I. Introduction
A. Nature of the research problem: The observed triad of inadequate well-child care in infancy, poor health, and increased use of emergency department (ED) services for non-emergent or ambulatory care sensitive conditions (ACSCs) by Medicaid children has been recognized long enough for it to be accepted by many as “the norm” (1-3). The postulate tested in this analysis is that this scenario is actually driven by underuse of early and periodic screening, diagnosis, and treatment (EPSDT)/well child care in infancy. To enhance child health and development, the American Academy of Pediatrics (AAP) recommends frequent well child visits in infancy (4, 5). These recommendations are based on consensus expert opinion and despite AAP appeal for research documenting clinical effectiveness, excepting immunizations, well child care effectiveness has not been objectively confirmed (6, 7). A current paradigm is that correction of the underuse of needed healthcare both increases the quality of care and cost (8). While policymakers clearly want improved quality of care for Medicaid children, with no confirmation of the clinical effectiveness of well-child care and published findings indicating short-term increased cost for this care, support for well child care is at best, guarded (5-9).

B. Purpose, scope, and methods of investigation: The goal for this investigation was to confirm the clinical effectiveness of EPSDT/well child care by testing the hypothesis that receipt of the AAP recommended number of visits in the first two years of life is associated with reduced healthcare utilization and cost birth to six years (4, 5). Lack of objective evidence confirming the clinical effectiveness of well child care and its association with long term healthcare cost represents a serious gap in information that has made many government policymakers uncertain whether correcting the underuse of well child care in infancy by Medicaid children is worth any short term added cost (9). With achievement of this goal, policymaker support for methods to correct the underuse of well-child care and the improved well-being of Medicaid children could be simultaneously facilitated. This study was a secondary data analysis using linked state Medicaid claims and birth certificate files. South Carolina Medicaid data include detailed individual-level measures of socioeconomic characteristics of mothers, such as marital status, level of family income, and education or information that is not available in administrative data.

C. Nature of the findings: Consistent with the hypothesis, having the recommended number of EPSDT visits in the first 24 months of life was associated with a reduced adjusted rate of ACSC ED visits birth to six years but it was also associated with a greater adjusted rate of sick child office visits and of course, more EPSDT visits birth to six years. These additional healthcare use findings were not hypothesized and resulted in children with the AAP recommended number of EPSDT visits in the first two years of life having a greater adjusted total Medicaid cost birth to six years than children with fewer visits (p<.001). This finding was specifically related to the
increased cost for primary care provider (PCP) EPSDT and sick child office visits and prescription drug use.

II. Review of the literature
Healthcare quality is a measure of how well health services facilitate desired health outcomes. The healthcare paradigm challenged in this analysis was that correcting the underuse of needed services such as preventive care, increases both quality and cost of care (8).

The American Academy of Pediatrics (AAP) recommends an age-based schedule of well-child (preventive care) visits throughout childhood including 6 visits in year one and three visits in year two (4, 5). These visits include close physical and developmental screening, accommodate immunization schedules, and provide needed parental anticipatory child care guidance.

Limited well child care utilization and poor health are characteristics disproportionately shared by low-income children (1-3). Even if increased utilization of well child care improves the quality of care, with the paradigm of its associated increased cost and limited evidence of its clinical effectiveness, government policymakers are uncertain whether this preventive care quality improvement is worth any added cost (7-9). Thus, there was urgent need for a close evaluation of the clinical effectiveness and long term cost associated with receipt of the AAP recommended number of EPSDT visits in infancy by Medicaid children. Data generated prior to this analysis had indicated that receipt of increased numbers of EPSDT/well child visits by low income children in year one of life is associated with reduced utilization of expensive emergency department care in year two and that poor health is less common among low income children receiving more well child care in their first two years of life (2, 11) but long term outcomes were not available.

III. Study Design and Methods
Study design
Data were obtained from the South Carolina Budget and Control Board, Office of Research and Statistics (ORS) as linked state Medicaid claims and birth certificate files. Previous research by this PI using South Carolina Medicaid data indicate that the data and linkages used for this analysis have a high degree of completeness, reliability, and validity (2,11-15).

