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Peak Flow versus Symptom Monitoring to Manage Childhood Asthma

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I am a senior level student in the College of Nursing and a fifth year student at the University of Kentucky. I became a research intern in the spring semester of 2005, working under the guidance of Dr. Patricia V. Burkhart, Associate Professor of Nursing, whose research focuses on children and adolescents with asthma. In my role as a research intern on a clinical trial supported by a grant awarded to Dr. Burkhart from the National Institutes of Health and a Faculty Research Support Grant at the University of Kentucky, I have expanded my understanding of the basic concepts of conducting research and gained experience working with the pediatric and adolescent populations.

Throughout my internship I have participated in and contributed to research team meetings; developed an understanding of the Institutional Review Board process; scheduled and attended monthly video conferences with the University of Iceland to develop a grant proposal and to conduct a pilot study; assisted with mentoring a fellow research intern; and developed an abstract and Power Point presentation for the Closing Address at the 2006 Student Scholarship Showcase, in the College of Nursing at the University of Kentucky.

I was one of the co-authors, with Dr. Burkhart, of an abstract accepted for an oral podium presentation at the Sigma Theta Tau 17th International Nursing Research Congress held in Montreal, Canada, in July, 2006. I attended and co-presented with Dr. Burkhart at this conference after obtaining funding to support my travel expenses. I attribute much of my success and accomplishments to the support and encouragement I continuously receive from Dr. Burkhart. She stands out as one of the most positive role models in my life.

In addition to being an undergraduate student and a research intern, I currently work as a Nursing Care Tech at the University of Kentucky Hospital, working throughout the summer of 2006 as a SNAP (Student Nurse Apprentice Program) participant in the UK Hospital Emergency Department. In addition, I am a member of the Delta Psi Chapter of Sigma Theta Tau International, Honor Society of Nursing; a member of the National Society of Collegiate Scholars; and a National Dean's List member since 2003. I enjoy spending time with my family and friends and I love the outdoors.

I am focused, confident, self-assured, and interested in learning and becoming a high quality nurse. I strive for success and enjoy dedicating the time and energy needed to achieve positive outcomes in each endeavor. My involvement as a research intern has been an excellent opportunity to learn about childhood asthma and to reach out to those who suffer from this disease. Nursing is an evidence-based practice and our research efforts are helping to advance the profession's understanding of pediatric asthma self-management. I will graduate from the College of Nursing in May of 2007 and work as a registered nurse while pursuing a graduate degree. My long-term goals are to provide patient care, offer health care leadership, utilize and implement research findings in a patient-care setting, as well as assist in the development of programs intended to improve patient awareness and management of health conditions.

Mentor: Patricia Vernal Burkhart, PhD, RN, Associate Professor, College of Nursing



Peak Flow versus Symptom Monitoring to Manage Childhood Asthma

Abstract

Asthma is the most prevalent chronic respiratory disease in children. If asthma is not well managed, it can result in significant morbidity and mortality. The purpose of this paper is to assess the effects of peak flow versus symptom monitoring on asthma health outcomes in children. A literature review was conducted for research articles related to peak flow and symptom monitoring as they relate to asthma outcomes in children. The MEDLINE, PubMed, and CINAHL databases were accessed. The search was narrowed to include articles from the years 2000-2006 using the search terms child, asthma, peak flow meter, and symptom monitoring. The benefits of peak flow monitoring versus symptom monitoring in improving health outcomes is a controversial issue. Reliable evidence that can be generalized to the child asthma population is equivocal. Further evidence-based research is needed to determine whether peak flow monitoring or symptom-based asthma action plans promote the best health outcomes in children with asthma.

