RELATIONSHIP BETWEEN CONTINUITY OF CARE AND EMERGENCY DEPARTMENT UTILIZATION IN CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER IN BRITISH COLUMBIA

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ABSTRACT

RELATIONSHIP BETWEEN CONTINUITY OF CARE AND EMERGENCY DEPARTMENT UTILIZATION IN CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER IN BRITISH COLUMBIA

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Continuity of care with a primary care provider has long been thought to lead to improved health outcomes and greater patient and physician satisfaction. The benefits of continuity of care remain controversial, however, and have not been firmly established for pediatric patients. The objective of this study was to examine whether continuity of care with a primary care provider is associated with the number of emergency department (ED) visits in children and adolescents with a diagnosis of attention-deficit/hyperactivity disorder (ADHD) in British Columbia. We analyzed two years of physician claims records for over 4000 British Columbia children aged 4 to 16 to determine individual continuity of care (COC) scores for each study participant. Multinomial logistic regression analysis was then applied to determine if a relationship exists between COC computed during two years and number of ED visits made during the following year.

Our results showed a weak association between continuity with a primary care provider and ED use. In multivariate analysis, continuity was associated with a lower likelihood of making a single ED visit (odds ratio, 0.85; 95% confidence interval, 0.70-1.05) and is more strongly associated with a lower likelihood of making multiple ED visits (odds ratio, 0.81; 95% confidence interval, 0.62-1.05). Other variables that were associated with outcome include: age, socio-economic status, overall number of general practitioner visits, pediatrician visits, psychiatrist visits, and illness burden.

This study demonstrates that high primary care provider continuity is associated with lower ED use for children aged 4 to 16 with ADHD in British Columbia. The results suggest that strategies to improve continuity of primary care provider among this population may lead to decreased ED utilization and should therefore be encouraged.

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*ADHD: attention-deficit/hyperactivity disorder;
COC: Continuity of Care index;
UPC: Usual Provider of Care index;
ADG: ambulatory diagnostic groups;
ED: emergency department.

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*COC: Continuity of Care index;
UPC: Usual Provider of Care index;
ED: emergency department;
ADG: ambulatory diagnostic groups.

GLOSSARY

Attention-Deficit/Hyperactivity Disorder (ADHD). ADHD is a diagnosis applied to children and adults who consistently display certain characteristic behaviours over a period of time. The most common core features include: distractibility (poor sustained attention to tasks), impulsivity (impaired impulse control and delay of gratification), and hyperactivity (excessive activity and physical restlessness). (1)

Comorbidity. The presence of two or more diagnosed illnesses at the same time.

Confounding Variable. A variable that is associated with an independent (predictor) variable that also influences the outcome. (2)

Continuity of Care. Care from a single physician over extended periods of time regardless of the nature of the health conditions. (3)

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Chapter 1

INTRODUCTION

Purpose

A continuous relationship between a patient and primary care provider over extended periods of time has long been thought to have a positive effect on healthcare use and patient outcomes. There have been few studies, however, to prove this association. Gill and colleagues showed that continuity of care in a state-wide U.S. Medicaid population is associated with a significantly lower likelihood of making a single emergency department (ED) visit (odds ratio [OR], 0.82; 95% confidence interval [CI], 0.70-0.95) and even more strongly associated with multiple visits (OR, 0.65; 95% CI, 0.56-0.76). (4) Christakis and colleagues found that compared to children with the highest continuity of care, children with medium continuity were more likely to have visited the ED (hazard ratio: 1.28 [1.20-1.36]) and those with the lowest continuity were even more likely (hazard ratio: 1.58 [1.49-1.66]). (5)

The purpose of the current study is to examine whether continuity of care with a primary care provider is associated with emergency department utilization in British Columbia children diagnosed with attention-deficit/hyperactivity disorder (ADHD), conduct disorder (CD), or oppositional defiant disorder (ODD). Evidence supports the link between continuity of care with a primary care provider and ED use. Best practices in the care of children with ADHD emphasize the importance of continuity of care with a primary care

provider for children with ADHD or one of the other childhood psychiatric illnesses. Therefore, the research hypothesis for this study is that continuity of care with a primary care provider in children with ADHD, CD, or ODD is associated with ED use.

Research Objectives

The specific objectives of this study were to:

- Determine if a relationship exists between continuity of primary care provider and emergency department (ED) visits in children with ADHD.
- If a relationship between continuity of care and ED use is found, determine confounding variables (e.g. age, sex, socio-economic status, and illness burden) that may affect ED use in ADHD children.

Rationale

Of the over 400,000 children living in the lower mainland, 3-5%, or 12,000 to 20,000 children, can be expected to have ADHD (6, 7), a condition for which continuity of care may be particularly important. For those children with ADHD, continuous care with one primary care physician could be stressed as an important part of disease management. The evidence is sparse, but studies in other jurisdictions have shown an inverse relationship between continuity of care and ED use in children and adults. (4, 5, 8) If we show a similar result, our findings will provide further support for the claim that increased continuity of care is associated with decreased ED use. And if so, there are important implications for health systems and policy makers. Mechanisms whereby patients can maintain existing relationships with providers will need to be created and fostered. During this time of healthcare reform

and restructuring, continuity may need to remain a focus for all patients in the system. If our hypothesis is borne out in analysis, an area for further research is into understanding the mechanisms of action of continuity of care for children with ADHD.

The Following Sections

Chapter 2 contains an overview of the literature on continuity of care. A description of the definitions and conceptualization of the term by different groups of care providers will be given. Next, the factors influencing continuity will be discussed as well as evidence of improved health outcomes resulting from continuity with a specific care provider. Finally, several measurement tools will be described and the merits of each discussed. Chapter 3 gives an overview of the history of ADHD as the diagnosis has evolved over the decades. The epidemiology of the disorder and significant comorbidity will be discussed. Recommended management schemes will be described and an argument for the importance of continuity of care with a primary care provider will be made. Chapter 4 contains the methodological details of the study design, cohort selection, data preparation and analysis methods. Chapter 5 presents the study results, and Chapter 6 discusses some of the important findings and limitations of the study. Chapter 7 provides a summary, describes the policy and practice implications of the findings, and then looks forward to future study designs required to begin answering some of the questions raised.

Chapter 2

CONTINUITY OF CARE

Introduction

In the past, medical care was typically provided by a single practitioner who would treat entire families over a lifetime. Stability of the population and the doctor allowed long-term relationships to develop between patients and providers. In the early part of this century, the doctor's memory was relied upon to recall a patient's history. Medical records were infrequently kept and any written records that were kept were used mainly as memory aids for medications rather than as clinical records. (9)

With increasing fragmentation of medical care, industrialization, and mobility of patients and doctors, concern over continuity of patient care has grown proportionally. There appears to be, however, a diversity of opinion regarding the nature and definition of continuity of care. This has resulted in difficulty interpreting the importance of studies undertaken on the subject thus far. (10)

Barbara Starfield called for standardization of the term in 1980 in her editorial entitled *Continuous Confusion.* (11) She noted that if 'continuity' is used in different ways by different researchers, it was inevitable that some would show it to be a valuable, necessary component

of healthcare while others would conclude the opposite. Yet, more than twenty years later, there has been no consensus on the definition or operationalization of the term.

This chapter will give an overview of the definitions used in different medical fields by various groups of providers. Then, continuity of care as it is used in this thesis, with this patient population will be defined. Next, the relevant dimensions of continuity will be described and operationalized. From there, an overview of the research on health outcomes as a result of continuity will be given. Finally, there will be a discussion of different methods of measuring continuity in practice, with emphasis on the methods used in this thesis.

Conceptualization

As described in the discussion paper by Haggerty and colleagues, (3) continuity of patient care has been conceptualized differently by different provider groups. Each group has its own set of roles and responsibilities, and therefore focuses on the elements of continuity most salient to them. The main areas of focus on continuity have been in mental health, nursing care, condition-specific healthcare, and primary care. For children with ADHD, primary care continuity is of greatest importance. The syndrome typically spans many years, with changing presentations and comorbidities. The primary care physician acts as a sort of case manager to ensure that the child receives appropriate care as his/her condition changes over time. For this reason, continuity of care with a primary care physician will be the focus of this study. For the remainder of the paper, the term 'continuity of care' will refer to continuity of care with a primary care provider.

Bass and Windle defined continuity of care in 1972 as 'the relationship between past and present care in conformity with the therapeutic needs of patients.' (12) Breslau and Reeb, in 1975, considered continuity to be 'the extent to which a single physician manages the health needs of a patient...the more the patient visits occur with a single physician, the more care is considered continuous.' (13) In 1976, Shortell stated that continuity of medical care is the extent to which medical care services are received as a coordinated and uninterrupted succession of events, consistent with the medical needs of the patient. (14) Rogers stated in 1980 that continuity could be described by the amount of prior knowledge possessed by the elements (consumers and providers) involved in medical care. (10)

Common themes in each of these definitions include the focus on medical needs of the patient and the inclusion of a time variable—a linking of past and present. Continuity can therefore be described in terms of care experienced by individuals over time. (15) It is this longitudinality, or long-term personal relationship between patients and their practitioners, undifferentiated by problem or condition, that will be the focus of this thesis. Here, continuity will be defined in terms of concentration, that is, the extent to which an individual receives primary medical care over a defined period from one provider. The more a patient's visits are to one primary care physician, the more continuous his/her care is said to be. Rather than treating the symptoms of ADHD independent of other co-existing conditions, the primary care provider is responsible for managing all medical needs of the patient, not only those specific to ADHD.

Operationalization

In order to measure continuity and make comparisons between patients and practices, the concept must be operationalized into measurable components. Starfield notes that the definition of continuity must include characteristics that are measurable. (16) In an early attempt at operationalizing continuity, Shortell sees continuity as having five characteristics: the extent to which the same provider is seen at each visit, the degree to which broken appointments are minimized, the extent to which unnecessary or duplicated diagnostic procedures are minimized, the extent to which patient follow-up and compliance are realized, and the degree to which care is delivered in a single location. (14) Hennen describes four dimensions comprising the 'continuity environment': chronological, geographical, interdisciplinary, and interpersonal. (17) Freeman has identified six elements of continuity: continuity as experienced by patients, informational continuity, cross-boundary, flexible, longitudinal, and relational or personal continuity. (18) Of these elements, those which are amenable to measurement include: having the same provider, stability of patient-caregiver relationships, strong interpersonal relationships, educating the patient and communicating the patient's needs, and common management strategy. (16) Taken together, these elements can be further operationalized into the measurable components of continuity:

- Longitudinal continuity;
- Relational continuity;
- Informational continuity;
- Consistency of care plan.

Of these four components of continuity, only longitudinal continuity can be measured using physician claims. The other aspects of continuity are not relevant to this study and therefore are not mentioned in detail here.

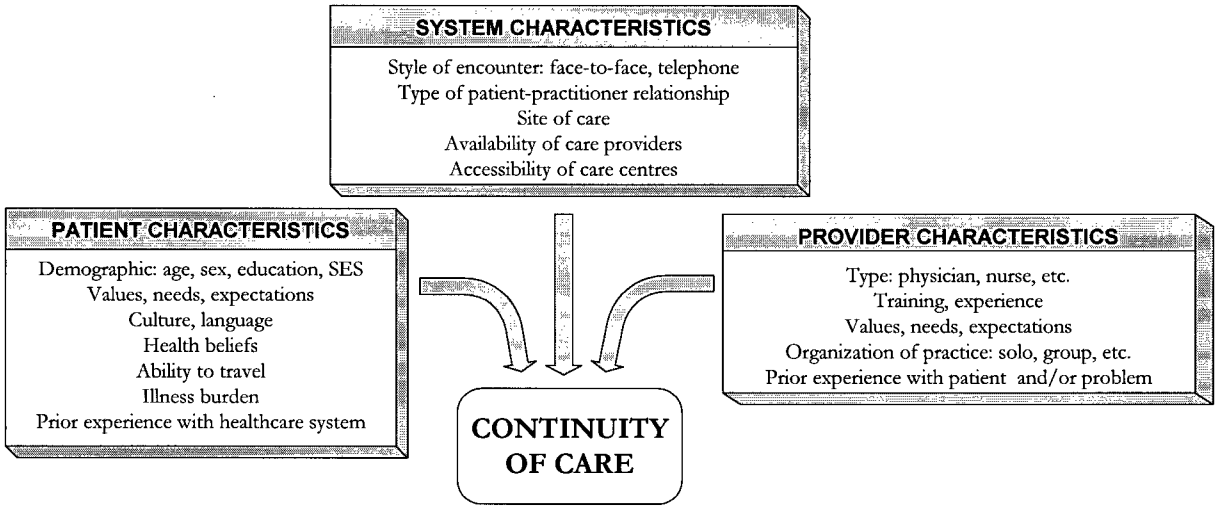
Longitudinal or chronological continuity refers to the care provided over time to a patient. It can be quantified by measuring duration of the patient/provider relationship, concentration of care (what proportion of visits occur with the primary provider), and by looking at the sequence of visits (the number of sequential visits that are with the same provider).

Influencing Factors of Continuity

The factors which influence whether or not continuity of primary care is achieved are varied and interrelated, thus making them difficult to isolate, and therefore almost impossible to study independently. These factors fall into three categories: patient characteristics, provider characteristics, and system characteristics. (19, 20) Patient factors include demographic and personal characteristics, education, income, culture and language, health beliefs, ability to travel, types of morbidity and illness burden, and prior experience with the healthcare system. Provider factors include type (physician specialty, nurse, etc), education, technical competence, personal characteristics, organization of practice, and prior experience with the patient and/or patient's problem. Organizational or accessibility issues may also affect the attainment of continuity. Factors affecting accessibility include: type of patient/provider relationship (active-passive, guidance cooperation, mutual participation),

style of encounter (face to face, telephone, written), site of care, and availability of alternate care providers. See Figure 1 for a list of the influencing factors.

Figure 1. Factors influencing continuity of care.



These influencing factors are not independent or mutually exclusive, however. They must be considered as interrelated domains that interact on many levels. Particular patient characteristics may combine with certain physician characteristics to have an effect on continuity specific to that one patient/provider pair. For example, a foreign-trained physician may interact differently with patients from his/her home country, possibly more easily establishing rapport, thus encouraging continuity of the relationship.

Benefits of Continuity

Many benefits of continuity in primary care (i.e. seeing the same physician over time) have been documented in the literature. They include: better problem/needs recognition, more accurate diagnosis, better concordance with care plans, fewer hospitalizations, lower costs, better prevention and increased satisfaction of both patients and healthcare providers. (21) See Appendix A for an overview of some of the studies that found benefits to continuity in primary care.

The following discussion gives a brief overview of the benefits found to be related to continuity of primary care. In a 1982 review, Dietrich and Marton assessed the effect of longitudinal care on quality of care. (22) They determined that longitudinal care from a provider improved patient satisfaction, compliance with medication and with appointments, and patient disclosure of behavioural problems. Starfield concludes similarly that continuity of care is

> associated with more indicated preventive care, better identification of patients' psychosocial problems, fewer emergency hospitalizations, fewer hospitalizations in general, shorter lengths of stay, better compliance with appointments and taking of medications, and more timely care for problems. (23, page 194)

This association has been demonstrated in several patient subpopulations including prenatal women, the elderly, children and adolescents, and the general adult population. Shear and colleagues used pregnancy as a tracer condition to analyze the association between clinician continuity and the quality of ambulatory care. (24) They used a retrospective cohort study design with two groups of pregnant women: one receiving much higher continuity of

care in a family practice centre and the other receiving lower provider continuity in an obstetrical clinic. They found that greater continuity of care was associated with significantly higher birth weight babies and better patient satisfaction.

Continuity of provider has also been shown to have a positive effect on health care utilization and patient outcomes in the elderly. Weiss and Blustein found that in patients over 65, long-standing ties with their physician resulted in a decreased likelihood of hospitalization and lower medical costs. (25) In a separate double-blind randomized control trial of 776 men aged 55 and older, those randomized to the provider continuity group had significantly different outcomes than those in the provider discontinuity group. (26) Continuity of outpatient care for these men resulted in greater patient satisfaction, shorter hospitalizations, and fewer emergent admissions.

A regular source of care has also been shown to reduce hospitalizations and length of stay in the general population. Those who lack a regular source of health care rely heavily on hospital emergency departments as their main health care provider, often for non-urgent problems. (27-31) The association between access to health care, one influencing factor of continuity of care, and its relationship to hospitalizations has been shown for chronic conditions such as asthma, hypertension, congestive heart failure, chronic obstructive pulmonary disease, and diabetes. (32) After controlling for the prevalence of the conditions, healthcare seeking, and physician practice style, Bindman and colleagues showed an inverse relationship between access to care and hospitalization rates.