Population studied
For adequate sample size, a three year birth cohort was studied. South Carolina children born 2000-2002 and continuously enrolled in Medicaid birth-six years (n=18,512) were analyzed.

Sample selection
To accurately assess the effect of well child care on health service utilization, a control for baseline child health was established by excluding children with conditions that predispose them to utilize more well child care and that would not be evenly distributed
among children in the analytic groups. Excluded children were those with major congenital anomalies and with recognizable genetic malformations (identified using International Classification of Diseases, Ninth Revision, Clinical Modification, ICD-9 codes). Study children were also restricted to those that were full term and appropriately grown at birth by requiring 37-42 weeks gestational age and excluding those with a birth weight less than the 5th or greater than the 95th percentile for gestational age (16, 17). These percentiles, based on published fetal growth norms, set a birth weight range for study children of 2357-4213 grams (17).

In 2000-2002, there were 61,112 South Carolina births insured by Medicaid. The study restrictions excluded 16,280 children, leaving 44,832 in the birth cohort. The majority of exclusions were due to birth anomalies (n=11,552), birth weight outside fetal growth norms (n=6,878), and gestational age less than 37 weeks or greater than 42 weeks (n=7,491). Of the children excluded, 5,913 met more than one of these criteria. Of the remaining 44,832 children, 19,610 (44%) remained consistently enrolled in Medicaid birth-six years. With successful linkage of Medicaid claims and birth certificate files for 94.4% of these children, 18,512 were available for analysis.

Variables used in analysis
Dependent variables analyzed in separate models included the annual Medicaid cost for each child birth to sixth birthday; the annual number of: sick child PCP visits; emergency department (ED) visits; hospital admissions; and both ED visits and hospital admissions specifically for ACSCs. The specific diagnoses for ACSC ED visits and hospital admissions, identified using ICD-9 codes, were those previously reported to be the most common ACSC diagnoses in emergency department and hospital settings for children insured by Medicaid (18). These diagnoses include: asthma; seizure; cellulites; ear, nose, and throat infections; bacterial pneumonia; kidney/urinary tract infection; and gastrointestinal infections.

The independent variable of primary interest was the annual number of EPSDT visits received in years 1 and 2. The number of EPSDT visits represents the combined number of visits for immunizations and/or screening services. EPSDT visits were identified by the ORS using the Health Care Financing Administration Common Procedure Coding System codes and definitions published annually by the American Medical Association as current procedural terminology (CPT) codes (19). The children were stratified for analysis into those that received at least the AAP recommended number of 6 or more EPSDT visits in the first year of life and 3 or more in the second year, and those that received fewer visits (20, 21). Further stratification partitioned the children into those that received the AAP recommended nine visits in years one and two and those that received fewer visits.

Control variables included maternal age and education in years at delivery, marital status, race/ethnicity, family income less than or equal to 50% of the Federal Poverty Guideline, or greater (up to 150% of poverty), maternal parity, whether the delivery was vaginal, and whether the mother received adequate prenatal care, as defined by the Kessner Index of Prenatal Care Adequacy (22). Type of delivery, vaginal or caesarean section, was
controlled for because it has been reported that the birth of a child in any way out of the ordinary (surgical delivery) may create parental emotional discomfort affecting infant care through the first two years of life or longer (23). Controls for child characteristics included rural/urban residential status assigned based on the largest town in the mother’s county of residence. Children residing in counties with a town of at least 25,000 residents were considered to reside in urban areas; those in the remaining counties were considered to reside in rural areas. Additional child controls included birth weight in grams, gender, and gestational age in weeks. These controls were included because parenting behaviors have been associated with such factors. Although children with low birth weight or congenital conditions were excluded, it is useful to include individual-level measures of child development in the models because parental behavior is clearly influenced by even minor deviations from expectation (24, 25).