My program of research focuses on testing effective self-management strategies, including peak flow monitoring, to improve health outcomes and quality of life for children with asthma. Results of our studies have significant implications for improving the health and well being of children diagnosed with asthma. This paper summarizes some of the literature regarding the use of peak flow meters to improve asthma self-management and health outcomes, including the intervention we tested in our own randomized, controlled clinical trial funded by the National Institute of Nursing Research at the National Institutes of Health. I feel this paper is quality work for an undergraduate student, and I am excited to assist Ms. Ohlmann to achieve her research internship goal of becoming a published author. It is with pleasure that I endorse this work for publication in Kaleidoscope.

Introduction

Asthma education including avoidance of asthma triggers, self-monitoring of asthma symptoms, the use of asthma action plans, and adherence to prescribed asthma medications are recommended as part of asthma self-management. Written asthma action plans that direct asthma self-management interventions have been found to be beneficial in reducing asthma morbidity (NAEPP, 1997; 2003). However, there is much debate regarding whether the patient's action plan should be based on symptom monitoring or peak flow monitoring. This clinical controversy is part of the quest for best practices to help in the management of this chronic disease. Adequate disease management is a critical factor in the effort to reduce asthma-related morbidity and mortality.

The National Asthma Education and Prevention Program (NAEPP, 1997; 2003) *Guidelines for the Diagnosis and Management of Asthma* recommend that patients with moderate or severe persistent asthma and those who do not perceive their symptoms until airflow obstruction is severe be taught to use a peak flow meter (PFM) at home. This is particularly relevant for children who generally have poor symptom perception (Yoos & McMullen, 1999). Peak expiratory flow rate (PEFR) provides a quantitative measure to detect the existence and severity of airway obstruction during an asthma exacerbation and guides therapeutic decisions. Once the child's personal best PEFR is determined, an asthma action plan can be developed so that the child and family know what to do if the PEFR decreases, indicating compromised airflow. However, "evidence neither supports nor refutes the benefits of written action plans based on peak flow monitoring compared to symptom-based plans in improving health care utilization, symptoms, or lung function," (NAEPP, 2003, p. 85). The purpose of this literature review is to compare the effects of peak flow monitoring versus symptom monitoring for children with asthma.

Prevalence and Impact of Childhood Asthma

According to the National Health Interview Survey conducted by the Centers for Disease Control and Prevention (CDC, 2003), asthma is a chronic respiratory disease affecting 9.1 million (12%) children in the U.S. under the age of 18. Of the respondents, 4.0 million children (5.4%) reported having an asthma attack in the past year. Asthma is characterized by episodes of inflammation and narrowing of the small airways in response to asthma triggers, such as allergens, infection, exercise, abrupt weather changes, or exposure to airway irritants. Symptoms of asthma include cough,

shortness of breath, wheeze, and chest tightness (CDC, 2002). Among the children 5-17 years of age who reported having at least one asthma attack in the past year, 14.7 million school days were missed due to an asthma related episode. Children aged 0-17 years had 5 million visits to private physician offices and hospital outpatient departments (687 visits per 10,000). Over 727,000 Emergency Department visits were reported (100 per 10,000) among children aged 0-17 years, with the highest being children aged 0-4 years. Asthma deaths are rare among children; however, 187 children aged 0-17 years died in 2002 from asthma (0.3 deaths per 100,000), with Non-Hispanic blacks having the highest mortality rate (CDC, 2002). The possibility of exposure to the many environmental and physiological triggers signifies the importance of children with asthma having a dependable written action plan to serve as a guide for self-management.

Guidelines Recommended for Asthma Self-Management

One of the objectives of *Healthy People 2010* (ODPHP & DHHS, 2000) is to reduce asthma deaths, hospitalizations related to asthma, emergency department visits for asthma exacerbations, activity limitations, missed school days related to asthma episodes, and to increase the proportion of persons with asthma who receive formal patient education. The importance of asthma education, including interventions to improve the ability of children and their parents to recognize changes in airflow, is also emphasized. The NAEPP guidelines suggest that available scientific evidence regarding objective peak flow monitoring versus symptom-based asthma self-management is equivocal. Comprehensive asthma self-management programs that include peak flow monitoring may improve patients' health outcomes, but the guidelines suggest that the issue needs to be studied further (NAEPP, 1997; 2003).