In addition, a strong association has been found between provider continuity and emergency department utilization in a disadvantaged population. Mainous and Gill examined the association between provider continuity and future hospitalizations in a US Medicaid population. (4, 33, 34) An analysis of paid Medicare claims showed continuity of care with a provider was associated with decreased future likelihood of hospitalization and significantly lower likelihood of making one or multiple emergency department visits.

Child Health Outcomes

Although the association between continuity of care and adult health outcomes is strongly supported in the literature, there is less data to support the relationship in children. Some studies have shown that children with a regular source of healthcare receive more age-appropriate preventive care, have higher levels of overall ambulatory care, and have lower emergency department utilization. For children receiving healthcare in community health clinics, O'Malley and Forrest showed both continuity of site and continuity with a clinician was associated with increased levels of preventive care and overall ambulatory care. (35) Christakis and his colleagues showed infants with both medium and high continuity to have increased likelihood of receiving timely Measles-Mumps-Rubella immunization compared with patients in the lowest tertile of continuity. (36) In another study by Christakis, continuity of care was found to be associated with ED utilization in children and adolescents. (8) All Medicaid managed patients aged 0-19 (785) were followed at one medical centre in Washington State for four years. Compared to those in the lowest continuity of care tertile,

those in the medium tertile had 30% lower ED utilization and those in the highest tertile had 35% lower ED utilization.

Child Mental Health Outcomes

The child mental health literature does not typically distinguish between two very different concepts: 'continuum of care' and continuity of care. Continuum of care generally refers to the smooth transition from inpatient care to community treatment following an illness requiring hospitalization, typically an acute episode of severe psychiatric illness. In contrast, continuity in child mental health refers to the longitudinal care received from one practitioner (typically a primary care physician) over time for the management of chronic mental health conditions. In a search of Medline, PubMed, HealthStar, and PsychInfo, after removing articles describing the continuum of care, no published studies on longitudinal care for chronic mental health conditions could be found. Studies of children with serious emotional disturbances show that these children often receive services from a wide variety of providers and across an extended period of time (37), but no study has looked at the outcome of providing longitudinal care to children in need of mental health services.

Not all studies of continuity of care have concluded positive effects on outcome, however. In two controlled studies to evaluate the effectiveness of comprehensive and continuous pediatric care, Gordis and Markowitz were unable to demonstrate any effect of continuous care over conventional ambulatory care in children. (38) In a claims-based retrospective study of all tonsillectomies and adenoidectomies during 1973 in Manitoba, Roos et al. found no causal relationship between continuity and quality. (39) More recently,

continuity of care has not been shown to be a straightforward predictor of individual outcome in adults (40) or pediatric mental health patients. (41) While these studies found no relationship between continuity and outcome, no study to date has found negative outcomes resulting from continuity.

In the continuity of care literature in general, there seems to be mounting evidence of the positive effects of continuity on health outcomes, patient and physician satisfaction, and improvements in the healthcare system. In the future, more well-designed case-control studies comparing one group receiving continuous care with one not receiving continuous care will lend further evidence to the current belief of these positive benefits.

Measurement of Continuity

Measuring continuity of care is important as the basis for research as well as a means of quality assurance. Once the elements of interest are determined and appropriate measurement tools identified, it becomes possible to establish a baseline and track changes in continuity to different patient groups over time. The effect of interventions aimed at improving continuity can be established as well as the outcomes resulting from continuity of care.

As with the operationalization of the term, measurement of continuity must begin with the individual dimensions of interest. Whether one is assessing the longitudinal nature of the patient/provider relationship, the interpersonal relationship, information transfer, or coordination of care plan, the measurement tool chosen should reflect the dimension under

study. Although different methods have been developed to measure the many aspects of continuity, here the focus is on the longitudinal patient/practitioner relationship; therefore only longitudinal measures of continuity will be described.

One method for assessing the longitudinality of the patient/practitioner relationship is with the use of surveys and the other is by using a patient's healthcare utilization history. At the population level, the extent to which individuals identify a regular source of care is often ascertained with household surveys. At the facilities level, this can be accomplished by reviewing patient rosters to indicate that a practitioner or group of practitioners identifies a population for which it is responsible. (21)

A patient's healthcare utilization history can also be used to assess the concentration of care, or the degree to which the patient sees the same physician over time. Several longitudinal measures of concentration of care have been developed for use at the population level, each with scores ranging from 0 to 1 depending on the pattern of providers seen. Here, we will describe five of the more commonly used measures. It is generally agreed upon that all visits to the same provider over a defined interval constitutes complete continuity (scored as 1) and all visits to a different provider over the same interval is complete dispersion of care (scored as 0). For each measure, better longitudinality results in a higher score; however, these measures differ in how deviations from complete continuity are handled.

One advantage of using these measures to quantify continuity of care is that each can be calculated using secondary data sources such as billing data or computerized patient records.

(3) The main disadvantages of these measures are that they are not comparable across populations and they do not incorporate underlying elements such as the extent of the patient/practitioner relationship or the practitioner's knowledge base. (42) Below is a description of the more commonly used measures; for a more complete list and the formulas for each, see Appendix B.

Usual Provider Continuity

The Usual Provider Continuity score (UPC), developed by Breslau and Reeb in 1975 (13), is a simple ratio of number of visits to the regular provider over total number of visits during the same period. It has been widely used and has great face validity. The scores can be interpreted intuitively and it may be adapted to measure site continuity rather than provider continuity. The drawbacks of using this measure are that complete visit information is required and it is highly sensitive to utilization; i.e. scores decrease as the number of visits increase and for someone with only 1 visit, the score is 1, indicating complete continuity. (21, 43)

Continuity of Care Index

Developed by Bice and Boxerman in 1977, (44) the Continuity of Care index (COC) is a measure of the dispersion or concentration of visits among all providers seen. While the UPC tends to inflate scores for those with few visits, the COC corrects for this statistical problem by incorporating more detailed visit information. One disadvantage is that detailed utilization information is needed to calculate the measure and it lacks an intuitive interpretation. In addition, the calculated value of this measure falls quite rapidly with

increasing numbers of providers. It is, however, the most commonly used and validated of the continuity measures.

Likelihood of Continuity

Developed by Steinwachs in 1979, the Likelihood of Continuity score (LICON) incorporates provider availability into the equation. The LICON measures the probability that the number of providers seen is fewer than would have occurred under random conditions, given the patient's level of utilization and the number of available and accessible providers. (45) The LICON is useful for comparing two group practices, or a group practice and a hospital outpatient department, but falls short when trying to measure continuity in a community sample. In this setting, a multitude of other factors affect accessibility of the available providers, in addition to the difficult first step of accurately specifying the number of providers that are truly available.

Sequential Nature of Provider Continuity

Steinwachs also proposed the use of the Sequential Nature of provider Continuity (SECON), which incorporates the sequential nature of healthcare visits. The SECON equals the fraction of sequential visit pairs at which the same provider is seen. (45)

Modified Continuity Index

Magill and Senf developed the Modified Modified Continuity Index (MMCI) as a measure that would be less sensitive to the increased numbers of providers and patient visits

typically seen in a residency practice. (46) The measure is easy to calculate and applicable to a residency practice, but is less meaningful when applied to the general population.

Summary

Continuity of care has been defined and operationalized differently by different groups of providers over the years. As a result, there exists no consensus on how to measure the concept of continuity or the benefits of having a long-lasting patient/practitioner relationship. There is evidence of positive outcomes from a longitudinal relationship with a practitioner in more accurate diagnosis, better recognition of patients' problems and needs, and patients exhibit better concordance with treatment protocols and keeping appointments. In addition, a reduction in hospitalizations and emergency room use has been demonstrated in some populations, and patients and physicians report higher levels of satisfaction as continuity increases.

With the multitude of definitions of continuity, measurement tools, and confounding factors, the current body of research is difficult to summarize and positive effects of continuity difficult to conclude. Only when continuity is explicitly defined and operationalized, appropriate measurement tools are used, and all confounders are accounted for in the analysis will meaningful, interpretable, and policy-relevant research into the outcomes of continuity of care be possible.

Chapter 3

ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

Historical Perspectives

Historically, the antecedents of our current conceptualization of attention-deficit/hyperactivity disorder (ADHD) can be traced to the late 19th and early 20th century when Still described children with what he termed "morbid defects in moral control." (47) In the same era, others were describing behavioural disorders occurring as a result of brain injury. (48, 49) Symptoms such as inattention, hyperactivity, and poor impulse control following a head injury or CNS infection lead to the conclusion that such symptoms were in effect *brain damage*. In time, these same symptoms were seen in children with no history of brain injury. To account for the lack of obvious insult, it was assumed that the injury was so minimal; its only manifestation was in the behavioural syndrome, thus the new term *minimal brain damage*.

With time, the behavioural manifestations such as overactivity, restlessness, distractibility, and short attention span were themselves identified as a syndrome: the *hyperkinetic (hyperactive) child syndrome*. (50) In the early 1960s, the behavioural syndrome and the frequently associated learning disability were linked together to be called *minimal brain dysfunctions* (MBDs). (51) The diagnosis MBD was considered a real advancement incorporating the diverse manifestations of the syndrome, while not emphasizing one

particular aspect of it. In time, however, it became apparent that combining the learning disability and the behavioural syndrome within one diagnosis served only to compound the complexities of them both. In addition, there were no clearly defined diagnostic criteria for MBDs; a fact that reflects the general lack of progress in the classification of behavioural disorders in general. (52)

The Diagnostic and Statistical Manual of Mental Disorders

The diagnosis of ADHD is established on the basis of a history of symptoms presenting the main features of the disorder: inattention, impulsivity, and at times, hyperactivity. How to quantify these symptoms and how many symptoms are necessary for a diagnosis remain issues of ongoing research. The first diagnostic manual appeared with the publication in 1952 of the Diagnostic and Statistical Manual of Mental Disorders, First Edition (DSM-I), (53) followed by the second edition in 1967 (DSM-II). (54) Here, the focus began to change from brain damage to behavioural manifestations, as reflected in the new term *Hyperkinetic Impulse Disorder*. In 1980, with the publication of DSM-III, the focus again shifted from considering hyperactivity to be the primary problem to considering inattention as the primary deficit. (55) The diagnosis of *Attention Deficit Disorder* (ADD) in DSM-III required the presence of three symptom dimensions: inattention, impulsivity, and hyperactivity. The next version of the manual was the 1987 DSM-III-R in which the diagnostic criteria for *Attention-Deficit/Hyperactivity Disorder* (ADHD) appeared as a single, unweighted list of 14 items. (56) Symptom criteria were met only if the "behaviour is considerably more frequent than that of most people of the same mental age." Then in 1991, a multi-site DSM-IV Field Trial was

mounted to help refine and test new concepts underlying the diagnosis of ADHD before publication of the DSM-IV in 1994. (7) The outcome of the trials defined the validity of proposed ADHD symptoms, resulting in increased specificity of the diagnosis at the loss of some sensitivity. The DSM-III-R had been accused of setting too low a threshold for the ADHD diagnosis, raising concerns that children were being inappropriately diagnosed. (57) The current DSM-IV criteria "tightened" the ADHD diagnosis by:

- Reviving the ADD without hyperactivity diagnosis found in DSM-III which was lost in the revised version, renaming it *ADHD, predominantly inattentive type*;
- Further specifying that inattention symptoms should be present in a structured environment (e.g., school or occupation);
- Requiring that ADHD symptoms cause significant impairment in social or academic functioning or cause marked distress.

In keeping with its two-factor model of ADHD (inattention, hyperactivity/impulsivity), the DSM-IV instructs clinicians to draw their conclusions from a list of inattentive behaviours and a second list of impulsive/hyperactive behaviours. From these two dimensions, three subtypes have been derived: the predominantly inattentive type, the predominantly hyperactive/impulsive type, and the combined type, for children who meet the criteria on both dimensions. For the complete DSM-IV ADHD definition and subtypes, see Appendix C.

Establishing a Diagnosis

The first step in establishing a diagnosis of ADHD is to determine whether the child meets the DSM-IV diagnostic criteria (see Appendix C). There is no single manual for a practitioner to consult that serves as a standard of diagnosis or assessment methods. Rather, there are a variety of published guidelines for diagnostic criteria and evaluation procedures from which to choose. (57)

The diagnosis of ADHD is dependent on the report of characteristic behaviours by those observing the child, primarily parents and teachers. Information from parents is best obtained through a combination of interview and rating scales. The interview allows the clinician to obtain a clear understanding of the child's behaviour and determine if behaviours are occurring often, as described in the criteria. The literature suggests that additional information should be gathered about the family and home situation, birth, medical and school history. Behaviour rating scales filled out by parents can also yield valuable information; however, they are meant to be used in conjunction with interviews, not in place of them.

Interviewing the children themselves is also suggested in the literature. While they may not give an accurate report of their ADHD behaviours, they can give insight into their feelings and expose any underlying conditions such as anxiety or depression. These conditions may either be the cause of their symptoms or may alter therapy as in the case of comorbidity. Since many of the symptoms likely occur in the school setting, teacher information is extremely valuable in making a diagnosis. Again, behaviour-rating scales can be an effective means of obtaining the relevant information.

Direct observation in a clinician's office may be helpful, but is often not representative of the child's usual behaviour. Some schools now provide direct observations of the child in a classroom setting by a psychologist. This information, in addition to the physician's physical and neurologic examination of the child may help establish a diagnosis where one is appropriate. (58)

Epidemiology

Attention-deficit/hyperactivity disorder (ADHD) is considered the most prevalent neurobehavioural disorder of childhood (59) and is the most frequently diagnosed behaviour disorder in North American children. (60) Due to the difficulties inherent in diagnosis and the frequent changes in labels and definitions over the recent past, estimates of the prevalence of ADHD vary widely in the literature. Estimates range from 1% to 26%, depending on the population assessed and the diagnostic criteria used. (61) The most conservative prevalence estimates (1% to 5%) have occurred in student populations with documented ADHD diagnoses. (62, 63) The highest estimates (16% to 26%) have occurred with much smaller sample sizes and with participants meeting ADHD screening criteria rather than those with a known diagnosis. (64, 65)

Boys are six times more likely than girls to have ADHD in clinical studies and two to three times more likely in population-based studies. (7, 66, 67) Offord and colleagues found that urban children were more likely to have ADHD than rural children (67), and low socio-economic status has been linked to higher rates of emotional disturbance in studies in

Canada (68, 69), Britain (70), and the United States (71). Using the widely accepted DSM-IV prevalence rate of 3% to 5% of the total child population, we would expect approximately 20,000-33,000 children in British Columbia to meet the diagnostic criteria for ADHD. (6, 7)

Administrative Prevalence vs. Epidemiological Prevalence

It is important to note that the rate of recognition of a disorder in clinical practice, termed administrative prevalence, or diagnosed prevalence, often differs from the epidemiological prevalence, or the actual community prevalence. Taylor and colleagues found in 1989 that the administrative prevalence of hyperkinetic disorder underestimated the true epidemiological prevalence by 1/2000 (0.05%) in the UK and by 1-2/100 (1.5%) in the USA. (72) Administrative prevalence depends on several factors including: referral and access to services, problem recognition by clinicians, cultural factors that influence tolerance of symptoms, and actual presence of symptoms. Thus, administrative prevalence can change rapidly with social change, even though the epidemiological prevalence has not changed. One example is the change in educational regulations in the U.S. in 1990, which corrected the assumption that ADHD was solely a consequence of learning or emotional disorders. In the three years following, the administrative prevalence of ADHD doubled in the U.S. (73)

For administrative prevalence to accurately reflect epidemiological prevalence, children must be reliably assessed and diagnosed by a healthcare professional. It is known, however, that not all children meeting diagnostic criteria for a disorder will be seen by a physician or mental health provider. Two studies of the provision of services to children with psychiatric

disorders found that only a minority of children are diagnosed and treated. In the Isle of Wight study, Rutter and colleagues found that nine tenths of children with psychiatric disorder identified epidemiologically had not been expertly diagnosed. (74) In New York, Langer and associates noted that less than 50% of the seriously impaired children were referred and only one in five received treatment for six months or longer. (75) Offord and colleagues found that Ontario children with psychiatric disorders, compared with children without these disorders, were four times more likely to utilize mental health and social services; however, five out of six of these children had not utilized services in the previous six months. (67)

Comorbidity

Comorbidity is a common feature of ADHD. The presence of comorbid conditions tends to complicate the diagnostic process and can have an impact on natural history and prognosis as well as the management of children and adolescents with ADHD. (76) Comorbidity is present in as many as two-thirds of clinically referred children with ADHD. (77) Common coexisting disorders are oppositional defiant disorder, conduct disorder, affective disorders, anxiety disorder, and learning disorders. (See Table 1 for prevalence rates of comorbid conditions).