Statistical techniques employed
Since children were not randomized into study groups, selection bias was assessed using bivariate analyses (26). These analyses compared the characteristics of mothers and children between the children as dichotomized by their EPSDT utilization in year 1, year 2, and years 1 and 2. Chi-square tests were used for categorical data; student’s t-tests for continuous measures. Multivariate analyses were used to compare each dependent variable for the children adjusted for control variables. Because the count data in this analysis exhibited overdispersion (a more than usual variation of data around the mean), negative binomial regression was used to adjust the estimates of interest for the confounding effects of maternal and child control variables. Linear regression models adjusted for all maternal and child control variables (covariates) were used to compare cost between the children in each of the 3 EPSDT dichotomizations.

IV. Detailed Findings
Only 31.3%, 12.1%, and 8.7% of the children received the recommended number of EPSDT visits in year one, year two, and both years 1 and 2, respectively. The children having fewer than the recommended number of EPSDT visits had considerably fewer than the recommended six visits in year one, three visits in year two, and nine visits in both years one and two with a mean (SD) of 3.5 (1.5), 1.2 (0.8), and 4.5 (2.0), respectively.

Bivariate comparisons of maternal and child characteristics for the children in the 3 EPSDT stratifications demonstrated similar variations (data not shown in tables). Because receipt of the recommended number of EPSDT visits in both year one and year two is most consistent with the hypothesis, these comparisons are shown in Table I. Mothers of children that received the AAP recommended number of EPSDT visits in years one and two had slightly more education (11.6 years compared with 11.4). They were also more likely to be primiparous; White; urban; have an income greater than the Federal poverty guideline; and have adequate prenatal care (p<.001).

Table II presents the health care utilization results adjusted for the maternal and child characteristics shown in table I. Children with the recommended number of EPSDT visits in years one and two had 97% more EPSDT visits (CI 1.93-2.01) and 62% more
sick child office visits (CI 1.50-1.76) in the first six years than children with fewer visits. Children with the recommended number of EPSDT visits in both years had 10% fewer ED visits birth-six years with 8% fewer emergency visits and 12% fewer ACSC visits. There were no discernable differences in total or ACSC hospital admissions in the first six years based on the three EPSDT utilization stratifications. For each outcome, such as sick child office visits, Table II shows the adjusted rate ratio, where the rate for those with at least the recommended EPSDT visits is the numerator. Rate ratios less than 1.00 suggest that children having at least the recommended number of EPSDT visits had less utilization of the given outcome. For each rate ratio estimate, Table II also presents the lower and upper bounds of the 95% CI and the p-value.

Table III shows the results of linear regression models adjusted for all maternal and child control variables. The total Medicaid cost and cost for each health service used birth-six years was compared for children with at least and with fewer than the recommended number of EPSDT visits in the first two years. The adjusted costs (mean, SE) for PCP EPSDT visits and sick child office visits and for prescription drugs were greater (p<0.001) for children with the recommended EPSDT visits. The costs for ACSC and urgent (emergency) ED visits, ACSC and urgent hospitalizations, and dental visits were not different. The adjusted (mean, SE) total Medicaid cost for health services birth-six years was greater (p<0.001) for children with the AAP recommended number of EPSDT visits in the first two years of life than for children with fewer than the recommended number.

Table I. Bivariate Comparisons of Maternal and Child Characteristics* by Early and Periodic Screening, Diagnosis and Treatment (EPSDT) Utilization