An Expert Asthma Panel agreed that there are two distinct arguments for recommending peak flow monitoring: (a) clinician-patient communication is enhanced by the use of peak flow monitoring, and (b) patient awareness of the disease status and control is increased by peak flow monitoring if taught correctly (NAEPP, 2003). PEFR monitoring is recommended as part of asthma self-management for children with moderate and severe persistent asthma, to detect the presence and severity of airway obstruction. In addition, the Expert Panel recommended prescribing a PFM for any patient with asthma who prefers to rely on an objective measure, rather than perceived signs

and symptoms of an asthma exacerbation (NAEPP, 1997; 2003), because symptom perception is often difficult and inaccurate. For subjective symptom monitoring to be effective, the child must understand that coughing, wheezing, chest tightness, and breathlessness are symptoms of an asthma exacerbation (CDC, 2002). Accurate and early recognition of these symptoms allows for adequate treatment to be implemented. Nurses are responsible for educating children with asthma on how to manage their disease by teaching these self-monitoring strategies.

Teaching Asthma Self-Monitoring Strategies

Peak flow monitoring provides a simple objective measurement of airway narrowing and can be taught to children. According to the NAEPP guidelines, peak flow meters are recommended for patients with persistent asthma. During an asthma exacerbation the airways of the lungs narrow. A PFM can measure how well air moves out of the lungs during forced expiration and can detect narrowing hours or even days before symptoms occur. PFMs can be used by children age five and older to help them learn what makes their asthma worse, decide if the treatment plan is working, decide when to add or stop medicine, and decide if emergency care is necessary (NAEPP, 1997).

According to Piaget's cognitive developmental theory (1962), school-age children are in the stage of concrete operations and begin to develop an understanding of the relationship between objects and ideas. During this stage, a child can mentally process how to use a peak flow meter and can understand what the meter is measuring. When teaching a child to use a PFM, the nurse should first have the child move the indicator to the bottom of the PFM. The child should stand up, take a deep breath filling the lungs completely, and blow out as hard and as fast as possible in one single blow. The number noted on the meter should be written down as long as a mistake in technique was avoided (NAEPP, 1997). If the child coughs or needs to repeat the blow again, the child should be reassured and encouraged to try again. School-age children are eager to build skills and engage in tasks, such as using a PFM, which can help them to obtain a sense of competence or mastery (Hockenberry et al., 2003). After achieving a successful reading on the PFM, the steps need to be repeated two more times and the highest of the three PEFr values should be recorded in the child's asthma diary (NAEPP, 1997).

The NAEPP (1997) guidelines describe a child's personal best PEFr number as the highest peak flow number achieved over a two-to-three week period when the child's asthma is under good control, meaning that the child is not experiencing any asthma symptoms. Peak flow monitoring should be performed first thing in the morning, between noon and 2 PM each day, each time a short-acting inhaled bronchodilator medication is administered to relieve symptoms, and at other times suggested by the health care provider. The child's personal best is used as a baseline to guide the development of a written action plan that includes appropriate interventions based on whether the child is in the green zone (at least 80% of personal best), yellow zone (50-80% of personal best), or red zone (< 50% of personal best). The green zone indicates good asthma control, and the patient's current asthma medications should be taken as prescribed. The yellow zone represents caution, the airways are constricting, and the patient's prescribed bronchodilator medication is needed. The red zone signifies a medical alert for which the child should seek medical attention immediately in the emergency department

or from the health care provider. The asthma diary should be used daily to keep track of the child's peak flow values and should be shared with the patient care provider at each health care visit.