Table 1. Prevalence rates of comorbidity in children and adolescents with ADHD.

	Prevalence (%)					
	AACAP (77)	Bird et al (65)	Offord et al (78)	Anderson et al (79)	Zarin et al (80)	Cohen et al (81)
Study Year	1997	1988	1989	1987	1998	1993
Comorbid Disorder	Review	Puerto Rico	Ontario	New Zealand	USA	USA
Oppositional defiant disorder	50	93		47	31	54
Conduct disorder	30-50		43			56
Mood disorders	15-20		19		20	
Anxiety disorders	20-25	51		26	10	23
Depressive disorder		27		15		13
Learning disorder	10-25				7	

There is much debate as to the meaning of this overlap in clinical presentations. Angold and Costello (82) have speculated possible explanations for the co-presentation of symptoms:

1. The overlap is no greater than chance; clinicians are simply more likely to have complex cases present to their practices.

2. The comorbid condition is second to the ADHD; for example an ADHD child becomes depressed as a result of chronic school problems (the opposite could also be true).

3. ADHD has a distinct genetic or environmental etiology, while ADHD with the comorbidity has a completely separate set of etiologic factors.

4. ADHD has a particular cause, but different environments cause ADHD children to take different paths.

Regardless of cause, comorbidity is important at a clinical level because the comorbid condition likely will result in a child with different clinical presentation, life course, and response to treatment than a child with ADHD alone. (83) Co-existing psychiatric conditions have been most extensively studied in this population of children; however, comorbidity of any condition can contribute to a disproportionate increase in illness burden

and healthcare utilization. The following section describes a system developed in the United States for classifying the variety and severity of diagnoses carried by a person over a defined period of time.

Ambulatory Diagnostic Groups (ADGs)

Ambulatory diagnostic groups (ADGs) were developed by Starfield and Weiner in 1990 with the goal of clustering together similar conditions based on their expected impact on health services resource consumption. The primary conceptual basis of the classification system was the expected persistence or recurrence of the condition over time. (84, 85) The authors originally developed this system by examining the relationship between morbidity and use of healthcare services among children enrolled in a Health Maintenance Organization over a six-year period. (86) They determined that children with multiple types of diagnoses were more likely to be persistently high service users than were other children. The categorization of morbidity was subsequently modified for use in adults, and has been extensively validated in the U.S. (84, 85), Spain (87), and more recently, Reid and colleagues tested its use in Manitoba and British Columbia. (88)

Treatment of ADHD

Two primary treatment modalities exist for ADHD: pharmacological and behavioural.

Pharmacological Treatment

Stimulant medications have been used for over 50 years to treat ADHD and methylphenidate (trade name Ritalin) is now the most commonly prescribed psychotropic medication for children in the United States. (89) The clinical efficacy of psychostimulants in controlling symptoms and normalizing behaviour has repeatedly been shown since the first double-blind placebo-controlled trial of methylphenidate and dextroamphetamine in the mid 1960s (89-93), and at least 70% of ADHD children will have a positive response to one of the major stimulants on the first trial. (76) Methylphenidate is a powerful stimulant, however, with potentially harmful side effects. The most common short-term side effects: decreased appetite, stomachache, insomnia, and headache are reported by approximately half of the children taking methylphenidate. (94, 95) In 1972, Safer and his colleagues (96) reported the potential of methylphenidate to retard growth in children and there is evidence that some patients exhibit significant reduction in growth rate while being treated with methylphenidate. (89) To date, no studies have assessed the risks of using these medications over long periods of time, and medium- and long-term effectiveness of the medication remains unknown.

Psychosocial Interventions

Psychosocial interventions are those focused on the family, the school, and the child. Parent management training has been shown to not only reduce the child's disruptive behaviour at home, but also increase the parent's self-confidence in dealing with the child and decrease family stress. School-based interventions focus on academic performance, while child-focused interventions include individual psychotherapy to treat underlying conditions while improving the child's impulse control, anger control, and social skills. (76)

Two psychosocial interventions for ADHD have been identified by Pelham and colleagues (97) that meet criteria for well-established treatments: behavioural parent training and behavioural intervention in the classroom setting. Both of these treatments are based on general principles of behaviour modification (i.e. reinforcement, punishment, extinction, and stimulus control) and have been used for over 30 years. They have limited short-term effects on some ADHD symptoms such as hyperactivity, but large effects on other symptoms are seen in about 50% of patients including opposition, defiance, and aggression.

Multimodal Treatment

Though it is generally believed that the most effective treatment modality is a combination of both pharmacological and behavioural interventions, there has been little data to support this assumption. (77) It seems intuitive, however, that since medical treatment and psychosocial treatment have complementary effects, a wider range of symptoms may be treated than with either treatment alone. Large prospective studies are currently underway in North America and Europe to determine the efficacy of multimodal treatment strategies for ADHD. (98-101)

The Need for Continuity

Achieving effective, multimodal treatment in ADHD will not happen in one patient/ physician visit. The integration of pharmacotherapy with a number of environmental, educational, psychotherapeutic, and school-based approaches must be tailored to each individual child and adjusted to account for personal or environmental changes over time. Each child diagnosed with ADHD requires appropriate follow-up, including medication

monitoring for efficacy, adverse effects, and ongoing need. (102) The evaluation and monitoring of treatments requires input and cooperation from the patient, parents, and teachers and further underscores the importance of the clinician's role as coordinator or case manager. In their 1997 Practice Parameters for the Assessment and Treatment of ADHD, the American Academy of Child and Adolescent Psychiatry state: "ADHD has an extended course, requiring continuous treatment planning to deal with the effectiveness of current treatment and the emergence of new problems." (77)

It seems clear that the most effective management of ADHD and any existing comorbidities will result from careful evaluation of treatments and regular monitoring throughout the course of illness. This will likely best be achieved with one practitioner coordinating the care and managing referrals to specialists as they become necessary. It follows then that children receiving care from disparate primary sources, with no provider or informational continuity from visit to visit, are at risk of mismanaged treatment and the consequences. However, as yet no evidence is available to test these assertions.

Chapter 4

METHODS

Study Design

The study design is a retrospective claims based analysis of all children, aged 4-16 on January 1, 1995 living in the Capital Health Region or the Lower Mainland of British Columbia, with a diagnosis of attention-deficit/hyperactivity disorder (ADHD), conduct disorder (CD), or emotional disturbance (oppositional defiant disorder, or ODD). Continuity of primary care provider was computed for two years (1995-1996), and emergency department use in the third year (1997) was the outcome.

BC Linked Health Data Set

The British Columbia Linked Health Data Set (BCLHD), administered at the Centre for Health Services and Policy Research (CHSPR) at the University of British Columbia, is a retrospective population-based administrative health data file of all persons registered with the BC health care system. (103) The integration of population-based administrative health databases through deterministic and probabilistic linkage at the individual level has allowed healthcare researchers and policy makers access to a valuable resource for health services research and planning. As of the end of 1999, the BCLHD included Medical Services Plan payment data (i.e. billing claims by physicians and other providers), hospital separations,

Continuing Care, Pharmacare records (all prescriptions covered under the provincial Medical Services Plan), births, deaths, National Population Health Survey data, BC Cancer Agency incidence data, Workers' Compensation Board of BC data, and mental health utilization data. (104)

All requests for access to the BCLHD go through a formal approval process. Each request is reviewed by a committee comprised of Ministry of Health staff, CHSPR faculty, and representatives of the Ministry's Information and Privacy Program and the Research and Evaluation Branch. Once the request has been classified by level of confidentiality and security, both scientific peer review and ethics committee review are considered before access is granted.

Study Population

The data come from the BCLHD and are a linkage of Medical Services Plan (MSP) and hospital separations files. Included in the original data set were all children aged 0-16 during the years 1994 to 1998, living in the Lower Mainland and Victoria (Health Regions: Vancouver, Burnaby, North Shore, Richmond, Surrey, Simon Fraser, Fraser Valley, and Capital Health), who received at least one of three diagnoses used as a proxy for ADHD. The ICD-9 diagnoses included were:

- 314: Hyperkinetic syndrome of childhood;
- 313: Disturbance of emotions specific to childhood and adolescence;
- 312: Disturbance of conduct, not elsewhere classified.

To be included in the final cohort, the child must have met each of the following criteria:

- Age 4 to 16 years on January 1, 1995;
- Continuously enrolled in Medical Services Plan insurance for the entire study period (1995-1997);
- Made more than three general practitioner (GP) office visits during the 1995 and 1996 calendar years;
- Received two or more diagnoses of interest (ICD-9 312, 313, or 314) during the 1995 and 1996 calendar years.

ADHD is a complex, multi-faceted syndrome for which there is no gold standard of diagnosis. Diagnosis is based on a variety of measures including parent and teacher reports, behavioural characteristics, and the persistence of particular symptoms. These symptoms, however, may be represented by a constellation of diagnostic codes. Three ICD-9 codes have been included here (312, 313, and 314) to define our working approximation of the concept of ADHD. The inclusion of additional diagnostic codes takes into account the diagnostic ambiguity of the syndrome in addition to idiosyncratic physician coding behaviour. For the purpose of this study and the remainder of this paper, "children with ADHD" will refer to children with two or more recorded diagnoses of ADHD, conduct disorder, or emotional disturbance.

Data Preparation

The administrative Medical Services Plan (MSP) data set contained all physician claims filed during the four fiscal years 1994 to 1997. Since it is an administrative billing data file, and multiple claims often result from one visit, duplicate claims for individual visits were first

deleted. In addition, we were interested in visits to general practitioners (GPs), pediatricians, and psychiatrists, so all other specialist visits and all procedures, including diagnostic procedures and surgeries, were deleted from the files. The remaining database contained all consultations, counselling, home visits, emergency visits, and institutional visits to GPs, pediatricians, and psychiatrists. The calendar years 1995-1997 were chosen as the years that would capture the largest number of children continuously enrolled in MSP insurance. Therefore, all visits prior to 1995 and after 1997 were removed.

Main Outcome Measure

The main outcome was emergency department (ED) visits. For the analysis, ED visits during the one-year period (1997) following the COC computation period (1995-1996) was the dependent variable. ED visits were determined from the MSP files service code field. Most children (95%) in need of emergency services in Vancouver are taken to BC Children's Hospital where all specialist emergency physicians are reimbursed on a fee-for-service basis (personal communication, Greg Baldwin, BC Children's Hospital Emergency Services, May 30, 2001). In addition, 96% of BC general practitioners bill fee-for-service (105), thus allowing the capture of pediatric emergency visits through administrative sources.

Continuity of Care Measures

A continuity score was calculated for each participant in the study using the longitudinal measure of continuity developed by Bice and Boxerman called the Continuity of Care Index

(for the remainder of the paper, 'COC' will refer the continuity index developed by Bice and Boxerman). (44) This measure was chosen for several reasons. For one, the COC incorporates more detailed visit information, thus providing a more accurate continuity score. Secondly, this measure is more mathematically sound than previously developed indices that tend to inflate scores for those with few visits. Thirdly, it was determined that the sequential nature of visits was of less importance than the actual number of visits to different providers, therefore COC was chosen over measures based on the sequence of visits. Finally, detailed information on physician availability was not available for all study participants, therefore no measure incorporating this variable could be used.

COC was calculated for the calendar years 1995-1996 based on ambulatory care visits, defined as face-to-face encounters with a primary care physician, including visits to physician's offices and walk-in clinics. Since emergency visits were the outcome of interest, and we were interested in measuring continuity with a primary care physician, emergency visits and specialist visits were not included in computing the continuity measure. Christakis and colleagues found that the COC became more stable as the number of visits increases (5), therefore continuity was only calculated for those children with four or more GP visits.

Continuity of Care Index

The COC models the dispersion in patient/provider contacts and establishes an index based on the concentration of care. This concentration index is a measure of the extent to which a given individual's total number of visits over a specified time period are with a single provider. The values range from 0 to 1; 0 indicates maximum dispersion and 1 indicates complete continuity.

The equation is of the form:

$$\text{COC} = \frac{\sum_{i=1}^{k} n_i^2 - N}{N(N-1)}$$

Where n_i = number of visits to provider i, N = total number of visits and k = the total number of providers seen. For a description of the mathematical basis for the equation, see Bice, 1977. (44) See the example below (Figure 2) for the method used to calculate COC for each study participant.

Figure 2. Example of COC calculation.

For a patient with a total of 12 visits (N = 12) to 4 different providers with the visit pattern represented below, COC is calculated in the following way:

$$\text{COC} = \frac{\sum n_i^2 - N}{N(N-1)} = \frac{\sum n_i^2 - \sum n_i}{N^2 - N} = \frac{\sum \left(n_i^2 - n_i\right)}{N^2 - N}$$

Provider i	Number of Visits to Provider i (n_i)	n_i^2	$n_i^2 - n_i$
1	2	4	2
2	4	16	12
3	5	25	20
4	1	1	0

$$\sum \left(n_i^2 - n_i\right) = 44; \quad N^2 - N = 132; \quad \text{COC} = \frac{44}{132} = 0.33$$

Usual Provider Continuity

Several different continuity measures have been used in similar studies, each with its own advantages and disadvantages. We wanted to see how the COC compared with another commonly used measure; therefore, we also calculated the Usual Provider Continuity index (UPC) (13) for each study participant over the same two years. The UPC was chosen over other measures because it has been used extensively due to its ease of calculation, values which are easy to interpret and compare across populations, and is generally thought to have high face validity. It is a simple ratio of visits to the regular provider, which is defined as the provider with whom the greatest number of visits took place. The equation is:

$$\text{UPC} = \frac{n_i}{N}$$

Where n_i = number of visits to the usual provider and N = total number of visits.

For a comparison of how each measure behaves in several hypothetical visit patterns, see Table 2 below.

Table 2. Comparison of the Continuity of Care Index and Usual Provider Continuity Index. (Adapted from Christakis, et al 2001 (5))

	Continuity Measure	
Visit Sequence*	COC	UPC
AAAAAAAA	1.00	1.00
AAAABAAA	0.75	0.88
ABAABAAA	0.57	0.75
ABAACAAA	0.54	0.75
ABCBAEFA	0.23	0.38
ABCDEFGH	0.0	0.13

*Each unique letter denotes a different provider.

Ambulatory Diagnostic Groups (ADGs)

The Johns Hopkins ADG case-mix system developed by Starfield and Weiner (84), has recently been validated for use in British Columbia and Manitoba by Reid and colleagues. (88) They found that the application of the ADG system in Canada is feasible using existing data sources and that the system is able to explain approximately 50% of the variation in same-year physician costs. They constructed multivariate regression models to compare the ability of ADGs to explain individual variation in healthcare expenditures. The result of the regression models is a series of β weights assigned to each of the 32 ADGs that can be used to weight the impact of each group on not only expenditures specifically, but illness burden and therefore healthcare utilization in general.

Initially, study participants were dichotomized according to whether they had a diagnosis in each of the 32 ADGs during the second year of the study (1996) using the ACG version 4.0 software. (106) (For each ADG, the child would receive a '0' if he had no recorded diagnosis in that group, or a '1' if he received at least one diagnosis in that group during the year). The ADGs were then weighted according to Reid's β weights, and the sum of these weighted ADGs was computed for each child. The higher the value of the summed weighted ADGs, the higher the illness burden for that child. The weighted ADGs for the entire group were then divided into tertiles (high, medium, and low illness burden) and added to a regression model as categorical dummy variables.

Other Covariates

A number of additional covariates were considered as potential confounding factors based on the literature and clinical experience. These include patient characteristics such as age, sex, and socio-economic quintile; health service utilization characteristics such as continuity, number of visits to GPs, and use of specialists; and access factors such as residential location as it relates to availability of providers. Each of these variables was checked for correlation with the outcome, ED use. Any variable significant at the $p<0.1$ level was included during building of the model.

