23.5% greater overall utilization for the intervention group, a value that is very close to the 22.9% greater overall utilization based on bivariate analysis. The rate ratio for ED utilization is equivalent to 22.2% less ED utilization for the intervention group, a value that is very close to the 23.7% less ED utilization based on bivariate analysis.

(3) Economic benefits of Health-e-Access for parents and employers.

Space limitations precludes a full presentation of the many findings confirming substantial value for parents and their employers. We only present the most noteworthy findings. Among the 578 respondents to the pre-telemed survey, 56.2% indicated they had, at some time, given their child an antipyretic medication to hide illness symptoms from childcare or school personnel. There were only modest differences between city (58.7%) and suburban (50.0%) parents and between childcare (58.2%) and school (54.4%) parents. The likelihood that antipyretics were so used varied with responsibilities outside the home, from 75.7% for respondents with both school and work responsibilities, 59.1% with only work, 57.8% with only school, to 46% with neither of these responsibilities ($P < .01$).

Among the 68.3% of *pre-telemed survey* respondents working outside the home, 64.6% were hourly employees and thus would almost certainly lose pay when they missed work due to a child's illness. Among the 76.0% of these respondents either working outside the home or going to school, 50.6% had to keep their child out from school or childcare within the past 3 months and 34.9% missed some work/school because of this. The mean (SD) number of times the respondent kept their child home and missed work during this period were, respectively, 1.38 (2.59) and 0.97 (2.56). Among the 74.1% of *post-telemed survey* respondents working outside the home, 76.6% were hourly employees. Among the 82.1% of these respondents either working outside the home or going to school, 59.7% had to keep their child out from school or childcare within the past 3 months and 41.1% missed some work/school because of this. The mean (SD) number of times the respondent kept their child home and missed work during this period were, respectively, 1.39 (1.79) and 0.93 (1.61).

Limiting analysis to just those responding both before and after experience with telemedicine and who indicated they were working ($N = 66$), *prior to telemedicine*, the mean number of times the respondent kept their child home and missed work during the past 3 months were, respectively, 1.39 (2.21) and 0.80 (1.23); and the last time their child was sick 59.1% said they missed work. For these same 66 respondents, *with telemedicine* available the mean number of times the respondent kept their child home and missed work during the past 3 months were,

respectively, 1.38 (1.90) and 1.18 (2.11); and the last time their child was sick 74.0% said they missed work.

V. DISCUSSION AND INTERPRETATION OF FINDINGS

Conclusions to be drawn

(1) Findings demonstrate that implementing the HeA telemedicine model, which includes integration of telemedicine visits in busy primary care practices, is feasible, acceptable to parents and providers. The model fit needs for care of acute childhood illness identified in childcare and elementary schools well as indicated by high rates (97%) of telemed visit completion. Continuity of care enabled by telemed visits (83%) was also high, especially in view of the fact that other forms of “convenience care” (retail based clinics, urgent care centers, ED “fast track care”) preclude continuity with the medical home. The continuity achieved should also be considered in view of a pre-study survey findings. Among parents using city childcare sites, 75% indicated that afternoon calls to their child’s doctor about an illness usually prompted guidance to go to the ED. Continuity varied substantially among participating practices, suggesting that ability to integrate telemedicine varied substantially. Integration, based on continuity, probably reflects a broad range of factors such as interest and commitment of the providers, flexibility in organization and scheduling systems in the practice, and demand for telemed visits by patients of the practice. A strong correlation existed between demand for visits and continuity; practices with the greatest demand for telemed visits were most likely to accommodate requests for telemed visits. This suggests that until practices perceive telemedicine to be clinically or financially important, telemedicine programs designed to enhance access to primary care will need to incorporate back-up clinician(s) to be able to provide visits service when the a clinician from the medical home is not available. Using a web-based system, such as one HeA uses, this is readily accomplished.