<table>
<thead>
<tr>
<th>Maternal</th>
<th>Received at least recommended EPSDT visits in both years 1 and 2 (n=1,105)</th>
<th>Received fewer than recommended EPSDT visits in both years 1 and 2 (n=11,592)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years, mean (SD)</td>
<td>23.2 (5.5)</td>
<td>23.4 (5.4)</td>
<td>.230</td>
</tr>
<tr>
<td>Education in years, mean (SD)</td>
<td>11.6 (1.9)</td>
<td>11.4 (1.9)</td>
<td>.001</td>
</tr>
<tr>
<td>Married, n (%)</td>
<td>200 (22.6)</td>
<td>1,867 (19.9)</td>
<td>.051</td>
</tr>
<tr>
<td>Parity at delivery, primiparous, n (%)</td>
<td>579 (52.4)</td>
<td>3,824 (33.0)</td>
<td>.001</td>
</tr>
<tr>
<td>Race White, n (%)</td>
<td>407 (36.9)</td>
<td>3,411 (29.4)</td>
<td>.001</td>
</tr>
<tr>
<td>Race African American, n (%)</td>
<td>582 (52.7)</td>
<td>7,055 (60.9)</td>
<td>.001</td>
</tr>
<tr>
<td>Race Hispanic, n (%)</td>
<td>76 (6.9)</td>
<td>690 (6.0)</td>
<td>.214</td>
</tr>
<tr>
<td>Urban, n (%)</td>
<td>797 (72.1)</td>
<td>6,707 (57.9)</td>
<td>.001</td>
</tr>
<tr>
<td>Family income &lt;50% of poverty, n (%)</td>
<td>258 (24.2)</td>
<td>3,303 (29.8)</td>
<td>.001</td>
</tr>
</tbody>
</table>
Table II. Health service use in years 1-6 for children with the American Academy of Pediatrics (AAP) recommended number of early and periodic screening, diagnosis, and treatment (EPSDT) visits* in years 1 and 2 (numerator) compared with children having fewer visits in both years (denominator).

<table>
<thead>
<tr>
<th>Six year outcomes</th>
<th>Rate ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPSDT visits</td>
<td>1.97</td>
<td>1.93, 2.01</td>
<td>.001</td>
</tr>
<tr>
<td>Sick child office visits**</td>
<td>1.62</td>
<td>1.50, 1.76</td>
<td>.001</td>
</tr>
<tr>
<td>All ED visits</td>
<td>0.90</td>
<td>0.84, 0.96</td>
<td>.001</td>
</tr>
<tr>
<td>Emergency ED visits</td>
<td>0.92</td>
<td>0.86, 0.99</td>
<td>.020</td>
</tr>
<tr>
<td>ACSC ED visits</td>
<td>0.88</td>
<td>0.81, 0.95</td>
<td>.001</td>
</tr>
<tr>
<td>All hospital admissions</td>
<td>1.12</td>
<td>0.91, 1.37</td>
<td>.281</td>
</tr>
<tr>
<td>ACSC hospital admissions</td>
<td>1.18</td>
<td>0.89, 1.57</td>
<td>.261</td>
</tr>
</tbody>
</table>

*Data source: South Carolina Office of Research and Statistics, representing all children continuously enrolled in Medicaid birth-six years.

+Results of regression analyses adjusted for maternal and child confounders in table I; reference category is children with fewer than the recommended EPSDT visits.

Table III. Compared adjusted mean (se) health care costs ($) for South Carolina Medicaid-insured children birth-six year with at least and fewer than the recommended number of early and periodic screening, diagnosis, and treatment (EPSDT) visits in the first 24 months of life

<table>
<thead>
<tr>
<th>At Least the Recommended EPSDT Visits (n=1,105)</th>
<th>Fewer Than the Recommended EPSDT Visits (n=11,592)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPSDT cost, $656 (8.6)</td>
<td>$316 (2.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Service</td>
<td>Mean (SE) 1</td>
<td>Mean (SE) 2</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Sick child office visit cost, mean (se)</td>
<td>$603 (18.8)</td>
<td>$360 (5.8)</td>
</tr>
<tr>
<td>ACSC emergency department visit cost, mean (se)</td>
<td>$355 (25.3)</td>
<td>$388 (7.8)</td>
</tr>
<tr>
<td>Emergent emergency department visit cost, mean (se)</td>
<td>$372 (21.4)</td>
<td>$369 (6.8)</td>
</tr>
<tr>
<td>ACSC hospital admission cost, mean (se)</td>
<td>$142 (37.7)</td>
<td>$154 (11.6)</td>
</tr>
<tr>
<td>Emergent hospital admission cost, mean (se)</td>
<td>$211 (57.3)</td>
<td>$230 (17.6)</td>
</tr>
<tr>
<td>Dental care cost, mean (se)</td>
<td>$905 (32.4)</td>
<td>$848 (9.9)</td>
</tr>
<tr>
<td>Prescription drug cost, mean, (se)</td>
<td>$1367 (62.2)</td>
<td>$1021 (19.1)</td>
</tr>
<tr>
<td>Total Medicaid cost, mean (se)</td>
<td>$4611 (126.3)</td>
<td>$3687 (38.7)</td>
</tr>
</tbody>
</table>

Each linear regression model adjusted for maternal age, education, parity, marital status, race, urban/rural residence, mode of delivery, family income and child gender, gestational age, and weight.