Data Analysis

Descriptive Statistics

All analyses were performed using SPSS Version 10.0. (107) Frequencies were determined for the ordinal variables: age group, socio-economic quintile, sex, and COC and ADG tertiles. Summary descriptive statistics including mean, standard deviation, and range were determined for the continuous variables: age, number of ED visits, number of GP and specialist visits, number of different providers seen, and COC.

Wilcoxan Rank Sum Test

Since four variables: GP visits, number of GPs seen, and pediatrician and psychiatrist visits were not normally distributed and their variances were not equal, t-tests could not be used to test for significant differences in mean value of these variables between ED-visitors

and non-visitors. The nonparametric Wilcoxan rank sum test does not require these two underlying assumptions; only that the distributions have the same general shape. Histograms were run for each of the variables, and the distributions of each were shown to be of the same general shape. Therefore, the rank sum test was used to test for significant differences in median number of GP visits, specialist visits, and number of different GPs seen between those visiting the ED and those not visiting the ED. The rank sum test was also used to compare these variables among COC tertiles, ADG tertiles, age groups, and socio-economic quintiles.

Model Building

The outcome variable, ED visits, could not be examined as a continuous variable due to extreme skewedness and kurtosis of the data. The log transformed ED variable remained extremely skewed and therefore violated the assumptions required for linear regression. The association between continuity and ED use was therefore measured using multinomial (or polychromatous) logistic regression with 3-level categorization of emergency visits as the dependent variable: no visits, one visit, or multiple ED visits. Binary logistic regression with two outcomes (ED visit or no ED visit) was not used because there may be important differences between those with only one ED visit and those with multiple visits. It was hypothesized that additional uncontrolled confounders or chance may contribute to a child making a single ED visit. In addition, a 3-level outcome would allow a dose-response relationship to be shown between COC and outcome if one exists.

The model was first run using COC as the only predictor variable. It was then run controlling for the number of GP visits made during the initial two-year period, since it has

been shown to be a negative confounder of the association between continuity and ED use. That is, GP office visits are positively associated with ED use but negatively associated with continuity. (4, 33) Third, the model was run with the addition of weighted ADG tertiles, since illness burden is a known predictor of healthcare service use. (85, 87, 108) Finally, all additional covariates described in the literature and those expected to have clinical relevance to the predictors or outcome were forced into the final model to determine the effect of continuity on outcome independent of other factors.

Model Checking—Goodness of Fit

Goodness of fit was assessed using a chi-square test and likelihood ratio tests of the final model. The chi-square for the final model determines whether the model as a whole achieves statistical significance. When the result of this test is significant, at least one effect in the model is statistically significant. If that is the case, the next step is to determine which effects significantly contribute to the model, which is done by checking individual likelihood ratio tests.

Likelihood ratio tests produce chi-square statistics that determine the effect of each individual covariate in the model. The chi-square statistic is the difference in –2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model, with the null hypothesis being that all parameters of that effect are 0. In this way, a test is made of the marginal contribution of each variable to the model.

The final check, how much of the variation in outcome amongst the data is explained by our model is done by checking the pseudo R-square values. Pseudo R-square measures attempt to summarize the strength of the relationship between the independent and dependent variables if they are found to be significantly correlated. A covariate that is added to the model may be significant, but it may be dropped if it does not contribute to the overall R-square value.

Model Checking—Interactions

All categorical covariates in the final model were checked for any significant interactions. To test for any bivariate interactions between age group, SEQ, COC, and ADG, a full factorial model was run. Again, the change in –2 log likelihood was checked to determine if each interaction term was significant. In this case, no significant interactions were found among these covariates, so the interaction terms were not included in the final model.

The Final Model

The final model includes 7 variables. Four independent variables analyzed as categorical variables: age groups (4-6 years, 7-9, 10-12, and 13-16), socio-economic quintile (SEQ 1-SEQ 5), COC tertiles, and ADGs tertiles. The number of GP visits, pediatrician visits, and psychiatrist visits were analyzed as continuous variables.

Chapter 5

RESULTS

Overview

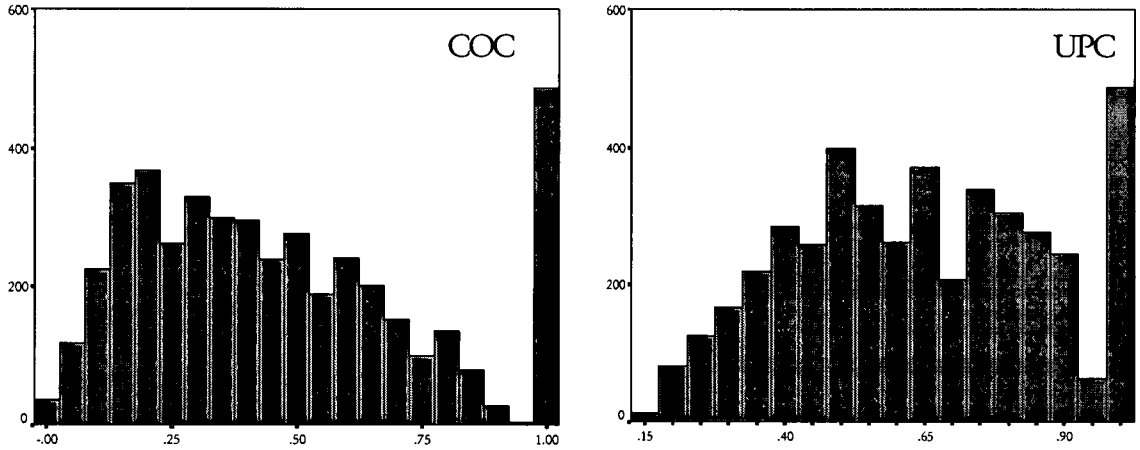
The results show an inverse relationship between continuity of care with a primary care provider and ED visits with a trend toward statistical significance. Other covariates significantly associated with ED use include age group, illness burden as determined by ADG case-mix, number of GP visits, pediatrician visits, and psychiatrist visits.

Descriptive Statistics

COC and UPC

The COC and UPC scores range from 0 to 1. Mean COC score for the total sample was 0.46 (standard deviation 0.28) while mean UPC was 0.64 (standard deviation 0.22). While COC scores cannot easily be interpreted, the simple ratio of visits computed for UPC allows for an intuitive interpretation of the value. A UPC of 0.64 can be interpreted to mean that on average, 64% of all GP visits were to the 'usual' GP—that is the GP seen most frequently. The two measures were 97% correlated, with nearly normal distributions except for the large proportion of study participants (11%, or 486) with COC and UPC scores equal to 1 (See Figure 3).

Figure 3. Histograms for COC and UPC for the study population.



ED Visits

Out of the 4418 study participants, the vast majority (3296, 74.6%) had no ED visits, 15.5% (685) had exactly one ED visit, and 9.9% (437) had two or more visits. The greatest number of ED visits for an individual in the follow-up year was 14 (see Figure 4). The distribution of total ED visits differed by COC scores, with those in the lowest COC tertile making the largest number of repeat ED visits (see Figure 5).

Figure 4. Histogram of ED visits for the study population.

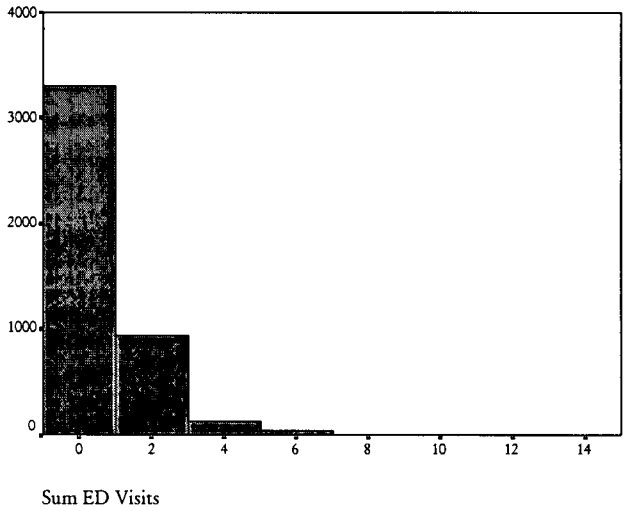
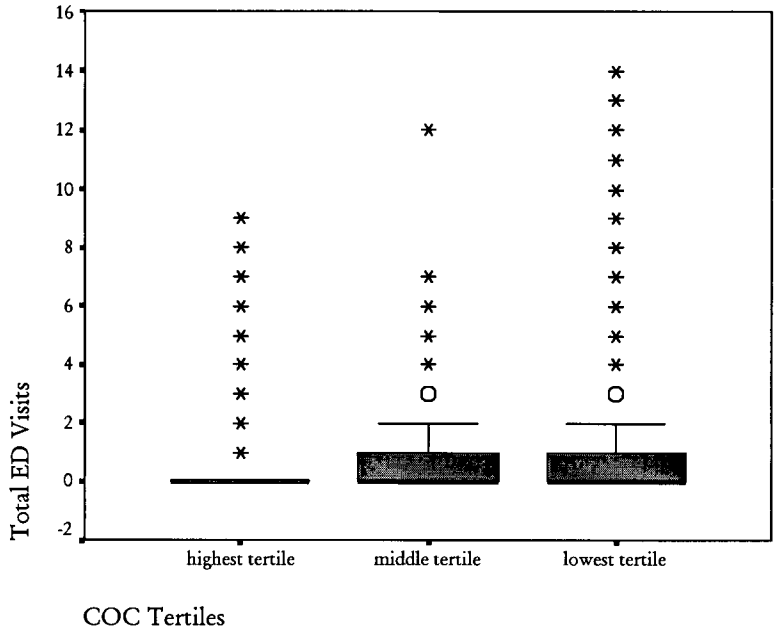


Figure 5. Box plots of ED visits by COC tertile.



Demographics

Of the 16,490 children who had a diagnosis of ADHD enrolled in MSP coverage from January 1, 1995 through December 31, 1997, 931 (5.6%) moved residence during that time and 974 (6.3%) had a cancellation of longer than 30 days, and therefore were not included. Of the remaining 14,585 children, 10,008 were aged 4-16 with more than 4 GP visits during the 2 year period, and 4418 had two or more recorded diagnoses. Table 3 summarizes the characteristics of the included patients. The average age was 9.2 years and 74% were male. Ninety-seven percent of the study population reside within the eight urban health regions in British Columbia: Fraser Valley, South Fraser Valley, Simon Fraser, Vancouver, Burnaby, North Shore, Richmond, and Capital Health. The highest concentration, nearly one third of these children, lives in the South Fraser Valley. Mean socio-economic quintile (SEQ) for the cohort was 3.10 (SD 1.37).

Table 3. Summary of included patients.

	Total Sample $N = 4418$ No. (%)	0 ED Visits $N = 3296$ No. (%)	1 ED Visit $N = 685$ No. (%)	Multiple ED Visits $N = 437$ No. (%)
Sex**				
Male	3285 (74.4)	2480 (75.2)	510 (74.5)	295 (67.5)
Female	1130 (25.6)	813 (24.7)	175 (25.5)	142 (32.5)
Age, years**				
4-6	1039 (23.5)	798 (24.2)	160 (23.4)	81 (18.5)
7-9	1380 (31.2)	1066 (32.3)	201 (29.3)	113 (25.9)
10-12	1182 (26.8)	859 (26.1)	203 (29.6)	120 (27.5)
13-16	817 (18.5)	573 (17.4)	121 (17.7)	123 (28.1)
SEQ				
SEQ 1	761 (17.2)	568 (17.2)	104 (15.2)	89 (20.4)
SEQ 2	834 (18.9)	637 (19.3)	118 (17.2)	79 (18.1)
SEQ 3	927 (21.0)	673 (20.4)	168 (24.5)	86 (19.7)
SEQ 4	988 (22.4)	743 (22.5)	162 (23.6)	83 (19.0)
SEQ 5	841 (19.0)	622 (18.9)	124 (18.1)	95 (21.7)
COC tertile*				
Highest	1599 (36.2)	1225 (37.2)	237 (34.6)	137 (31.4)
Middle	1486 (33.6)	1103 (33.5)	223 (32.6)	160 (36.6)
Lowest	1333 (30.2)	968 (29.4)	225 (32.8)	140 (32.0)
GP visits**				
4-10	2363 (53.5)	1864 (56.6)	329 (48.0)	170 (38.9)
>10	2055 (46.5)	1432 (43.4)	356 (52.0)	267 (61.1)
Pediatrician visits**				
0	1765 (40.0)	1356 (41.1)	260 (38.0)	149 (34.1)
1 or more	2653 (60.0)	1940 (58.9)	425 (62.0)	288 (65.9)
Psychiatrist visits*				
0	2158 (48.8)	1632 (49.5)	336 (49.1)	190 (43.5)
1 or more	2260 (51.2)	1664 (50.5)	349 (50.9)	247 (56.5)
ADG tertile**				
Highest	1472 (33.3)	975 (29.6)	280 (40.9)	219 (50.1)
Middle	1472 (33.3)	1114 (33.8)	219 (32.0)	139 (31.8)
Lowest	1474 (33.4)	1207 (36.6)	186 (27.2)	79 (18.1)

ED: emergency department; SEQ: socio-economic quintile; COC: continuity of care index; GP: general practitioner; ADG: ambulatory diagnostic groups

* Significantly different at the $\alpha = 0.1$ level

** Significantly different at the $\alpha = 0.01$ level

Girls in the study population were different from boys in several ways: they were typically older (mean age 9.4 vs. 9.1, $p<0.05$) and had lower COC scores (mean 0.43 vs. 0.46, $p<0.01$). Girls were more likely to make multiple ED visits; while they represent only 25.6% of the sample population, girls make up 32.5% of those making multiple ED visits. In

addition, girls made more visits to GPs, pediatricians, and psychiatrists, and had higher illness burden than boys. See Table 4.

Table 4. Comparison of study girls and boys.

	Total Sample $N = 4418$ No. (%)	Girls $N = 1130$ No. (%)	Boys $N = 3285$ No. (%)
Age, years*			
4-6	1039 (23.5)	256 (22.7)	783 (23.8)
7-9	1380 (31.2)	350 (31.0)	1030 (31.4)
10-12	1182 (26.8)	258 (22.8)	923 (28.1)
13-16	817 (18.5)	266 (23.5)	549 (16.7)
SEQ*			
SEQ 1	761 (17.2)	195 (17.3)	565 (17.2)
SEQ 2	834 (18.9)	202 (17.9)	631 (19.2)
SEQ 3	927 (21.0)	209 (18.5)	718 (21.9)
SEQ 4	988 (22.4)	253 (22.4)	735 (22.4)
SEQ 5	841 (19.0)	258 (22.8)	582 (17.7)
COC tertile**			
Highest	1599 (36.2)	362 (32.0)	1236 (37.6)
Middle	1486 (33.6)	406 (35.9)	1078 (32.8)
Lowest	1333 (30.2)	362 (32.0)	971 (29.6)
ED visits**			
0	3296 (74.6)	813 (71.9)	2480 (75.5)
1	685 (15.5)	175 (15.5)	510 (15.5)
2 or more	437 (9.9)	142 (12.6)	295 (9.0)
GP visits**			
4-10	2363 (53.5)	543 (48.1)	1818 (55.3)
>10	2055 (46.5)	587 (51.9)	1467 (44.7)
Pediatrician visits			
0	1765 (40.0)	458 (40.5)	1307 (39.8)
1 or more	2653 (60.0)	672 (59.5)	1978 (60.2)
Psychiatrist visits**			
0	2158 (48.8)	484 (42.8)	1672 (50.9)
1 or more	2260 (51.2)	646 (57.2)	1613 (49.1)
ADG tertile**			
Highest	1472 (33.3)	432 (38.2)	1041 (31.7)
Middle	1472 (33.3)	377 (33.4)	1094 (33.3)
Lowest	1474 (33.4)	321 (28.4)	1150 (35.0)

ED: emergency department; SEQ: socio-economic quintile; COC: continuity of care index; GP: general practitioner; ADG: ambulatory diagnostic groups