(2) Multivariate analysis adjusting for potential confounding by age, sex, month of year, socioeconomic area of residence and insurance type confirmed findings of bivariate analysis that telemedicine access was associated with substantially less ED utilization. While demonstrating 22.2% fewer ED visits among children with access to telemedicine, findings also included 23.5% more visits for illness, overall. Findings are likely to be generalizable for urban areas throughout the United States. The observed overall utilization rate for illness among control children, 273.7 visits per 100 children per year, was similar to acute illness utilization rates found in a recent National Ambulatory Medical Care Survey.²⁹

Additional overall utilization due to telemedicine visits is a large part of the cost of reducing ED utilization through this telemedicine model. To provide a metric for the tradeoff between reduced ED visits and increased overall visits, we applied rate ratios generated from multivariate analysis to utilization rates in the control group (i.e., taking control group rates as baseline values), calculating the projected increase in annual overall visits per 100 children (64.3) and the projected decrease in ED visits (12.8). Based on the projected rate changes derived in this way, the tradeoff was 5.0 additional visits overall per ED visit avoided. One may consider this a cost-effectiveness measure, with overall visits added as the unit of cost and ED visits avoided as the unit of effectiveness.

(3) Our study addressing benefits to parents and employers expands on our early, important finding that access via HeA for children in inner-city childcare was associated with a 63% reduction in absence from childcare due to illness. The large proportion of parents who have used antipyretics in an attempt to hide illness symptoms suggests that childhood illness

represents a major source of conflict between parents and from child-site staff and a major challenge to parents' capacity to meet work, school and family responsibilities. Observations on the association between child illness and work loss also confirms that childhood illness presents a major challenge to parents' capacity to meet work, school and family responsibilities. There was no indication in survey results that telemedicine decreased this burden.

Explanation of study limitations

(1) Feasibility and acceptability of a health services innovation designed to improve primary care reflect not only design of the innovation but also community-specific attributes such as program leadership, program marketing, existing commitment to primary care within the child healthcare community, interest and commitment of child care programs, school personnel and other potential neighborhood access points, and healthcare-related politics. Thus, while the design of HeA should be readily generalizable to other communities, execution of the design depends significantly on community-specific attributes.

(2) Close matching between intervention and control child-months was possible on major determinants of acute illness utilization except childcare enrollment. Infectious disease exposure in intervention and control child-months was very similar for school-age child-months, comprising 66% of both groups, because school attendance is mandatory. Among the 34% of child-months during preschool periods, however, infectious disease exposure probably was greater for intervention child-months. In this age range, all intervention children attended large childcare centers, whereas the proportion of control children attending childcare of any kind was unknown. A recent study found that for preschool children in New York State with working mothers the proportion attending any form of childcare (including nanny, relative, or family-home childcare) was 75%, but the proportion using center-based care was only 27%.³⁰ These values are consistent with national estimates. Because childcare attendance, especially in large childcare programs, increases the incidence of infectious disease exposure and minor acute illness episodes,^{31,32,33,34} conservative bias likely prevailed in this study. With a greater incidence of acute illness, greater illness utilization of all types would be expected for the intervention group. Had intervention and control groups been perfectly matched on childcare attendance, the difference in ED visits probably would have been greater, with even fewer ED visits by the intervention group. At the same time, the difference in overall utilization probably would have been less, with total visits for the intervention group closer to that for the control group.

(3) The major limitation is that representativeness of the sample could not be ensured, given that we could only interview parents who we were able to contact and who were willing to respond to surveys. Among children included in the utilization impact study (Aim #2), 48.4% of child sites were child care programs and 87.6% of the sites (school or childcare) were in the city. Among children whose parents responded to both pre- and post-telemed surveys, 61.9% of child sites were childcare programs and 82.5% of the sites (school or childcare) were in the city.

Comparison with findings of other studies

A substantial research literature on provider-to-provider telemedicine exists, but the literature on primary care telemedicine models such as HeA remains sparse. Consistent with the definition of primary care,³⁵ we use the term primary care telemedicine to include models designed to be the point of first contact with the primary care medical home. No prior research

has been published on primary care telemedicine to address acute childhood illness in community access points.

Policy implications: Application of findings to actual MCH health care delivery

Findings provide strong evidence that policy decisions encouraging the wide dissemination of the Health-e-Access telemedicine model, including a requirement for insurance payment for services at the patient site and at the clinician site, would improve access to high quality care and reduce healthcare costs.

