



PEDIATRIC FORUM

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Pediatric Forum

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Target audience

This education activity is designed for pediatricians, family physicians and related child health care providers.

Educational objectives

- Articles will review commonly encountered clinical conditions and provide updates in pediatric medical and surgical care.
- Each individual article will have activity-specific learning objectives.

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DIAGNOSIS AND MANAGEMENT OF INFLAMMATORY BOWEL DISEASE IN CHILDREN



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OBJECTIVES

*After completing this
article, the reader should
be able to:*

1. Understand the indications, effectiveness and disadvantages of newer, less invasive diagnostic tools in children with symptoms suspicious of inflammatory bowel disease (IBD).
2. Understand the indications, risks and benefits of biologic therapy in children with moderate to severe Crohn's disease and ulcerative colitis
3. Understand general pediatric issues in children with IBD to include the use of nonsteroidal anti-inflammatory drugs, isotretinoin, smoking and vaccinations.

Recent studies suggest an increasing frequency of inflammatory bowel disease (IBD) with over one million individuals affected in the United States, 10 to 15% of whom are in the pediatric age range.^{1,2} This review will highlight important advancements in early diagnosis and biologic therapy.

The gold standard for the diagnosis of IBD remains endoscopic evaluation with tissue histology. While no substitute exists for an accurate and complete medical history and physical examination of a child with possible IBD, newer and less invasive modalities like serological biomarkers, wireless video capsule endoscopy and advanced imaging are being developed with improving sensitivity and specificity. These less invasive techniques are particularly attractive for children where invasive procedures provide angst to both parents and children.

Clinical Symptomatology

The majority of patients present with abdominal pain, weight loss, diarrhea or bloody diarrhea, with or without extraintestinal manifestations. Children can also present with growth failure, delayed puberty, intermittent fevers, mouth ulcers, skin lesions (erythema nodosum, pyoderma gangrenosum) and rarely acute abdominal pain.

Routine Laboratory Screening

Noninvasive markers often are used to screen for bowel inflammation. The most common are the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). An elevated ESR or CRP is much more common in Crohn's disease (CD) than ulcerative colitis (UC),¹ but normal values do not exclude a diagnosis of IBD. Up to 50% of children with newly diagnosed UC and 20% of those with CD have a normal ESR. Fecal markers of inflammation have been developed. These proteins are released from activated neutrophils in bowel mucosa (eg, calprotectin). In UC all of these fecal markers correlate well with a clinical index of disease activity.² Similar observations have been made with fecal calprotectin in childhood UC and CD.³

Serological Biomarkers

Immune reactivity to specific microbial antigens has been reported in the sera of adults and children with IBD. It has been used for the following:

1. Screen patients with multiple symptoms suggestive of IBD;
2. Distinguish between UC and CD; and,
3. Predict severity and course.⁴⁻⁶

The prevalence of IBD-specific antibody markers in children and young adults is shown in Table 1. Increasing seropositivity and higher ASCA levels are associated with younger age of disease onset, stricturing and penetrating disease, need for surgery in both adults and children with CD, and shorter time to first complication.⁷⁻⁹ **A recent pediatric study**

Table 1

Marker	CD N= 81	UC N= 54	Non-IBD controls N= 63
ASCA IgA	33 (40.7%)	0	0
ASCA IgA or IgG	36 (44.4%)	0	1 (1.6%)
Anti-OmpC	20 (24.7%)	6 (11.1%)	3 (4.8%)
pANCA	15 (18.5)	38 (70.4%)	2 (3.2%)

Table 1. Prevalence of antibody profiles in children and young adults with IBD. Presently five biomarkers are commercially available for this type of analysis (Prometheus Laboratories, San Diego, CA). They include (ASCA IgA, IgG) anti-Saccharomyces cerevisiae, (OmpC) anti-E. coli outer membrane porin, (I2) anti-pseudomonas fluorescens CD-related protein (I2) IgA, anti flagellin (C Bir-1) IgA, and anti-perinuclear anti-neutrophil (pANCA) IgG with DNase sensitivity used to improve specificity.

showed that the combination of hemoglobin and a sedrate was more predictive of IBD than serological testing; hence, it is nondiagnostic in children with abdominal pain and no other history or symptomatology suggestive of IBD.