* Significant at $\alpha = 0.05$

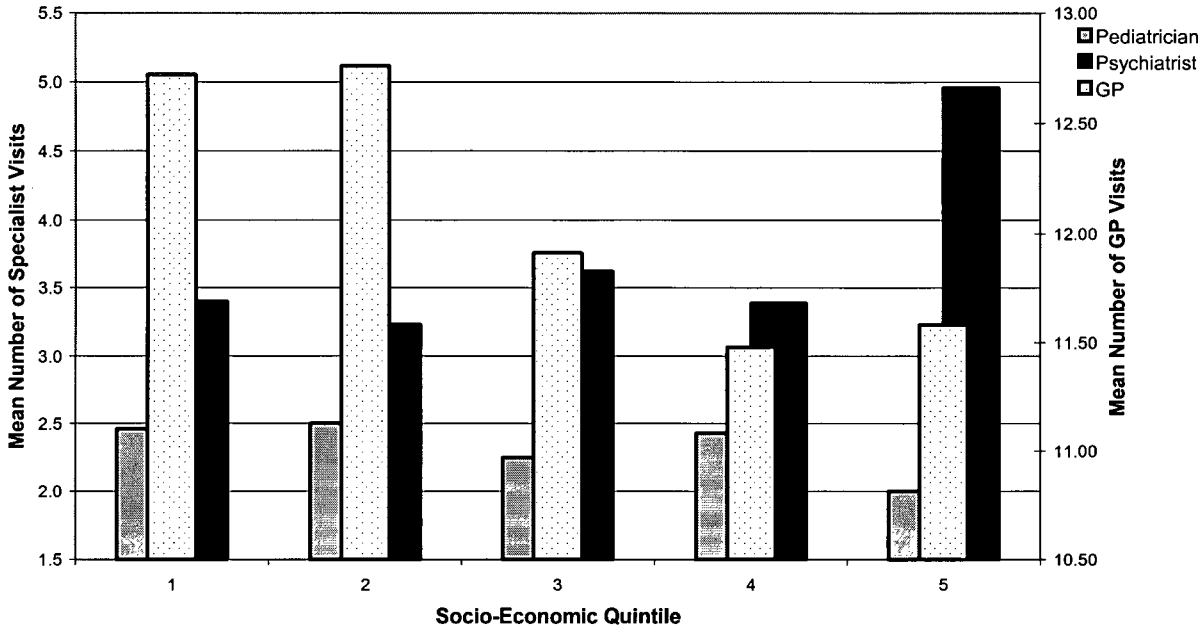
** Significant at $\alpha = 0.01$

Healthcare Utilization

The study population made a mean of 12 GP visits over the two years 1995-1996 (range 4 to 239) and they saw an average of 4 different GPs during this period (range 1 to 25). Sixty percent of these children saw a pediatrician and 51% made at least one visit to a psychiatrist. Those with at least one ED visit made significantly more visits to GPs (14.0 vs. 11.4, $p<0.001$), pediatricians (2.6 vs. 2.2, $p<0.01$), and psychiatrists (4.6 vs. 3.4, $p<0.01$). Those with ED visits saw an average of 4.5 different GPs compared with non-ED visitors who saw a mean of 3.8 ($p<0.001$). Girls saw more different GPs than boys (4.3 vs. 3.8, $p<0.001$), and had a greater number of GP visits (13.3 vs. 11.6, $p<0.001$) and psychiatrist visits (4.8 vs. 3.3, $p<0.001$). There was no difference in number of visits to pediatricians between boys and girls. Of those visiting the ED in 1997, girls averaged 1.9 visits while boys made an average 1.7 visits ($p<0.01$).

Socio-economic quintile (SEQ) was correlated with number of GP and specialist visits, number of different providers seen, and COC (see Figure 6). Those children in the lowest SEQ made significantly more GP visits (12.7 vs. 11.6, $p<0.001$), fewer psychiatrist visits (3.4 vs. 5.0, $p<0.001$), more pediatrician visits (2.5 vs. 2.0, $p<0.01$), saw an average 4.1 different GPs compared with 3.8 in the highest SEQ ($p<0.01$), and had lower COC scores (0.44 vs. 0.46, though not statistically significant).

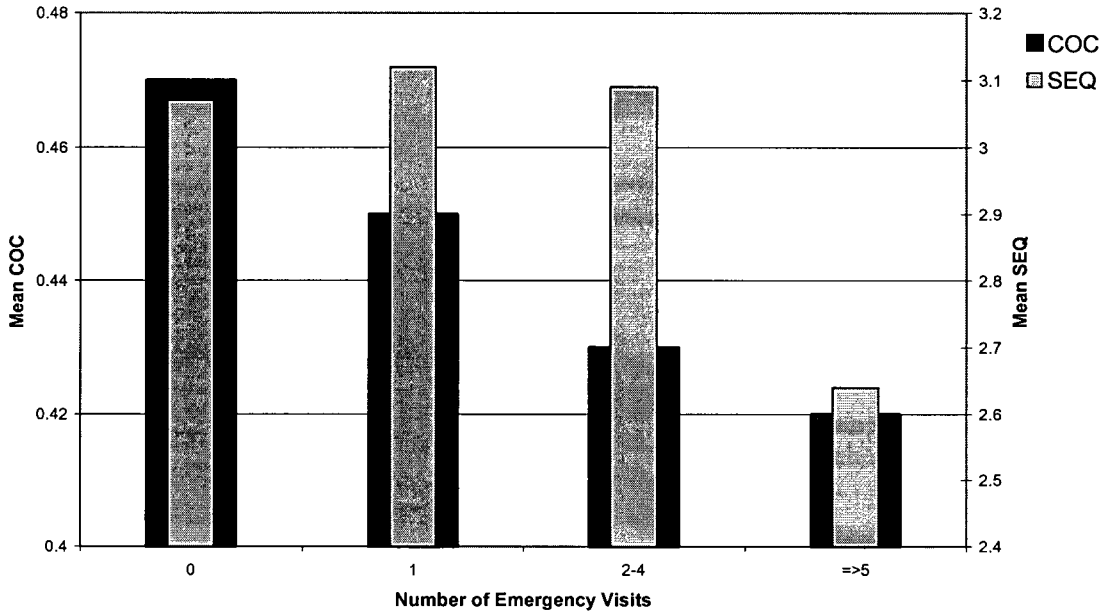
Figure 6. Relationship between socio-economic quintile and physician visits.



Continuity

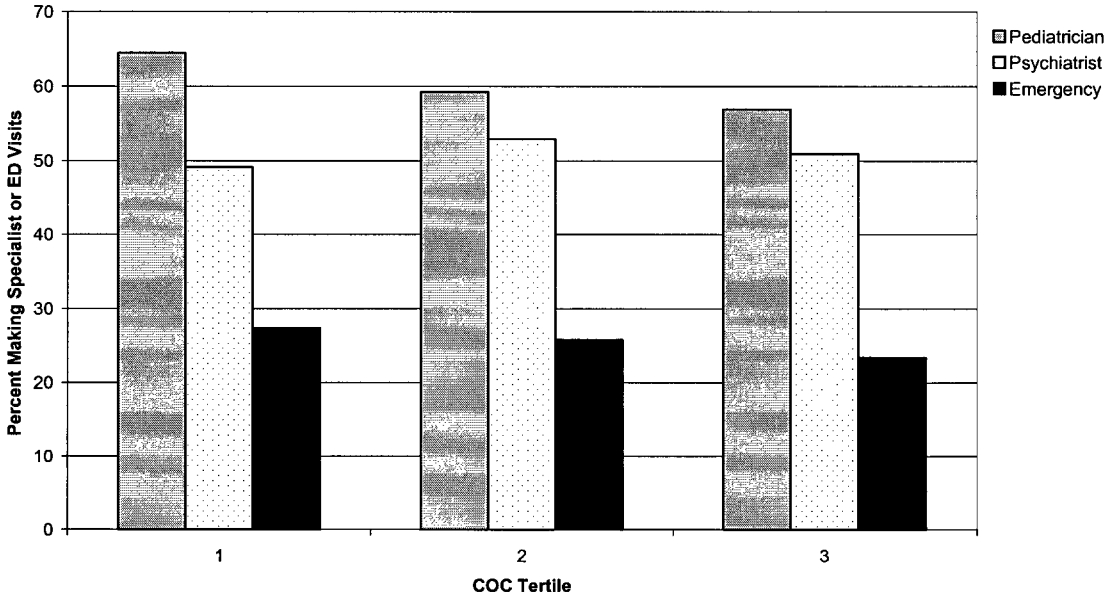
Mean Continuity of Care (COC) score for the sample was 0.46 and ED-visitors had significantly lower mean COC than non-ED visitors (0.43 vs. 0.46, $p<0.01$). (See Figure 7) The same trend was observed with UPC scores: ED-visitors had a lower mean score (0.62) compared with non-ED visitors (0.64, $p<0.01$). Boys had higher mean COC overall than girls (0.46 vs. 0.43, $p<0.001$); however, ED-visiting boys had significantly lower COC than their non-ED-visiting counterparts (0.44 vs. 0.47, $p<0.05$), while girls' COC did not differ significantly by ED status (0.41 vs. 0.43, not significant).

Figure 7. Relationship between ED visits, COC, and socio-economic quintile (SEQ).



When continuity scores were divided into tertiles, some trends were observed. Those with the lowest continuity (tertile 1) saw the greatest number of GPs (6.0), while the middle tertile (tertile 2) saw an average of 4.0 and the highest tertile (tertile 3) saw only 2.2 different GPs. Pediatrician visits differed slightly depending on COC tertile; 65% of those in tertile 1 saw a pediatrician, in contrast to 59% in tertile 2 and 57% in tertile 3. (See Figure 8) Emergency room use also differed based on COC; those in tertile 1 were most likely to make an ED visit (27.4%), followed by tertile 2 (25.8%), and those in tertile 3 were least likely (23.4%) to visit the ED. No significant difference was found in psychiatrist use by COC tertile.

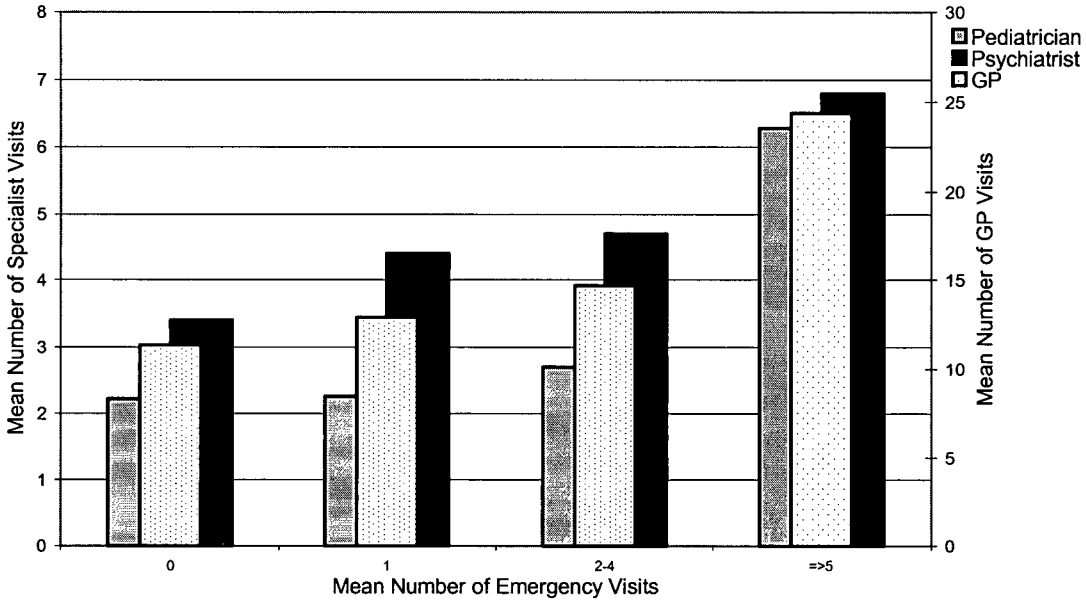
Figure 8. The relationship between COC tertiles and ED use, pediatrician visits, and psychiatrist visits.



Utilization Patterns

Several trends were found between the number of emergency room visits and visits to all physicians. Those children making more than four visits to the ED also made significantly more GP visits (24.4 vs. 11.4, $p<0.001$), pediatrician visits (6.3 vs. 2.2, $p<0.001$), and psychiatrist visits (6.8 vs. 3.4, $p<0.001$) than those with no ED utilization (see Figure 9). High ED-users saw an average of 6.3 different GPs over the two years compared with 3.8 for non ED-users ($p<0.001$) and tended to be older (10.8 vs. 9.1 years, $p<0.001$). No significant difference was found in COC, UPC, or socio-economic quintile between the group with greater than 4 ED visits (N=50) and those with none (N=3296). Compared to those with no ED use, however, the group with 2-4 ED visits (N=387) had significantly lower COC (0.42 vs. 0.46, $p<0.05$) and UPC (0.61 vs. 0.64, $p<0.01$).

Figure 9. Relationship between number of ED visits and physician visits.



Ambulatory Diagnostic Groups (ADGs)

Out of 4418 individuals, 315 (7%) were assigned to one ADG, 2455 (56%) had 2-4 ADGs, 1587 (36%) had 5-9 ADGs, and 61 (1%) had 10 or more ADGs. In univariate analysis, 16 ADGs were found to be significant predictors of multiple ED visits, while only 8 ADGs were found to predict single ED visits. For a complete listing of unadjusted odds ratios and 95% confidence intervals for each ADG, see Table 5.

Table 5. Ambulatory diagnostic groups as predictors of emergency department use.

Ambulatory Diagnostic Group	No.*	(%)	Likelihood of a Single ED Visit vs. No ED Visit, OR (95% CI)	Likelihood of Multiple ED Visits vs. No ED Visit, OR (95% CI)
Time limited				
Minor	1285	(29.1)	1.45 (1.22-1.73)	1.52 (1.23-1.87)
Minor (primary infections)	2203	(49.9)	1.15 (0.97-1.35)	1.48 (1.21-1.81)
Major	74	(1.7)	1.00 (0.52-1.92)	1.43 (0.72-2.84)
Major (primary infections)	189	(4.3)	1.21 (0.82-1.79)	1.39 (0.89-2.18)
Allergies	414	(9.4)	1.22 (0.93-1.60)	1.07 (0.76-1.50)
Asthma	344	(7.8)	1.41 (1.06-1.88)	1.78 (1.29-2.45)
Likely to recur				
Discrete	354	(8.0)	1.32 (0.99-1.77)	1.92 (1.40-2.61)
Discrete (infections)	945	(21.4)	1.08 (0.88-1.32)	1.34 (1.06-1.68)
Progressive	12	(0.3)	0.60 (0.08-4.81)	2.84 (0.75-10.7)
Chronic medical				
Stable	350	(7.9)	1.15 (0.85-1.56)	2.17 (1.61-2.93)
Unstable	168	(3.8)	1.54 (1.04-2.28)	1.87 (1.20-2.90)
Stable (orthopedic)	42	(1.0)	1.61 (0.76-3.44)	1.69 (0.69-4.11)
Stable (ear, nose, throat)	93	(2.1)	1.42 (0.85-2.38)	1.05 (0.52-2.11)
Stable (eye)	697	(15.8)	0.84 (0.66-1.06)	0.86 (0.65-1.15)
Unstable (orthopedic)	204	(4.6)	1.38 (0.96-1.99)	1.51 (0.98-2.31)
Unstable (ear, nose, throat)	8	(0.2)	0.96 (0.11-8.25)	3.03 (0.59-15.6)
Unstable (eye)	161	(3.6)	1.03 (0.66-1.60)	1.24 (0.75-2.03)
Dermatologic	362	(8.2)	0.93 (0.69-1.27)	1.03 (0.72-1.47)
Injuries/adverse effects				
Minor	1025	(23.2)	1.80 (1.50-2.16)	2.44 (1.98-3.02)
Major	791	(17.9)	1.44 (1.17-1.76)	2.05 (1.63-2.58)
Psychosocial				
Time limited, minor	364	(8.2)	1.22 (0.91-1.63)	1.69 (1.23-2.31)
Recurrent or persistent, stable	3615	(81.8)	1.07 (0.86-1.33)	0.91 (0.71-1.17)
Recurrent or persistent, unstable	121	(2.7)	1.53 (0.95-2.47)	2.68 (1.68-4.27)
Psychophysiological signs/symptoms				
Minor	2104	(47.6)	1.20 (1.02-1.42)	1.40 (1.15-1.71)
Uncertain	1286	(29.1)	1.36 (1.14-1.62)	2.35 (1.92-2.89)
Major	580	(13.1)	1.08 (0.85-1.38)	1.61 (1.24-2.09)
Discretionary	240	(5.4)	1.26 (0.89-1.80)	2.06 (1.44-2.95)
See and reassure	20	(0.5)	1.11 (0.32-3.91)	2.33 (0.76-7.19)
Malignancy	15	(0.3)	2.15 (0.66-6.99)	1.68 (0.36-7.80)
Dental	35	(0.8)	1.05 (0.40-2.76)	2.32 (0.99-5.43)

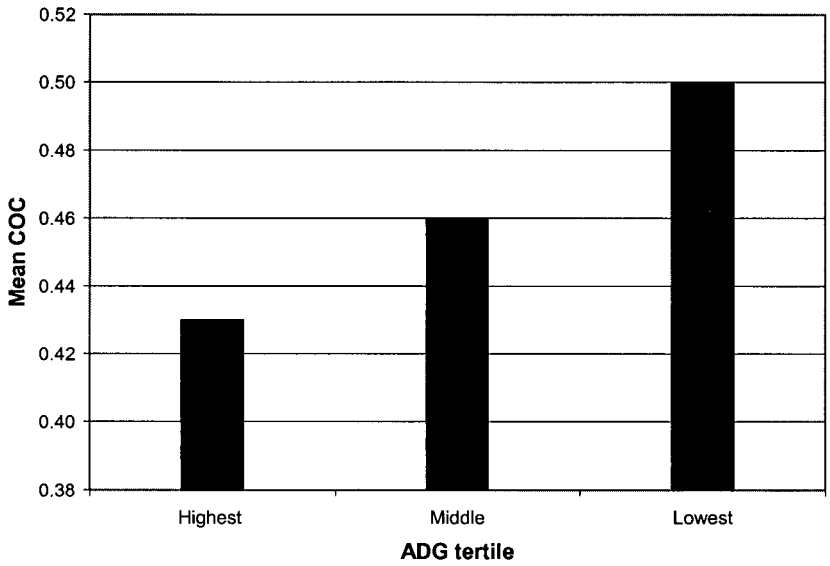
* N=4418 study participants

Ambulatory diagnostic groups are not mutually exclusive and therefore do not add up to 100%.