After the HeA model is fully integrated into a community's health system, we believe that a substantial proportion of the telemedicine visits occurring during the demonstration project would be averted through telephone management. This belief assumes that full integration will include telephone management, by a clinician or phone nurse, as part of a process that would lead to telemedicine access only if appropriate care were beyond the scope of phone management. Depending on information exchanged by phone, triage to in-person care rather than telemedicine would sometimes occur. The idea that phone management would narrow the use of telemedicine is consistent with observations on pediatric telephone call centers, which suggest a substantial portion of illness episodes that would otherwise lead to office or ED visits can be managed safely and effectively via telephone.³⁶

With telemedicine access tied to phone management, we expect that over time the cost-effectiveness metric (overall visit increase per ED visit avoided) of 5.0 would improve substantially. During this demonstration project, we placed few constraints on requests for telemedicine visits because we were concerned that constraints – for example, interaction with a nurse-staffed, telephone call center as the gateway to telemedicine visits – would discourage use of telemedicine. This seemed especially likely since telemedicine was new to parents, child settings and telemedicine assistants.

It also seems likely that many communities adopting the HeA model might improve on the observed cost-effectiveness metric through greater reduction in ED use than the 22.2% reduction achieved in Rochester. Between 20 – 70% of pediatric ED visits in the United States have been estimated to be non-urgent^{37,38,39} and thus are plausible targets for this telemedicine model. Families have good reasons to prefer a telemedicine visit to an ED visit for most illness because telemedicine is much more convenient. Parents with children who have used Health-e-Access estimated a telemedicine visit avoided 4.5 hours lost from work.²⁴ Almost all parents who have used this telemedicine system have been satisfied with the service (93%). This community has long had high levels of access to care.⁴⁰ Recognized strategies for improving access and reducing ED visits – insurance coverage, access to telephone management, extended office hours, “open-access” office scheduling systems, urgent care centers – have been in place in this community for many years. Although refinements will always be possible, we believe that strategies mentioned above had already achieved much of their potential for the study population by the time that the Health-e-Access model was initiated in 2001. Analysis was limited to children not only with insurance coverage, but also with insurance coverage that mandated the availability of 24/7 access to telephone triage and advice. Practices all provided some of the after-hours phone management themselves. Most signed over primary responsibility for this service to a nurse-staffed, community pediatric telephone management system for period (e.g., after 10:00pm) each day, while remaining available as back-up to phone nurses. Most of the participating practices also provided some regular evening or weekend office hours.

Suggestions for further research

Findings indicate the HeA model has tremendous potential to improve access and reduce costs if embraced by healthcare providers and payers. Further research would enhance knowledge about organizational refinements that would optimize this potential and ensure sustainability. In particular, we recommend the following. (A) The HeA model should be replicated in other communities under circumstances that allow qualitative and quantitative studies to address factors that enable and ensure acceptability and sustainability. (B) Studies, both in this community and others, should assess the impact on utilization and costs of telemed access that is linked to phone management. (C) Studies should assess the cost-effectiveness of other telemedicine access points, especially sites that can provide access outside of regular medical office hours inexpensively because they already operate evenings, weekends and holidays (e.g., retail based settings, community centers, fire stations). An important, plausible hypothesis is that after-hours access is less costly to provide than access in childcare, but childcare access is more cost-effective from a societal perspective because it has greater impact in reducing children's absence from childcare and, thus, in enabling parents to stay on the job.

VI. LIST OF PRODUCTS

Peer-Reviewed Publications

- McConnochie KM, Tan J, Wood NE, Herendeen NE, Kitzman HJ, Roy J, Roghmann KJ. Acute illness utilization patterns before and after telemedicine in childcare for inner-city children: A cohort study. Telemedicine and e-Health 2007;13:381-390
- Kopycka-Kedzierawski D, Billings R, McConnochie KM. Dental screening of preschool children using teledentistry: A feasibility study. Pediatric Dentistry 2007 (May-Jun); 29:209-213.
- McConnochie KM, Connors GP, Brayer AF, Goepf J, Herendeen NE, Wood NE, Thomas NE, Ahn DS, Roghmann KJ. Differences in diagnosis and treatment using telemedicine versus in-person evaluation of acute illness. Ambulatory Pediatrics 2006;6:187-195
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- McConnochie KM, Wood NE, Kitzman HJ, Herendeen NE, Roy J, Roghmann KJ. Telemedicine reduces absences due to illness in urban childcare: Evaluation of an innovation. Pediatrics 2005; 115: 1273-1282