V. Discussion and Interpretation of Findings including possible application of findings to actual MCH health care delivery situations, policy implications, and suggestions for further research

A. Conclusions to be drawn from findings (with reference to data supporting each) -
One plausible explanation for these observations is that parents of children with the recommended number of EPSDT visits in infancy may be more likely to bring sick children to their PCP office rather than to the ED. This would be a positive outcome for using the recommended number of EPSDT visits.

The number of sick child health care visits required (both ACSC ED and office visits as anticipated, was significantly (p<.001) greater for all children in the first year of life than in year 6. However, the number of sick child office visits was significantly (p<.001) greater and the number of ACSC ED visits was significantly (p<.001) fewer in each of the six years for children with the recommended number of EPSDT visits in infancy. The findings suggest a shift in care from the ED to the PCP office or more cost efficient care.
associated with receipt of the AAP recommended number of EPSDT visits in the first 24 months of life.

Are these results clinically important? The rate of sick child office visits was 62% greater and the number of ACSC ED visits was 12% fewer for children with the recommended number of EPSDT visits than for children with fewer visits in the first six years of life. This is clearly clinically significant. It is likely that the majority of state Medicaid offices would find a reduction in emergency department use for ACSCs of this magnitude helpful.

These findings indicate that children with the AAP recommended number of EPSDT visits in the first two years of life have a greater adjusted total Medicaid cost birth-six years than children with fewer visits (p<.001). This finding was directly related to the increased cost for PCP EPSDT and sick child office visits and for prescription drugs. Of particular interest was the finding that the adjusted Medicaid cost/child for ACSC ED visits was not less for children with the recommended number of EPSDT visits despite the fact that these children had fewer ACSC ED visits than children with less than the recommended number of EPSDT visits. The unadjusted Medicaid cost for ACSC ED visits was less (p<.03) for the children with the recommended number of EPSDT visits. Thus the significant unadjusted cost difference is due to the effect of covariates controlled for in the adjusted model rather than the number of EPSDT visits received per se. This finding is consistent with the uneven distribution of maternal and child characteristics (covariates) described in table I. A larger proportion of the children with the recommended number of EPSDT visits than of those with fewer than the recommended number have mothers with more education, a larger family income, urban residency, and only one child. These characteristics have previously been associated with both lower Medicaid cost and fewer ACSC ED visits (12, 22). Thus one might anticipate that if these covariates were controlled for in a statistical model, the adjusted mean cost for ACSC ED visits would be increased for children with the recommended number of EPSDT visits and decreased for children with fewer than the recommended number. Actually, the adjusted model does estimate that the mean Medicaid cost for ACSC ED visits was $33/child less for children with the recommended number of EPSDT visits than for children with fewer than the recommended number but that this difference was not statistically significant (p=0.205).

This analysis provides previously unreported information regarding the cost effectiveness of well child care in infancy for healthy South Carolina Medicaid children birth to six years. The findings describe modest cost effectiveness for use of the recommended number of well child visits in infancy and are useful for policymakers in their effort to accurately anticipate the cost of care in Medicaid/MCH delivery situations. Specifically, these findings support government policies to promote the use of the AAP recommended number of EPSDT visits. The hypothesis tested was that PCP well child/preventive care is associated with improved health and reduced use of both PCP and more costly non-primary care provider services, and stabilizes cost. These benefits were assessed birth to six years although these findings question whether they occur predominantly in the first six years or are observed longer term. While this analysis indicates that recommended
EPSDT utilization in infancy is associated with a shift in care from the ED to the office setting or more cost efficient child care, this analysis also indicates that the increased PCP EPSDT and sick child office visits and prescription drug use associated with this shift generates an increase (p<.001) in total Medicaid cost birth to six years. Thus the challenge to the current paradigm that correction of needed healthcare is associated with both increased quality of care and increased cost was not successful. Perhaps further research addressing a more long term assessment is needed?