A significant relationship was found between ADG and COC. As ADG tertile increased, mean COC decreased (see Figure 10). That is to say children with higher illness

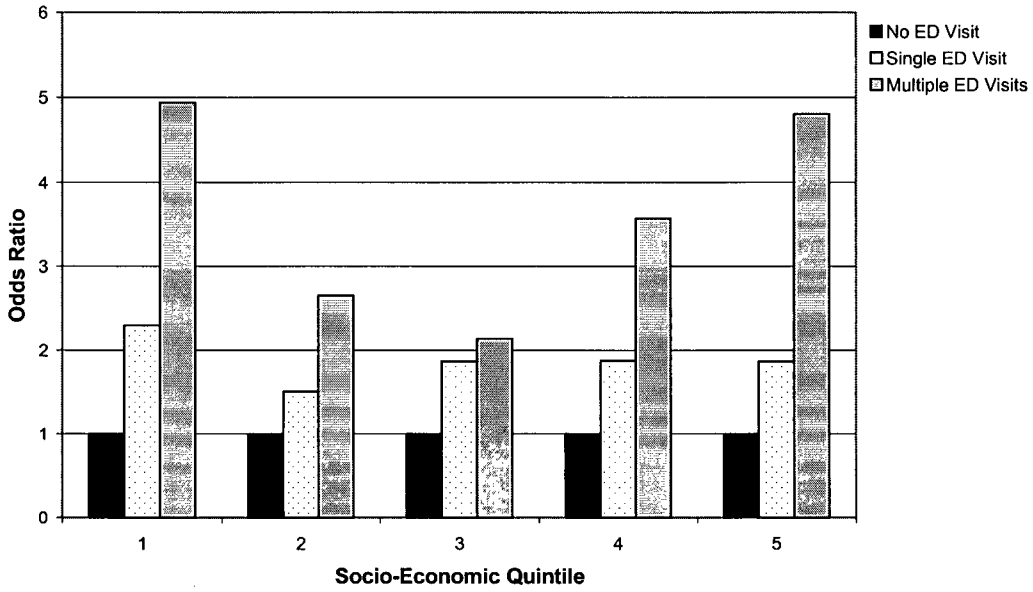
burden had significantly lower COC. The highest ADG group had an average COC of 0.43, middle had 0.46, and the lowest ADG group had a mean COC of 0.50 ($p<0.001$).

Figure 10. Relationship between ADG and COC.



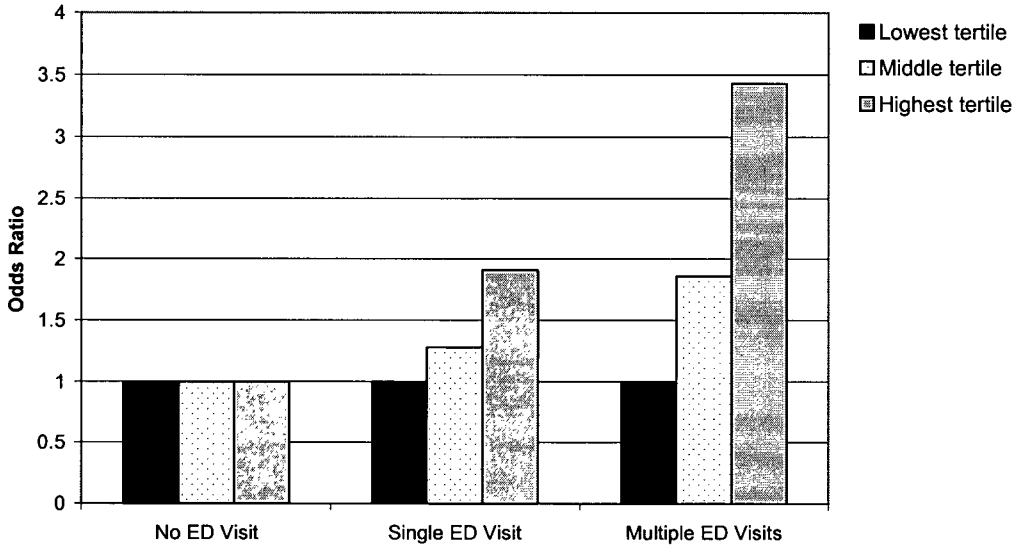
ADG tertiles were analyzed for correlation with other covariates in the model including COC, SEQ, sex, age, and specialist use. As expected, higher ADG tertile (higher illness burden) was associated with increased psychiatrist visits ($R^2=0.17$), pediatrician visits ($R^2=0.26$), and was most strongly associated with GP visits ($R^2=0.48$). While ADG tertiles were not significantly correlated with SEQ, differences between SEQ and weighted ADG status were found. Taken alone, ADG tertile had the greatest effect on ED use in children in the highest and lowest SEQ (see Figure 11).

Figure 11. Relationship between socio-economic quintile and ED visits for those in the highest ADG tertile.



When weighted ADG tertiles were analyzed independently, children in the highest and middle tertiles were at greater risk of both single and multiple ED visits compared with children in the lowest tertile (See Figure 12). Those in the middle tertile were 28% more likely to make a single ED visit (OR, 1.28; 95% CI, 1.03-1.58) and almost 2 times more likely to make multiple visits (OR, 1.91; 95% CI, 1.43-2.54) compared to those in the lowest tertile. The results were even more significant for those in the highest tertile compared with the lowest. Children in the highest ADG tertile were 86% more likely to make a single ED visit (OR, 1.86; 95% CI, 1.52-2.29) and 3.4 times more likely to make multiple ED visits (OR, 3.43; 95% CI, 2.62-4.50). ADGs alone, however, accounted for only 3% of the variation in ED use.

Figure 12. Effect of ADG tertile on risk of single and multiple emergency department (ED) visits in the following year.



When ADG tertiles were analyzed in relation to ED use in the same year rather than following year, the relationship is more striking. ADG tertiles alone accounted for 14% of the variation in ED use, and were highly significant in predicting single and multiple ED visits. Compared with children in the lowest ADG tertile, those in the highest tertile were 4.7 times (OR, 4.66; 95% CI, 3.75-5.78) more likely to make a single ED visit and more than 16 times (OR, 16.35; 95% CI, 10.98-24.35) more likely to make multiple ED visits.

Regression Model

In univariate analysis, continuity was associated with a decreased likelihood of making both a single ED visit and multiple ED visits (see Table 6).

Table 6. Parameter estimates of COC tertiles effect on ED use.

Risk of multiple ED visits vs. 0 visits							95% CI for Exp(B)	
	B	Std. Error	Wald	df	Sig.	Exp(B)	Lower	Upper
Intercept	-1.934	0.090	457.291	1	0.000			
COC tertiles								
Highest	-0.257	0.128	4.058	1	0.044	0.773	0.602	0.993
Middle	0.003	0.124	0.001	1	0.981	1.003	0.787	1.278
Lowest	0.000	.	.	0	.	.	.	.
Risk of single ED visit vs. 0 visits							95% CI for Exp(B)	
	B	Std. Error	Wald	df	Sig.	Exp(B)	Lower	Upper
Intercept	-1.459	0.074	388.693	1	0.000			
COC tertiles								
Highest	-0.184	0.103	3.203	1	0.074	0.832	0.681	1.018
Middle	-0.139	0.104	1.790	1	0.181	0.870	0.709	1.067
Lowest	0.000	.	.	0	.	.	.	.

a This parameter is set to zero because it is redundant.

Continuity as a single covariate, although somewhat significant in predicting ED visits, explained less than 1% of the variation in ED use and increased to over 3% on addition of GP office visits. The addition of ADG tertiles to the model increased the pseudo R-square to almost 5% and did not significantly change the effect of COC on risk of multiple ED visits. The addition of the categorical age groups increased pseudo R-square to just over 5% and decreased somewhat the significance of the contribution of COC to the overall model. The last three covariates entered into the model were pediatrician visits, psychiatrist visits, and socio-economic quintile, none of which significantly changed the effect of COC on either single or multiple ED visits.

The final pseudo R-square is 6.4% with those in the highest COC tertile having the lowest risk of multiple ED visits (OR, 0.81, 95% CI, 0.62-1.05). GP visits are positively associated with both a single ED visit (OR, 1.02; 95%CI, 1.01-1.03) and multiple ED visits

(OR, 1.04; 95%CI, 1.03-1.05). Pediatrician visits are positively associated with multiple ED visits (OR, 1.04; 95%CI, 1.02-1.07), while psychiatrist visits are positively associated with a single ED visit (OR, 1.01; 95%CI, 1.00-1.02). Compared to children in the youngest age group (4-6), those in the oldest age groups are more likely to have multiple ED visits; age 13-16 (OR, 2.16; 95%CI, 1.57-2.97) and age 10-12 (OR, 1.59; 95%CI, 1.17-2.16). The final stepwise regression model is presented in Table 7. Table 8 gives the parameter estimates for all variables in the model.

Table 7. Predictors of ED use during follow-up year.*

Variable	Likelihood of a Single ED Visit vs. No ED Visit, OR (95% CI)	Likelihood of Multiple ED Visits vs. No ED Visit, OR (95% CI)
Age, years		
7-9	0.98 (0.78-1.24)	1.19 (0.88-1.63)
10-12	1.23 (0.97-1.56)	1.59 (1.17-2.16)
13-16	1.02 (0.78-1.34)	2.16 (1.57-2.97)
Socio-economic quintile		
1	0.91 (0.68-1.22)	1.03 (0.75-1.43)
2	0.92 (0.70-1.22)	0.79 (0.57-1.10)
3	1.26 (0.97-1.64)	0.88 (0.64-1.22)
4	1.10 (0.85-1.43)	0.75 (0.54-1.03)
No. of office visits, 1995-1996	1.02 (1.01-1.03)	1.04 (1.03-1.05)
Total number of pediatrician visits	1.00 (0.97-1.02)	1.04 (1.02-1.07)
Total number of psychiatrist visits	1.01 (1.00-1.02)	1.01 (0.99-1.02)
Continuity tertiles		
Highest	0.85 (0.70-1.05)	0.81 (0.62-1.05)
Middle	0.85 (0.69-1.04)	0.97 (0.75-1.24)
ADG tertiles		
Highest	1.59 (1.26-2.00)	2.19 (1.62-2.96)
Middle	1.22 (0.99-1.52)	1.74 (1.30-2.33)

* ED indicates emergency department; OR, adjusted odds ratio; CI, confidence interval; COC, continuity of care index.

Reference groups for individual variables are as follows: lowest tertile for COC, 0 to 4 years for age, lowest tertile for ambulatory diagnostic groups (ADGs) quintile 5 for socio-economic quintile.

Table 8. Final model parameter estimates.

Risk of multiple ED visits vs. 0 visits	B	Std. Error	Wald	df	Sig.	Exp(B)	95% CI for Exp(B) Lower	Upper
Intercept	-3.289	0.221	220.549	1	0.000			
Age groups								
13-16	0.768	0.163	22.216	1	0.000	2.156	1.566	2.967
10-12	0.464	0.157	8.706	1	0.003	1.590	1.169	2.164
7-9	0.178	0.157	1.274	1	0.259	1.194	0.877	1.625
4-6	0.000	.	.	0	.	.	.	.
Socio-economic quintiles								
1	0.033	0.164	0.040	1	0.842	1.033	0.749	1.427
2	-0.232	0.168	1.906	1	0.167	0.793	0.570	1.102
3	-0.123	0.163	0.567	1	0.451	0.884	0.642	1.218
4	-0.293	0.165	3.160	1	0.075	0.746	0.541	1.030
5	0.000	.	.	0	.	.	.	.
Number of GP visits	0.039	0.006	37.482	1	0.000	1.040	1.027	1.053
Number of pediatrician visits	0.042	0.013	9.971	1	0.002	1.043	1.016	1.071
Number of psychiatrist visits	0.006	0.006	0.854	1	0.355	1.006	0.994	1.018
COC tertiles								
Highest	-0.212	0.132	2.585	1	0.108	0.809	0.624	1.048
Middle	-0.032	0.128	0.063	1	0.802	0.968	0.754	1.244
Lowest	0.000	.	.	0	.	.	.	.
ADG tertiles								
Highest	0.783	0.154	25.931	1	0.000	2.187	1.618	2.956
Middle	0.552	0.150	13.627	1	0.000	1.737	1.296	2.329
Lowest	0.000	.	.	0	.	.	.	.

Risk of single ED visit vs. 0 visits	B	Std. Error	Wald	df	Sig.	Exp(B)	95% CI for Exp(B) Lower	Upper
Intercept	-2.044	0.173	139.316	1	0.000			
Age groups								
13-16	0.021	0.139	0.024	1	0.878	1.022	0.779	1.340
10-12	0.207	0.121	2.937	1	0.087	1.230	0.971	1.558
7-9	-0.017	0.119	0.020	1	0.889	0.983	0.779	1.242
4-6	0.000	.	.	0	.	.	.	.
Socio-economic quintiles								
1	-0.092	0.147	0.394	1	0.530	0.912	0.683	1.217
2	-0.082	0.142	0.334	1	0.564	0.921	0.697	1.218
3	0.232	0.132	3.073	1	0.080	1.261	0.973	1.635
4	0.098	0.133	0.547	1	0.460	1.103	0.851	1.430
5	0.000	.	.	0	.	.	.	.
Number of GP visits	0.019	0.006	9.528	1	0.002	1.019	1.007	1.031
Number of pediatrician visits	-0.005	0.014	0.137	1	0.711	0.995	0.968	1.022
Number of psychiatrist visits	0.011	0.005	4.379	1	0.036	1.011	1.001	1.022
COC tertiles								
Highest	-0.158	0.104	2.280	1	0.131	0.854	0.696	1.048
Middle	-0.167	0.106	2.473	1	0.116	0.846	0.687	1.042
Lowest	0.000	.	.	0	.	.	.	.
ADG tertiles								
Highest	0.460	0.118	15.346	1	0.000	1.585	1.259	1.995
Middle	0.202	0.110	3.357	1	0.067	1.224	0.986	1.520
Lowest	0.000	.	.	0	.	.	.	.

a This parameter is set to zero because it is redundant.

Chapter 6

DISCUSSION

Overview

The following section describes the major findings of the study. First, each covariate in the final model will be described in detail, including its relationship with other covariates and the outcome. These seven covariates are: age, socio-economic quintile, GP visits, pediatrician visits, psychiatrist visits, continuity of care with a primary care provider (COC), and ambulatory diagnostic groups (ADGs). A discussion of the variation in ED use explained by the final model will then be given. Next, the internal and external validity of the study will be explored, followed by an evaluation of the evidence presented. Finally, a possible explanation for the findings will be proposed and the clinical significance of the results will be discussed.