The NAEPP recommends that all children with asthma be taught to recognize symptom patterns that indicate poor asthma control, especially those who choose not to use a PFM and prefer to treat their asthma based on their perceived symptoms. Understanding can be achieved by teaching children the signs and symptoms of an asthma exacerbation and by explaining how each symptom will make them feel. Uncontrollable coughing, periods of breathlessness, notable wheezing while breathing, and chest tightness or pressure indicates the emergent need for asthma treatment. When children experience these symptoms, it is important that they recognize them as the onset of an asthma exacerbation and report them to someone who can help facilitate appropriate treatment measures. Symptoms can occur in the early morning, during the day, at night, while at rest, and during exertion. Failure to recognize or the inaccurate interpretation of asthma symptoms creates serious concern and puts the child's life at risk. It is critical that children understand the symptoms signaling the onset of an asthma exacerbation and are prepared to treat their symptoms, based on a written asthma action plan provided by their health care provider (NAEPP, 1997).

Review of Relevant Literature

To achieve a better understanding of asthma self-management strategies and the possible benefits, a literature review of the most current studies on symptom and peak flow monitoring for children with asthma was conducted. The computerized databases of MEDLINE, PubMed, and CINAHL were accessed. The search was narrowed to include articles from the years 2000-2006 using the search terms child, asthma, peak flow meter, and symptom monitoring. Five publications, representing four studies, were found that compared PEFr with symptom monitoring in children with asthma (see Table 1).

A longitudinal randomized clinical trial compared the effect of PEFr with symptom monitoring in children (Yoos et al., 2002). The purpose was to determine whether PEFr monitoring decreased asthma morbidity compared with self-management guided by symptom recognition alone for children (N = 156) ages 6-19 years of age. Children were randomly assigned to one of three treatment groups: 1) subjective symptom monitoring, 2) PEFr monitoring when symptomatic, or 3) PEFr monitoring twice daily and when symptomatic. Each group received

asthma education, including training in subjective symptom recognition, as well as a personal action plan for asthma management. At three months post intervention, children using a PFM when symptomatic had lower asthma severity scores, fewer symptomatic days (symptoms decreased by 1 day per week), and less healthcare use for asthma three months after completing the intervention. Significant improvements were found in minority and poor children compared with Caucasian children of higher socioeconomic status when they used PFMs. These findings suggest that children who have greater asthma severity and those who face socioeconomic challenges seem to benefit most from using objective

peak flow monitoring to manage their asthma (Yoos et al., 2002).

Using the same sample as the Yoos et al. (2002) study, the authors assessed 136 children who remained in the study, completing a one-year follow-up. Of the children continuing to use a PFM one year after completing the study, 6% of the children were daily users, 63% reported use when symptomatic, and 30% discontinued use (McMullen, Yoos, & Kitzman, 2002). Children who reported more frequent symptoms also reported more frequent use of their PFM ($r = 0.48$; $p < 0.0001$). When the parents reported on their child's reaction to PFM use, 50% reported PFMs as beneficial because the objective data was reassuring to their child, promoting confidence and a sense of mastery. When parents were asked about their child's attitude toward PFM use, 15% reported it as neutral and 35% described their feelings as negative because regular use became a burden and the child became resistant to its use. Benefits were