Endoscopic Evaluation

Children currently being evaluated for IBD undergo both esophagogastroduodenoscopy and ileocolonoscopy at initial presentation. When possible, the inspection of the ileum can help differentiate UC from CD.

Wireless Capsule Endoscopy (WCE)

Although most cases of IBD are diagnosed without difficulty, WCE may be helpful in situations where standard evaluation is negative. Currently, controlled trials prospectively evaluating WCE and other diagnostic modalities are not available in children. A meta-analysis of the yield of WCE compared to other diagnostic modalities in adults with nonstricturing small bowel CD concluded that WCE should not be used to make an initial diagnosis, but is beneficial for diagnosing post-operative recurrence following resection surgery in patients with Crohn's disease.¹⁰

Older children and adolescents may be able to swallow the capsule, while younger children may require endoscopic placement in the duodenum. It is important to exclude the presence of a stricture prior to ingestion of the capsule. Though safe, capsule retention that required surgical or endoscopic retrieval occurred in 1.9% of patients.¹¹ Recently, a patency capsule has been developed that can be used before standard videocapsule endoscopy (VCE). This capsule is made of lactose and will dissolve over time.

Magnetic Resonance Imaging (MRI)

In children with suspected IBD, Gadolinium MRI (G-MRI) confirmed the diagnosis of either CD¹² or UC⁷ with a sensitivity and specificity of 96% and 92%, respectively.

MR enterography is a well-tolerated, effective noninvasive method in the evaluation of known or suspected CD in children.¹³ Contrast enhanced MR enterography as a diagnostic tool showed a sensitivity and specificity of 100% and 83% respectively. MR enteroclysis is a less invasive examination and useful for indicating transmural inflammation and bowel fistulae, in contrast to WCE which reveals only mucosal involvement.

Computed Tomography (CT)

While this is an excellent tool for detecting disease and complications, its use is limited by radiation exposure. Quantitative measures of mural attenuation and wall thickness at CT enterography correlated highly with ileoscopic and histologic findings of inflammation in CD.¹⁴

MANAGEMENT

The goals of medical therapy for pediatric IBD are induction of remission, maintenance of remission, prevention of disease progression, cancer prevention, quality of life improvement, post-operative recurrence prevention and normal growth and development facilitation. To date there is no single therapy that meets all these requirements.

5-Aminosalicylates (sulfasalazine, mesalamine, balsalazide)

For mild to moderate UC, 5-aminosalicylate medications are effective in inducing response and remission in 50 to 90% of adult patients and maintaining remission in 70 to 90%. Anecdotal experience in children suggests similar efficacy, but no controlled trials are available. A new, once daily 5-ASA medication (Lialda®) may be available for children in the near future.

In CD 5-aminosalicylates use has become controversial; however, they did show a significant effect in decreasing relapse in those with ileal disease alone, and induced remission in those with surgically induced remission.

Corticosteroids

For moderate to severe UC in children, acute response rates to corticosteroids are excellent (>80% of patients improve); however,

corticosteroid dependency is seen in almost 50%.¹² Corticosteroids also are used in the majority of children with CD presenting with moderate to severe disease with acute response rates over 80%.¹⁵ By one year, 31% demonstrate corticosteroid dependency and 8% require surgery.

Budesonide, a corticosteroid taken orally and released in the distal small bowel and proximal colon, acts locally and is purported to have less systemic side effects.¹⁶

Immunomodulators

In pediatric patients with UC and CD, immunomodulators have now become the standard of care. Two years post-diagnosis, 50% of newly diagnosed children with UC and 75% of those with CD are receiving an immunomodulator.

Side effects include dose related bone marrow suppression, hepatitis, pancreatitis (idiosyncratic), vasculitis and increased risk of infection. Chronic use of immunomodulators has been calculated to increase the risk of lymphoma by four-fold compared to the general population.¹⁷

Methotrexate also is used with success as an immunomodulator in Crohn's disease, particularly in children either failing or intolerable to Azathioprine or 6-MP.¹⁸

Biological Therapy

Infliximab is a chimeric monoclonal antibody against TNF- α . In May 2006, it was FDA approved for treatment of children with moderate to severely active CD.