Age Effects

The effect of age on ED use was analyzed by age group and was found to be significantly related to outcome. Although there was no significant age effect for single ED visits, older children were more likely than younger children to make multiple visits. Compared to those aged 4-6, those aged 13-16 were 2.2 times more likely to make multiple visits and those aged 10-12 were 1.6 times more likely to make multiple ED visits. No effect was found in the 7-9 age group.

Socio-economic Status

While socio-economic quintile (SEQ) was not significantly associated with ED visits, it was forced into the final model to control for the known effects of socio-economic status on both health and healthcare utilization. It has been shown that individuals who have poor socio-economic status (SES) have poorer health status, spend more days in the hospital, and have more contact with physicians. (109)

Although SEQ was not statistically significant in the final model, it was associated with the outcome as well as two covariates in the final model: GP visits and psychiatrist visits. Mean SEQ for those with 0, 1, and 2-4 ED visits remained constant at 3.1 while those with five or more ED visits had considerably lower mean SEQ (2.6) (see Figure 7, page 50). The relationship was not statistically significant, most likely due to the low number of children with five or more ED visits (50, or 1% of the sample), but nonetheless shows the relationship between SEQ and multiple ED visits.

SEQ was also significantly associated with number of physician visits. Figure 6, page 49 shows that as SEQ increases, GP visits drop while the number of psychiatrist visits rise. This trend is consistent with that found in other studies of the effect of socio-economic status on healthcare utilization. (109-111) Roos and colleagues found that rates of illness as well as rates of GP visits in Winnipeg are highest in the lower SEQs. Our findings are consistent with these results, and show that primary care is equitably distributed among those in greatest need. Of importance, however, is our finding that rates of psychiatrist use do not differ among those in SEQ 1-SEQ 4, but are considerably higher in the highest SEQ. While GP services may be equitably distributed, psychiatrist use certainly is not.

One final relationship observed between SEQ and ED visits is the effect of ADG on outcome for each SEQ independently. Figure 11, page 55 shows that the likelihood of making a single visit or multiple ED visits is greatest for the highest ADG tertile compared with the lowest ADG tertile for all 5 quintiles (except SEQ 2 in the case of a single ED visit). The effect of ADG on multiple ED visits, however, is most pronounced for those in the lowest and highest SEQs. This can be interpreted to mean that the poorest and wealthiest children in this sample are more likely to visit the ED as illness burden increases. In addition, children in the lowest SEQ have more GP visits on average to a larger number of different GPs, and slightly lower COC than those in SEQ 5 (0.43 vs. 0.46, not significant). Taken together, it would appear that children with the lowest SES have the highest illness burden and lower access to specialist services, which is consistent with other studies of SES and health status and healthcare utilization. (109-111)

Primary Care Physician Office Visits

The number of GP office visits made has been used in the past as a proxy for disease severity and has been found to be a negative confounder of COC on ED visits. That is, Gill and colleagues found that increasing GP office visits tends to decrease COC score and increase the number of ED visits. (4, 33) Although we controlled for disease severity using ADGs in this study, office visits were included as a positive confounder of the outcome. Office visits were significantly associated with both single and multiple ED visits. Each additional office visit made during the two-year COC computation period increased the likelihood of making a single ED visit by 2% and of making multiple ED visits by 4%.

Specialist Use

Specialist visits also had an effect on outcome and therefore were included in the final model. While pediatrician use was not associated with a single ED visit, it had the same effect as GP use on likelihood of multiple ED visits: each additional pediatrician visit resulted in a 4% increase in likelihood of making multiple ED visits. In contrast, psychiatrist use was not associated with making multiple visits, but was slightly associated with making a single ED visit. For each additional psychiatrist visit, children had a 1% increased likelihood of making a single ED visit.

Continuity of Care (COC)

While these results should be interpreted with caution, there does appear to be a weak relationship between continuity of primary care physician and emergency department (ED) visits in BC children with a diagnosis of ADHD. When continuity was assessed independently, children in the highest COC tertile had a decreased likelihood of making multiple ED visits compared with those in the lowest tertile (OR, 0.77, 95% CI, 0.60-0.99). The same was true for single ED visits, though the relationship was less significant (OR, 0.83; 95% CI, 0.68-1.02). The significance of COC decreased slightly as additional covariates were added to the model, although there was still some effect of COC on risk of single and multiple ED visits in the final model.

Ambulatory Diagnostic Groups (ADGs)

Disease severity, as determined by ADGs, had by far the greatest effect on ED use. Those in the highest ADG tertile (greatest disease burden) were 1.6 times more likely to make a single ED visit and 2.2 times more likely to make multiple ED visits compared with

those in the lowest tertile. Those in the middle tertile were somewhat more likely to make a single ED visit (OR, 1.2; 95% CI, 0.99-1.52), and were significantly more likely to make multiple ED visits compared with those in the lowest tertile (OR, 1.6; 95% CI, 1.26-2.00).

Children with higher ED utilization also have higher use of GPs, pediatricians and psychiatrists (see Figure 9, page 52). There are two possible explanations for this finding. The first, and most likely, explanation is that these children are simply sicker. They have a higher illness burden and therefore have more physician visits overall. The other possibility is one potential confounder not controlled for in this study: parental influence. It is well known that some adults are proportionally higher users of the healthcare system. This increased use of services by some parents will likely affect the care-seeking behaviour of the child since the parent typically makes the final decision of where care is sought.

It becomes apparent that the reason for increased service use is due to increased illness burden when a comparison is made of children across ADG groups. Compared with children in the lowest ADG tertile, those in the highest tertile made the most GP, pediatrician, and psychiatrist visits, saw the largest number of different providers, and made more ED visits. Since these weighted ADGs measure the variety and severity of different morbidity types, they are a direct measure of illness burden and are linked to healthcare service use.

ADG tertile was also found to be associated with COC. Figure 10, page 54 shows that those children in the highest ADG tertile, with the greatest illness burden, also have the lowest continuity scores. This is of interest since it could be argued that continuity with a

primary care provider increases in importance as illness burden increases. With the cross-sectional nature of this study, however, it is impossible to know if low continuity is a cause of increased illness level or is a result of it. It seems likely that as the number of diagnoses received by an individual increases, the number of physicians consulted will also increase. Since the number of different primary care physicians seen has the greatest effect on COC score, it seems logical that children with higher illness burden will have lower continuity scores, although this is not ideal given that higher continuity of primary care seems to be associated with more positive outcomes.

Variation in ED Use

Overall, our final model was able to explain only 6.4% of the variation in ED use among our population. While this value seems low, Newhouse and colleagues consider that the ADG system is able to predict no more than 20% to 25% of the variation in future adult hospital expenditures (which can be used as a proxy for admissions). (112) Considering the various unpredictable factors associated with future ED use in children, we would not have expected the explanatory power of our model to be much higher than 6%. There remains concern, however, with a low pseudo-R^2 value that there is a great deal of variation as yet unaccounted for. One possibility is that there may exist a confounder that would make the effect of COC on ED use insignificant when it is added to the model.

Before discussing possible explanations for these findings, it is necessary to assess the validity of the study by first addressing the external validity, or generalizability of the results. Next, the internal validity of the study must be estimated by assessing the influence of factors

such as chance, systematic error (bias), and unmeasured or uncontrolled confounding factors. (2)

External Validity

The present study relied on an administrative medical data file for study participant selection and compilation of physician visit histories. There are problems with using this type of data for research, although attempts have been made to overcome these difficulties in British Columbia. The probabilistic linkage of administrative data sources in the province has been shown to be accurate and effective for use in health services research. (103) Nevertheless, as discussed in Chapter 3, administrative prevalence does not always accurately reflect the epidemiologic prevalence. The concern is whether the data in the database is representative of the general population, in this case, the population of BC children with a psychological diagnosis. The amount of error can be estimated by comparing the administrative prevalence to the expected prevalence based on epidemiologic studies.

In any one year of data in the BCLHD, only 1% to 1.5% of Lower Mainland children had a recorded diagnosis of ADHD, based on BC Statistics population estimates. (6) For 1995 and 1996 combined, only 1.7% of BC kids appeared in the database with at least one diagnosis. This is lower than the DSM-IV prevalence of 3% to 5%, but is expected to be lower since we know not all children with a disorder are properly diagnosed. It is also consistent with Taylor and colleagues assessed administrative underestimation of the true prevalence of ADHD of 1-2/100. (72) If, however, all three ICD-9 diagnoses are combined,

between 2.4% and 3.4% of lower mainland children have a recorded diagnosis of hyperkinesis, conduct disorder, or emotional disturbance in any one year, and this number is 4.0% for 1995 and 1996 combined. Therefore, while the study aimed to look at all children with ADHD, the results can only be generalized to those with two or more recorded ADHD, conduct disorder, or emotional disturbance diagnoses (defined here as our working definition of ADHD).

In order to answer the question whether relationships between COC and ED use hold in the general child population of BC, future studies should add a control group to compare these children to other children in the province who do not have any of the diagnoses of interest. This, however, was not the intent of the current study. We were interested only in commenting on the relationship between COC and ED use in this subset of the BC child and adolescent population.

Internal Validity

Threats to the internal validity of a study can be described in terms of the effect of chance, the introduction of systematic error, or uncontrolled or immeasurable confounding factors described in detail below.

Chance

In order to draw inferences from our results, we must ensure that they are not the result of chance, or random variation in our sample. One of the major determinants of the degree

to which chance will affect a study's findings is sample size. The larger the sample size, the less variability and the more reliable will be the results.

The degree to which chance variability may account for the observed results can be quantified by performing tests of statistical significance. The Wilcoxan rank sum tests revealed statistically significant differences among particular groups in the study, and the seven covariates in the final logistic regression model were retained because they significantly contributed to the variability in the sample. COC was not significant at the $p<0.05$ level (typically chosen as the cut-off for statistical significance), which means that there is greater than a 5%, or 1 in 20 chance of observing that result due to chance alone. The p-values were near 0.1, however, meaning that there is a trend toward significance (not significant at $p<0.05$, but nearing significance with $p\sim0.1$). The interpretation of p-values can be problematic in that they are a reflection of both magnitude of the difference between groups and the sample size. With a large sample size as in this study, even a small difference or small contribution to the final model may be statistically significant.

We have largely accounted for the possibility that our results are due to chance by our large sample size and setting the p-value at 0.05. We will discuss in a later section, however, the interpretation of these results, specifically with respect to the difference between statistical significance and clinical significance.

Bias

There is always the possibility of systematic error, or bias, introduced through the use of administrative data. It has been proposed that administrative records, like any other data

collection mechanism, have sources of both random and systematic error. (113) Random error, if it is truly random, can be expected to cancel itself out, with no resulting effect on the overall utility of the data. It is the systematic error that is of interest, since this type of error leads to biases in the data. Threats to the validity in large healthcare databases include: sampling error, missing data, and measurement error.

Sampling and measurement error are inherent in all large databases. Sampling error arises from the way in which cases are selected for the database, where measurement error stems from problems with the operational definition of concepts. (114) In the present study, sampling error should not have resulted in systematic bias. Our sample selection criteria were explicitly stated and all children with at least one of the diagnoses of interest over a four-year period were to be included. This type of error would only have resulted in bias if one of the diagnoses of interest was systematically coded incorrectly or incompletely, or if errors had occurred during data extraction. This is unlikely, however, and is not considered a threat to the internal validity of the study.

Missing ED visit data is another potential source of bias. Of the three main hospitals in Vancouver, two out of three do not distinguish ED visits from other ambulatory visits. This would be a problem if studying ED visits in the adult population of Vancouver, however, approximately 95% of all pediatric ED visits by children in Vancouver occur at BC Children's Hospital, where ED visits are distinguished as such. The remaining 5% of pediatric ED visits are typically trauma patients, brought in with their parents (personal communication, Dr. Roy Purssell, Medical Director Emergency Administration, Vancouver Hospital, April 12, 2001) and would not be expected to affect the results of this study.

Measurement error is one potential source of bias with big implications for the validity of these study results. This type of error can occur because of mistakes in conceptualization or from problems in the data collection process. (115) Measurement error is particularly salient with this study population and the diagnosis of interest. The diagnosis of psychological illness relies heavily on the judgment of the physician and the current condition of the patient. In this study, we captured all children with at least one diagnosis of hyperkinesis, conduct disorder, and/or emotional disturbance. Over the two years 1995-1996, 15,328 children received at least one of the above diagnoses. Of these, almost half (48.6% or 7442) received a diagnosis of conduct disorder, almost one third (32.1% or 4927) were diagnosed with emotional disturbance, and 41.9%, or 6420 were diagnosed with ADHD.

Of these children, during the same two years, 2868 (18.7%) were diagnosed with two different conditions and 297 (1.9%) were diagnosed with all three conditions. In light of this fact, one key question must be asked: do these children truly have two or sometimes three comorbid conditions, or are the child's symptoms being recognized and reported differently by different physicians? While both of these possibilities are realistic, the latter will have the greater effect on the validity of the diagnostic codes in the database. While the ICD-9 codes in the BCLHD are generally thought to be reliable (116), the validity of the diagnostic codes in the database was further supported by the risk of ED visits by different ADGs in this study. For each ADG expected to result in higher rates of ED use (e.g. asthma, unstable chronic conditions, and injuries), higher unadjusted odds ratios for both single and multiple ED visits were observed. The opposite was true for ADGs not likely to result in ED visits

(e.g. allergies, stable chronic conditions, and dermatologic conditions). This supports the validity of ICD-9 codes in the database in general, and the ADG grouping mechanism.

Confounding

In all research studies, the first goal in statistical modeling is to control for all known or suspected confounders. In the present study, we controlled for several known, measurable confounders. Case-mix was controlled for using ADGs, which were found to be linked with physician visit rates and COC. Office visits were also included as a proxy for severity of illness, considering that children with higher illness burden will be visiting primary care physicians more often. (4) Other covariates shown to have an effect on either predictor or outcome were age, socio-economic quintile, and use of specialists.

The remaining potential threat to internal validity of the study is uncontrolled confounders including parental influence, accessibility issues, and provider factors. It is unknown whether these factors may influence the dependent or independent variables and what direction the effect may take. It was impossible to control for parental influence or to know its effect on continuity or ED use in the study participants; however, SES could have been considered a proxy for this type of social/demographic factor. Some parents may be more likely to take their child to emergency, while others might prefer to consult with a primary care physician before attending the ED.

The same can be said for provider factors that were not controlled for in this study. We don't know anything about physicians' training and experience, personal beliefs or values,

consultation style, or practice arrangements; all of which can affect both continuity and ED use in our study participants.

An attempt was made to control for geographic and accessibility factors by including only children living in urban and suburban areas of BC. In this way, we can assume that all the study participants have equal access to primary care physicians and emergency services. Unfortunately, this most likely is not true and sources of bias could have been introduced. First, a small percentage (3.5%) of the final cohort resided in smaller towns outside the urban centres of the lower mainland and Victoria. These children may have been referred to a physician or care centre located in one of the Health Regions included in this study. Their access to services would be expected to differ from children living in urban centres, given the supply of physicians in larger cities compared with rural towns, and factors related to infrastructure like public transportation and distance to the GP office or ED.

Evaluating the Evidence

Bradford-Hill's (117) now classic list of criteria has been used in establishing the existence of a causal relationship. The specific criteria applicable to this study include strength of effect, temporality, consistency across studies, coherence with existing data, and clinical plausibility. Although the observational nature of our study precludes definitive conclusions about causal relationships, there are several key features of our findings that support an association between continuity of care with a primary care provider and ED utilization.

The first is strength of effect. There is a weak protective effect, with a trend toward statistical significance, of continuity on a single visit and multiple ED visits when all other confounders are controlled for. Children in the highest COC tertile have a 20% lower likelihood of making multiple ED visits and 15% lower likelihood of making a single ED visit. The same effect (15%) is seen in the middle COC tertile with the risk of making a single ED visit compared to those in the lowest tertile.

The move from COC tertile 1 (COC scores 0.0-0.27) to tertile 2 (0.28-0.53) is easy to achieve. Table 9 shows that, for a child with 12 GP visits, increasing the concentration of visits to Practitioners 3 and 4 by just one visit each (highlighted columns), changes the COC classification from tertile 1 (COC=0.23) to tertile 2 (COC=0.30), with a resulting 15% reduction in the risk of a single ED visit.

Table 9. Example of different visit patterns producing different COC scores.