B. Explanations of study limitations
Several limitations are of importance in considering these results. First, these cost findings are unique to the South Carolina Medicaid system which limits their generalizability to the nation as a whole.

Because the children in this prospective cohort analysis were not randomized into study groups, variation in cost by those selected versus those not selected for analysis (selection bias) is likely as shown in table I (26). This is addressed in this analysis by using regression analysis, adjusting for previously identified confounding factors such as maternal age, education, marital status, family income, race, urban/rural residence, and parity. Nevertheless, because subjects were not randomly assigned into groups, causality can not be determined.

A schedule for EPSDT visits by children at age-based intervals is recommended by the AAP (5, 7). No assessment could be made in this dataset to determine if this schedule was followed and the findings may be related to the timing of the EPSDT visits rather than to the number received.

Using the number of Medicaid claims to document clinical care utilization can underestimate the amount of service obtained secondary to administrative factors (28, 29). Preventive care services and/or parental anticipatory guidance given in provider encounters not identified as EPSDT visits are not recorded and children cared for in a patient-centered medical home are not identifiable via claims data. Also, because there is no strict standardization for EPSDT visits, the care provided by different providers to similar aged children may vary (30). If the services provided or the procedures for filing claims vary in a consistent fashion the observed findings could be biased.

The data available do not allow determination of whether the reduced use of emergency and/or ACSC ED visits by children with the recommended number of EPSDT visits in the first two years of life was due to improved health or a shift in care from the ED to the office setting. It is clear, however, that the children who received the AAP recommended number of EPSDT visits used fewer (p<.001) ED visits in the first six years than children with less than the recommended number of visits.

This investigation assessed all health service use birth-six years. Determinants of use are multiple and claims data do not clearly identify these factors. Nevertheless, previously identified factors include child health status, provider characteristics such as inclination to refer to the ED and/or to suggest hospitalization, the accessibility and effectiveness of
preventive care, and of course, payer and patient incentives to use primary and non-
primary care provider services (2). Multivariate regression analysis was used to control
for many of the previously identified maternal and child determinants of health service
use. However, some determinants may have been inadequately adjusted for by the
covariates used. Perhaps the most important control lacking in these models is provider
characteristics. For example, if providers who encourage use of the recommended
number of EPSDT visits differ from those who do not in their likelihood to suggest ED
use, then this difference may have biased the results. It is conceivable that the findings
reported reflect provider characteristics and not effects of EPSDT use.

VI. Peer reviewed articles from this R40MC17166 investigation. Findings for two 2011
publications (one published and one in press) funded by this R40MC17166 research grant
are described here (10, 11).

1. Pittard, William B. Well Child Care in Infancy and Emergency Department Use
   by South Carolina Medicaid Children Birth to Six years Old. Southern Medical
2. Pittard, William B. Well Child Care in Infancy and Health Care Costs Birth-Six
   Years for South Carolina Medicaid Children. Journal of the South Carolina
   Medical Association. 2011; In Press.

The published manuscript describes reduced ambulatory care sensitive condition (ACSC)
ED visits and increased sick child office visits birth to six years by Medicaid children that
received the AAP recommended number of EPSDT visits in infancy as compared to
children that received fewer than the recommended number of visits (10). It is noted that
these observations suggest a cost effective shift in healthcare by children with the
recommended EPSDT visits from the emergency department (ED) to the PCP’s office for
ACSC diagnoses. However, with both increased EPSDT and sick child PCP visits, these
findings offer only modest evidence for reduced Medicaid cost. The manuscript “in
press” compares the cost for healthcare over the first six years of life for these same
Medicaid children (11). This manuscript reports that while children with the
recommended number of EPSDT visits in the first two years of life have, as
hypothesized, fewer ACSC ED visits birth-six years, their total Medicaid cost was greater
than the cost for children with fewer visits. This finding stems from the fact that while
the children with the recommended number of EPSDT visits had fewer ACSC ED visits,
they also had more EPSDT and sick child PCP visits as well as greater pharmaceutical
use which increased their Medicaid cost.
References