Abstracts, Presentations

- McConnochie KM, Wood NE, Herendeen NE, Ng PK, Roghmann KJ. Telemedicine Reduces Emergency Department Utilization in Urban Children. Platform Presentation, Pediatric Academic Societies' Annual Meeting, May 2008, Honolulu
- McConnochie KM, Feng Qian J, Noyes K, Wood NE, Roghmann KJ. Potential to Reduce Healthcare Costs by Replacing Emergency Department with Telemedicine Visits. Platform Presentation, Pediatric Academic Societies' Annual Meeting, May 2008, Honolulu
- McGowan JJ, Dixon BE, McConnochie KM, Scheideman-Miller C, Bryant CA. Impacting Quality and Safety via Telehealth. Panel presentation at the annual Fall meeting of the American Medical Informatics Association, November 2007, Chicago

- McConnochie KM, Herendeen NE, Wood NE, Roghmann KJ. Health Care When and Where You Need It, By People You Know and Trust. Poster presentation, AHRQ Annual Meeting, September 2007, Washington, DC
- McConnochie KM, Herendeen NE, Wood NE, Denk L, tenHoopen CB, Neuderfer JS. Can telemedicine for children in inner-city child care be integrated in the primary care medical home? Platform presentation, Pediatric Academic Societies' Annual Meeting, May 2007, Toronto
- McConnochie KM, Potential of Telemedicine for Developmentally Disabled Children and Adults. Invited teleconference presentation to the New York State Office of Mental Retardation and Developmental Disabilities Commissioner's Taskforce on Aging, March 9, 2007
- McConnochie KM, Herendeen NE. Clinical and Economic Impact of the Health-e-Access Telemedicine Model. December, 2006. Emergency Medicine Department Grand Rounds, University of Rochester Medical Center
- McConnochie KM. Clinical and Economic Impact of the Health-e-Access Telemedicine Model. October 17, 2006. National Virtual Telehealth Grand Rounds, sponsored by East Carolina University
- McConnochie KM. The Health-e-Access Telemedicine Model: Measuring the Impact. Invited panel presentation at the annual Spring meeting of the American Medical Informatics Association, May 2006, Phoenix, AZ
- McConnochie KM. Economic Model of Organizational Architecture to Guide Design and Performance Evaluation in an Urban, Primary Care Telemedicine Network. Platform presentation. Patient Safety and Health Information Technology Annual Meeting, Agency for Healthcare Research and Quality. Washington, DC, June 2005
- McConnochie KM, Tan J, Wood NE, Herendeen NE, Kitzman HJ, Dick AW, Roy J, Roghmann KJ. Telemedicine in Inner-City Childcare Reduces Utilization for Acute Illness. Platform presentation, Pediatric Academic Societies, May 2005, Washington, DC
- McConnochie KM, Wood NE, Kitzman HJ, Herendeen NE, Roy, J, Roghmann KJ. Telemedicine Reduces Absences Due To Illness in Urban Childcare: Evaluation of an Innovation. Poster presentation, American Telemedicine Association Annual Meeting, Denver, April 2005
- McConnochie KM, Tan J, Wood NE, Herendeen NE, Kitzman HJ, Dick AW, Roy J, Roghmann KJ. Telemedicine in Inner-City Childcare Reduces Utilization for Acute Illness. Poster presentation, American Telemedicine Association Annual Meeting, Denver, April 2005
- McConnochie KM, Brayer AF, Connors GP, Goepf J, Herendeen NE, Wood NE. Reliability And Efficacy Of Telemedicine In Diagnosis And Management Of Common Acute Childhood Illness. Poster presentation, American Telemedicine Association Annual Meeting, Denver, April 2005 (Winner of Blue Ribbon Award from ATA)
- McConnochie KM, Wood NE, Kitzman HJ, Herendeen NE, Roy, J, Roghmann KJ. Telemedicine Reduces Absences Due To Illness in Urban Childcare: Evaluation of an Innovation. Platform presentation, Pediatric Academic Societies, May 2004, San Francisco
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McConnochie KM. Telehealth Services in Rochester (NY) Head Start. Poster presentation at Head Start's 7th National Research Conference, Washington, DC, June 28, 2004

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- 1 McConnochie KM, Russo MJ, McBride JT, Szilagyi PG, Brooks AM, Roghmann KJ. Socioeconomic variations in asthma hospitalization: excess utilization or greater need? *Pediatrics* 1999;103(1). URL: <http://www.pediatrics.org/cgi/content/full/103/1/e75>.
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