	Number of Visits					
Practitioner	COC=0.18	COC=0.20	COC=0.21	COC=0.23	COC=0.30	COC=0.33
P1*	3	2	2	1	1	1
P2	3	4	2	3	1	1
P3	3	3	4	4	5	4
P4	3	3	4	4	5	6

* P1 = Practitioner #1, P2 = Practitioner #2, etc.; COC = Continuity of Care index

Second, we have ensured that the appropriate temporal relationship exists between the exposure and outcome by measuring COC in the two years preceding the outcome. It could be argued that ED use is more likely to be affected by COC in the same year, and that the effects of continuity on outcome may diminish over time. It could also be argued that those

with high continuity in one year are likely to have high continuity in the following year, though this may not always be true. We still found a negative association between continuity measured during the two years prior to the ED visitation; therefore, we can hypothesize that this relationship would only be stronger if measured concurrently with ED use.

Third, our findings are consistent with those of other studies conducted in different settings and with different patient populations. (4, 5, 8, 118, 119) Using similar methodology, Gill and colleagues found similar odds ratios for both single and multiple ED visits during the same year that COC was computed using a different continuity measure, the Modified Continuity Index. (4, 46) Their findings, however, were of greater statistical significance than the results in the present study. One possible explanation for the lower statistical significance of our results could be sample size. Our sample of 4418 children included only 985 (15.5%) with exactly one ED visit, in contrast to their 2869, or 25% of their sample, with a single ED visit. Our sample size may not have been large enough to afford the power to detect a difference in effect of continuity on a single ED visit. More importantly, they measured ED use in the same year as COC and ADG. We would expect a stronger relationship between predictors and outcome when they are measured in the concurrent year.

Finally, our findings are clinically plausible. Having consistent contact with a provider may lead to decreased ED use in a number of ways, discussed below as a possible explanation for our findings.

Possible Explanation

The inverse relationship between COC and ED use makes intuitive sense. When patients concentrate care with a single provider, this physician is more likely to accumulate knowledge about the patient and his/her medical conditions. This knowledge extends beyond simply knowing the diagnoses and medications, to include a finer understanding of each medical problem and how multiple problems interact and change over time. This is especially important in children with ADHD who are more likely to have comorbid conditions. Each additional diagnosis will change how the others affect the child's overall medical condition and will impact the course of illness and treatment over time. Once a physician has accumulated this knowledge and has an 'investment' in the care of the patient, the physician is better able to interpret the patient's symptoms and make a judgment about whether urgent care is needed or can wait for an office visit. Another explanation of the inverse link between continuity of primary care and emergency department use is that some children may use the ED as their preferred primary care source, with the result of reducing COC and increasing ED visits.

Continuity of care can also affect the patient's care seeking behaviour. When a child has a continuous relationship with a physician, the child and parent are likely to develop a sense of trust in the physician's knowledge and medical judgment. Therefore, it is possible that when the urgency of a condition is in question, the patient (or patient's parent in this case) with high continuity is more likely to seek the opinion of their physician before going to the ED.

At a basic clinical level, children with ADHD who have a continuous relationship with a GP may be more likely to receive more timely, appropriate care over the course of their illness. One example is improved medication management. For two children with identical illness courses in need of a change in medication, we would argue that the child with a continuous provider would receive better care. The physician will more easily recognize the patient's need, prescribe the change in medication, and potentially avert a serious crisis that may not be preventable in the child without a regular provider.

Clinical Significance

We have shown that increased continuity with a GP leads to decreased risk for ED visits, but we have yet to address whether this decrease is clinically significant. Clinical significance refers to the practical or applied value of the effect of the intervention. That is, is there some real, noticeable difference in the lives of patients? (120) The assessment of clinical significance represents an important advance in the evaluation of intervention effects, including treatment, but now extending to prevention, education, and rehabilitation as well. In this case, we consider the clinical significance of increasing continuity with a primary care provider as it relates to the prevention of multiple ED visits.

In the present study of BC children with a diagnosis of ADHD, conduct disorder, and emotional disturbance, 685 out of 4418 (15.5% or 1 in 6) made a single ED visit in the follow-up year. Our logistic regression model showed that those children in the middle COC tertile had a 15% reduced risk of making a single ED visit compared with those in the lowest

tertile. We previously described an example whereby two GP visits made to a different provider can change COC classification from the lowest tertile to the middle tertile (Table 9). In the best case scenario, if all the children in the lowest COC tertile could move into the middle tertile, the result would be 103 ED visits prevented in this population of children each year.

Aside from the quantitative example above, if it is agreed upon that the ED is not the ideal place for children to seek services, then it could be argued that any reduction in ED use would be desirable. If increasing continuity with a primary care physician, itself believed to be beneficial, can have any effect on ED use, it seems logical that continuity with a primary care physician should be encouraged. We will discuss the implications of these findings, and future research directions in the following chapter.

Chapter 7

CONCLUSION

Overview

The final chapter provides a summary of the key findings of the study and then discusses the policy and practice implications of these findings. The chapter concludes with a brief description of future research directives in the area of primary care provider continuity.

Summary

The main conclusion of this study is that a weak association exists between increasing continuity of care with a primary care physician (COC) with decreasing risk in a subsequent year of single and multiple emergency department (ED) visits in children with a recorded diagnosis of ADHD, conduct disorder, or emotional disturbance in British Columbia.

There were two other significant findings. One is that while primary care services seem to be equitably distributed by illness burden across socio-economic status (SES), with lower SES children having higher illness burden and higher utilization of primary care services, specialist care does not appear to be as equitably distributed for this population. Children with lower SES tend to be sicker; however, children in the highest socio-economic quintile made nearly 1.5 times the number of psychiatrist visits of children in the remaining quintiles.

The second key finding is that illness burden, as determined by ambulatory diagnostic groups (ADGs), was negatively associated with COC. Those children with the highest illness burden had significantly lower continuity with a primary care physician than those in the lower illness groups.

Policy Implications

The main policy implication of this study is that continuity of care with a primary care provider should be encouraged for children with ADHD. This study is one of many that have shown a positive outcome resulting from increased continuity with a primary care provider.

These findings can be used when designing healthcare services for children diagnosed with ADHD. In an attempt to reduce unnecessary ED visits and provide other potential benefits, continuity with a primary care provider, as measured in this study, should be encouraged for these children. One example of a healthcare structure that encourages this type of continuity is the managed care organizations (MCOs) in the United States. Patients are permitted to see only a limited number of physicians if the services are to be covered by the insurance plan (patients can see out-of-plan providers, but are charged more for these visits). COC, as it was measured here, would certainly increase within the population in this healthcare system. Two variables determine COC: total number of primary care visits and number of visits to each different provider. Decreasing the number of different GPs visited had the greatest effect on increasing COC in its mathematical construction. If this is true,

and our study results are correct, then simply encouraging patients to visit the same few GPs should lead to increased COC and thus, decreased ED visitation. We know, however, that it is not this simple. Seeing the same provider does not ensure the positive health outcomes that have come to be associated with primary care provider continuity. It is more likely that having a better relationship with providers or having a physician that 'knows you better' is what contributes to the positive outcomes. Seeing the same physician repeatedly may promote this type of relationship, but will not ensure it. Other strategies that may more effectively contribute to the positive outcomes observed include better communication skills by providers and better record-keeping systems.

In Canada, the Primary Care Reform Project is a series of pilot projects designed to restructure primary care with his type of continuity likely resulting as a by-product. (121) The new model of care will feature (and in many cases already does) physicians grouping themselves into networks within different communities around the provinces to serve a defined patient population. Being part of the network does not require that the physicians locate in the same offices, or buildings. The new arrangement, however, will encourage providers to make greater use of technology to improve information sharing regarding patient care within the network. Patients enrol in the system with a physician in an attempt to create a system of accountability, both physician to patient and patient to physician. This system, just like U.S. MCOs, should result in higher primary care COC scores of the participants, improved relationships between patients and providers, and again lead to a reduction in ED use.

It is difficult to determine, however, if the COC measured in this study is just a proxy for some underlying, more important elements of an ongoing relationship with a primary care provider. Two elements that may result from seeing the same physician that are not as easily measured but possibly have a greater effect on outcome are 1) improved patient/physician relationship and 2) accumulated knowledge about the patient and his/her conditions. It can be argued therefore, that simply seeing the same physician without the establishment of a relationship or knowledge accumulation and transfer will not result in the same benefits. This fact must be kept in mind in designing a healthcare system. Additional measures must be taken to go beyond patients simply seeing the same primary care physician to encourage a relationship to form between patient and physician and knowledge to be accumulated and passed on through time.

Practice Implications

Given the positive benefits of continuity with a primary care provider, practitioners should be cognizant of these benefits and should encourage this type of continuity with their patients. Practitioners should actively track their patients, and ensure that their patients receive appropriate follow-up and timely visits. Once the medical community is made aware of the benefits of primary care provider continuity, practitioners can begin to make the changes necessary to encourage the formation and maintenance of a continuous relationship with their patients.

Future Research Directions

Three areas for future research into continuity of primary care provider include the concept of COC, tools with which to measure COC, and methods for encouraging COC in practice.

Many groups have conceptualized continuity of care in different ways over the years. The first area for future research is into the concept of COC and determination of a universally adopted working definition of the concept. Once researchers use the term synonymously, the research produced will be comparable and can be combined to contribute to an expanding, scientifically sound body of literature supporting the benefits of continuity with a primary care provider.

Next, research should focus on developing tools and methods for measuring continuity of care. As with a common definition, universal use of a common set of measurement tools will contribute far more to the literature in support of improved outcomes resulting from continuity of care.

Finally, research is needed into the implementation of continuity of care. Once continuity has been defined and effective measurement tools developed, it will be possible to determine factors that influence continuity of care in practice. From there, strategies for increasing continuity of care can be developed.

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APPENDIX A: STUDIES OF IMPROVED OUTCOME WITH CONTINUITY

Author	Year	Population	Results
			Better problem/needs recognition
Steinwachs & Yaffe (122)	1978	Adult	Patients seeing a physician other than their regular provider were more likely to be judged as not needing care than if they had seen their own practitioner
Becker, et al (118)	1974	Pediatric	Children receiving care from a constant team over time were more likely to have their behaviour problems recognized than those who saw another physician
Gulbrandsen, et al (123)	1997	Adult	Physician's report of how well they knew their patients was correlated with better recognition of psychosocial problems
Kelleher, et al (124)	1997	Pediatric	Physician's recognition of psychosocial problems was associated with that child being the physician's patient rather than their group's patient
			More accurate diagnosis
Nazareth & King (125)	1994	Adult	Physicians made more accurate urinary tract infection diagnosis when they knew their patient better
			Better concordance
Charney, et al (126)	1967	Pediatric	Taking of medication was greater among children whose own physician prescribed it
Becker, et al (127)	1972	Pediatric	Taking of medication to treat otitis media was greater among children whose own physician prescribed it
			Fewer hospitalizations
Christakis, et al (5, 8)	1999 2001	Pediatric	Greater COC with primary care physicians is associated with lower ED utilization
Gill & Mainous (4, 33)	1998	Pediatric Adult	Continuity with a provider is associated with decreased future likelihood of hospitalization and emergency room use
			Lower costs
Flint (128)	1987	Pediatric Adolescent	Longitudinality was associated with a reduction in hospitalizations and overall costs
Weiss & Blustein (25)	1996	Elderly	Long-standing ties with a physician resulted in fewer hospitalizations and lower costs
			Better prevention
Lieu, et al (129)	1994	Pediatric	Patients were more likely to receive timely immunizations when they previously indicated a relationship with the doctor
Christakis, et al (36)	2000	Pediatric	Greater continuity of care was associated with more timely MMR immunization
O'Malley & Forrest (35)	1996	Pediatric	Both continuity of site and continuity with a clinician were associated with increased levels of preventive care
			Increased satisfaction
Wasson, et al (26)	1984	Men over age 55	Continuity of outpatient care resulted in greater patient satisfaction, shorter hospitalizations, and fewer emergent admissions
Shear, et al (24)	1983	Pregnant women	Greater continuity was associated with higher birth weight babies and higher patient satisfaction
Shortell (14)	1976	Adult	Weak correlation between increased patient satisfaction and improved continuity of care

APPENDIX B: CONTINUITY OF CARE MEASURES

For each of the following:

N = no. of visits during the time period; n_i = no. of visits to i[th] provider during the time period;

K = no. of different providers seen in N visits; M = no. of potentially available providers;

S_i = 1, if same provider is seen at sequential visits, and 0=otherwise;

$P_N(k)$ = probability of seeing K different providers in N visits, assuming random assignment among M available providers

Measures of Longitudinality	
Usual Provider Continuity Index (UPC) (130) Reflects the fraction of visits to the provider who was seen the most	$\frac{n_i}{N}$
Continuity of Care Index (COC) (44) Measures the extent to which an individual's total number of visits for a specific time period are with a single physician or group of referred providers	$\frac{\sum_{i=1}^{K} n_i^2 - N}{N(N-1)}$
Likelihood of Continuity (LICON) (45) The probability that the number of providers seen is fewer than would have occurred under random conditions	$1-\sum_{i=1}^{K} P_N(k)$
K Index (131) Reflects the total number of visits by a patient and the number of different providers seen	$1-\sum P_N(k)$
Modified Modified Continuity Index (MMCI) (46) Less sensitive to large number of providers, more meaningful interpretation	$\frac{1-\left(K/[N+0.1]\right)}{1-\left(1/[N+0.1]\right)}$
Measures of Continuity	
Rae Method (FRAC) (39) Concentration of care measure defined as one minus the Herfindahl index value for the distribution of visits by provider	$1-\left(\sum_{i=1}^{K}\left[\frac{n_i}{N}\right]^2\right)$
GINI (14) Commonly used to measure the relative degree of concentration (or inequality) of income in different countries	$2\sum_{i=1}^{M}\left(P_i-\frac{i}{M}\right)\frac{1}{M}$
Standardized Index of Concentration (CON) (14)) Measure of deviation from an even distribution of NOP over the studied population	$\sqrt{\frac{\sum_{i=1}^{M} P_i^2 - 1/M}{1-1/M}}$
Sequential Nature of Provider Continuity (SECON) (45) The fraction of visit pairs at which the same provider is seen	$\frac{\sum_{i=1}^{N-1} S_i}{N-1}$
Likelihood of Sequential Continuity (LISECON) (14) Accounts for the number of available providers	$\sum_{k=0}^{S} P_N(k)$

APPENDIX C: DSM-IV CRITERIA FOR ADHD

Definitions

The essential feature of Attention-Deficit/Hyperactivity Disorder is a persistent pattern of inattention and/or hyperactivity-impulsivity that is more frequent and severe than is typically observed in individuals at a comparable level of development....Some hyperactive-impulsive or inattentive symptoms that cause impairment must have been present before age 7, although many individuals are diagnosed after the symptoms have been present for a number of years....Some impairment from the symptoms must be present in at least two settings (e.g., at home and at school or work)....There must be clear evidence of interference with developmentally appropriate social, academic, or occupational functioning....The disturbance does not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder, and is not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorder, or Personality Disorder)....

Two lists of nine symptoms

(A) Either (1) or (2):

(1) six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Inattention

- (a) often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
- (b) often has difficulty sustaining attention in tasks or play activities
- (c) often does not seem to listen when spoken to directly
- (d) often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behaviour or failure to understand instructions)
- (e) often has difficulty organizing tasks and activities
- (f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
- (g) often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, tools)
- (h) is often distracted by extraneous stimuli
- (i) is often forgetful in daily activities

(2) six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with the developmental level:

Hyperactivity

- (a) often fidgets with hands or feet or squirms in seat
- (b) often leaves seat in classroom or in other situations in which remaining seated is expected
- (c) often runs about or climbs excessively in situations where it is inappropriate (in adolescents or adults, may be limited to subjective feelings of restlessness)
- (d) often has difficulty playing or engaging in leisure activities quietly
- (e) is often "on the go" or often acts as if driven by a motor
- (f) often talks excessively

Impulsivity

- (g) often blurts out answers before questions have been completed
- (h) often has difficulty awaiting turn
- (i) often interrupts or intrudes on others (e.g., butts into conversations or games)

Three subtypes

314.01 Attention-Deficit/Hyperactivity Disorder, Combined Type: if both Criteria A1 and A2 are met for the past 6 months

314.00 Attention-Deficit/Hyperactivity Disorder, Predominantly Inattentive Type: if Criterion A1 is met but Criterion A2 is not met for the past 6 months

314.01 Attention-Deficit/Hyperactivity Disorder, Predominantly Hyperactive-Impulsive Type: if Criterion A2 is met but Criterion A1 is not met for the past 6 months.