Table 1. Studies of Approaches to Childhood Asthma Management

Authors	Year	Sample Size	Age in Years	Study Design/ Sampling	Measurement of Asthma Systems	Health Outcomes/ Conclusions
Burkhart, P.V., Rayens, M.K., & Revelette, W.R.	2006	N = 77	7-11	Experimental Design: Simple Ran- dom Sam- pling	Electronic PEFR Monitor	Children using PEFR monitors experienced a significant decrease from baseline to week 16 in asthma episodes, physician or clinic visits for exacerbations, and missed school days. Of those who were at least 80% adherent, 33% had an asthma episode in the last 8 weeks compared to 57% of those who were less adherent.
McMullen, A.H., Yoos, L., & Kitzman, H.	2002	N = 136	6-19	Experimental Design: Longitudinal Clinical Trial; Stratified Random Sampling	Self-Report	One year after the intervention study, the majority of PFM users were only using the PFM during symptomatic times. Only 6% were daily users, 63% reported use when symptomatic, and 30% discontinued use. Daily use is not perceived as useful by most families and is an unrealistic expectation for most children.
Tinkelman, D. & Schwartz, A	2004	N = 41	5-15	Quasi- experimental Design: Longitudinal; Non-random Convenience Sampling	Self-Report	After 6 months of the education program, the number of missed school days and unscheduled doctors visits decreased by 67% and 60%, respectively. An 11% increase in the child's activity level was found. 14 children experienced a 62% decrease in symptom frequency during the day and a 34% reduction at night. One year into the program, the daytime and nighttime symptoms decreased by 69% and 100%, respectively. At 6 months, 71% of the children used their diary three times a week and about 90% used it once a week.
Wensley, D. & Silverman, M.	2004	N = 90	7-14	Experimental Design: Open, Prospective, Parallel-group Controlled Trial; Simple Random Sampling	Electronic PEFR Monitor	No significant differences were found in children's symptom scores, lung function tests, quality of life scores, PEFR, or their health care utilization. Based on these results, knowledge of PEFR did not enhance asthma self-management, even in acute episodes. Children were able to recognize changes in symptoms and respond accordingly before the PEFR recording was < 70%.

perceived by 36% of parents whose child used a PFM daily compared to 63% of parents of symptom-time PFM users. Most parents and children did not perceive the use of a PFM during asymptomatic times as beneficial in detecting lung function changes; therefore, children using PFMs while experiencing symptoms sustained better long-term adherence. Adolescents were twice as likely to discontinue PFM use compared with school-aged children. These findings support the use of PFMs for children who experience difficulty perceiving and controlling their asthma symptoms. New strategies are needed to engage adolescents in managing their asthma (McMullen et al., 2002).

Wensley and Silverman (2004) studied 90 children with asthma to determine whether incorporating PEFr recordings into a symptom-based asthma self-management program improved the child's symptom score, lung function tests, and quality of life. The children, ages 7-14 years, were randomized into a PEFr plus symptom-based management group or the symptom-only management group. Both groups recorded their symptoms in an asthma diary. The PEFr group performed twice daily monitoring. In both groups, adherence to monitoring decreased from 90% in Month 1 to 79% in Month 3 of the 12 week trial. No significant differences were found in their symptom scores, lung functions tests, quality of life scores, PEFr, or their reported health care utilization. The results of this study suggest that knowledge of PEFr did not enhance asthma self-management, even in acute episodes. Children were able to recognize changes in symptoms and respond accordingly before the PEFr recording was less than 70%. Possible limitations exist within this study: the study was not blinded after the subjects were randomized; more boys were randomized into the PEFr group; and both groups were given written asthma actions plans, so it could not be determined if guided self-management was effective. A small sample size may have impeded the ability to obtain statistically significant differences among the groups, and the thoroughness of the asthma self-management education provided to both groups may have improved the skills of the symptom management group and reduced the benefit of the twice daily PEFr monitoring (Wensley & Silverman, 2004). This suggests the need for a thorough nursing assessment to determine the child's ability to perceive symptoms and to ultimately decide if a PFM may help with asthma control.

Tinkelman and Schwartz (2004) reported on the experiences of children (N = 41) and their caregivers who participated in a six-month comprehensive, school-based asthma management program. Their aim was to determine whether the designed self-management interventions would reduce measures of asthma control, student absenteeism, and caregiver lost workdays. Study subjects were given two peak flow meters (one for school and one for home use), training in PEFr, a computerized asthma diary, monthly educational sessions on an asthma-related topic, and access to an asthma education resource. Parents of the children also received asthma education and an asthma action plan. At 6 months, the number of missed school days and unscheduled doctor visits decreased by 67% and 60%, respectively. An 11% improvement in the caregiver's perception of their child's activity level was found. Daytime and nighttime symptom frequency decreased by 62% ($p < 0.07$) and 34% ($p < 0.03$), respectively. Reduced symptom frequency persisted at 12 months post-intervention. Although this study did not specifically

focus on the outcomes when using a peak flow meter for self-management versus symptom-based asthma management, the results were supportive of asthma education and monitoring that involves the use of a peak flow meter. The children were taught to recognize symptoms and to take appropriate management steps (Tinkelman & Schwartz, 2004). These findings support nursing implementation of an asthma management program that includes the use of a PFM to improve child asthma control and quality of life.

In a recent clinical trial, asthma-related health outcomes were assessed for school-age children (N = 77; ages 7-11 years) who were taught daily peak flow monitoring (Burkhart, Rayens, & Revelette, 2006). Significant clinical findings were noted among all participants using a PFM, including a decrease from baseline to week 16 in asthma episodes, missed school days, and physician or clinic visits for asthma exacerbations. Of the subjects whose peak flow monitoring adherence rate was at least 80%, 33% had an asthma episode during the last 8 weeks. For those who were less than 80% adherent, the asthma episode rate during the last 8 weeks was 57% ($p < 0.04$). These findings suggest that frequent self-monitoring with a PFM may have enhanced children's awareness of their disease status signaling the need for early intervention to prevent asthma exacerbations. This daily self-monitoring strategy may have promoted asthma self-management, so that fewer school days were missed due to asthma and fewer visits to acute care centers were necessary for asthma exacerbations.

Significance to Nursing

Nurses caring for children in a primary care or in a hospital setting will frequently encounter children with asthma and be responsible for educating the child and family about asthma self-management. Intensive one-on-one asthma education, guidance, and support from a nurse educator may positively impact the patient's health outcomes (NAEPP, 1997; 2003). Based on the current research, nurses cannot confidently say that using a peak flow meter daily or during asthma episodes to guide treatment yields better outcomes than patient perception of symptom severity. When patient education is needed for a child with asthma, the research question being reviewed becomes an issue. Should nurses teach parents and their children how to use a peak flow meter and keep a daily diary of their peak flow recordings and symptoms or should nurses put more emphasis on teaching subjective-symptom monitoring to determine the plan for treatment?

Conclusion

A review of recent data-based research articles published during the last five years that compared health outcomes for children who used objective PEFR versus symptom monitoring was conducted. Only four studies were found, with one of the studies published in two separate articles (i.e., McMullen et al., 2002 and Yoos et al., 2002). The available evidence regarding peak flow monitoring versus symptom monitoring for improving asthma outcomes in children remains equivocal. Some results were supportive of asthma education and monitoring involving the use of a peak flow meter (Burkhart et al., 2006; Tinkelman & Schwartz, 2004), but others concluded that knowledge of PEFR did not enhance asthma self-management, even in acute episodes (Wensley & Silverman, 2004). It has been suggested that all children may not benefit from PFM use, but those who have greater asthma severity, those who face socioeconomic challenges, and those who experience difficulty in perceiving and controlling asthma symptoms may benefit most (McMullen et al., 2002; Yoos et al., 2002). Further evidence-based research is needed to determine whether peak flow monitoring or symptom-based asthma action plans promote the best health outcomes for children with asthma. These findings would provide nurses with the evidence to incorporate these self-management strategies into their practice to enhance the quality of patient care and improve patient health outcomes.

Recommendations for Future Research

The NAEPP guidelines (2003) suggest that future research needs to center on studies:

- With adequate power and objective measurement tools to determine whether peak flow monitoring provides benefits over symptom monitoring when managing childhood asthma
- Focusing on children, because children may not be able to readily recognize and report asthma symptoms as well as adults
- Comparing short-term (i.e., only during exacerbations of asthma) versus long-term (i.e., daily) use of peak flow meters for asthma management
- Evaluating the influence of disease severity and age of the child in determining the benefits of peak flow monitoring

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