Extraintestinal manifestations like pyoderma gangrenosum, vasculitis, uveitis, erythema nodosum and arthritis also have been treated with infliximab with good response.^{19,20}

Infliximab is contraindicated in patients with active tuberculosis, serious infection, opportunistic infections, demyelinating disease or malignancy. Acute infusion reactions are common. The association between infliximab use and the development of malignancy has been controversial. Recently, a particularly aggressive malignancy, hepatosplenic T-cell lymphoma, has been described in young patients (<30 years of age, mostly male) who have been treated with both infliximab and either azathioprine or 6-mercaptopurine.²¹ This disorder is extremely rare with a high fatality rate.

Two other anti-TNF agents, adalimumab and certolizumab, have shown efficacy with response and remission rates similar to infliximab. These antibodies are more fully humanized and believed to have less allergic reactions.

Newer biological agents for CD include natalizumab, which has shown clinical efficacy in both adults and children. Newer biological agents for UC include an anti-CD3 antibody (visilizumab). Leukocytapheresis has been studied with some promise in small series of corticosteroid refractory and dependent patients with UC.^{22,23}

Nutritional therapy

Nutritional therapy can be used as primary therapy or adjunctively. The sole use of enteral nutrition with either elemental or polymeric diets has been associated with short-term remission rates of 20 to 80% in children with CD.²⁴ In patients with growth failure or significant osteopenia, and in whom the avoidance of corticosteroids is prudent, enteral nutrition should be considered

Antibiotics/Probiotics

Though widely used in the treatment of IBD, only few situations occur in which antibiotics have proven

efficacy. Metronidazole is used to treat perirectal fistula, though recurrence rates are high and toxicity often limiting.²⁵ Ciprofloxacin also is used in this setting, but data are limited. Both agents also are used in the treatment of pouchitis following colectomy and ileoanal pouch procedures for ulcerative colitis. Rifaximin, a newer nonabsorbed oral antibiotic, has shown modest benefit in moderately active CD.

Probiotics have not been reproducibly shown to alter the natural history of CD; however, they have been shown to be helpful in the treatment and prevention of pouchitis.²⁶

GENERAL PEDIATRIC ISSUES

Depression

True prevalence of depression, anxiety and psychiatric illness is underestimated in children with IBD. Warning signs include school absenteeism/failure, medication noncompliance, social withdrawal, alteration in energy levels/sleep-wake cycles and therapy escalation without disease activity.

Nonsteroidal anti-inflammatory drugs (NSAIDs)

These should be used with caution in children with IBD. When given to patients with quiescent CD or UC, nonselective NSAIDs were associated with a 17 to 28% relapse rate within nine days of ingestion.

Isotretinoin and Colitis

In a study which evaluated the strength of causality, the conclusion in a subgroup of patients determined that Isotretinoin may serve as a trigger for IBD. This should not prohibit use of Isotretinoin, but careful consideration needs to be

given to patients with suggestive symptoms, prior personal or family history of IBD.

Smoking

Smoking can exacerbate quiescent CD, increase the rate of early surgical recurrence of disease and predispose patients to disease complications.

THE FUTURE

A combination of genetic, serologic and clinical factors will likely be used to categorize patients in the future. Increasing understanding of the inflammatory cascade in IBD is facilitating the development of more

efficacious therapies. When treating children with IBD it is important to remember that to a child, it is the quality of life that matters.

Figure 1 Typical treatment pyramid for children and teenagers with ulcerative colitis

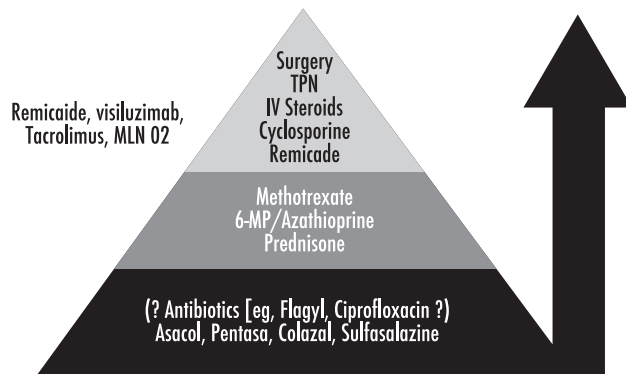
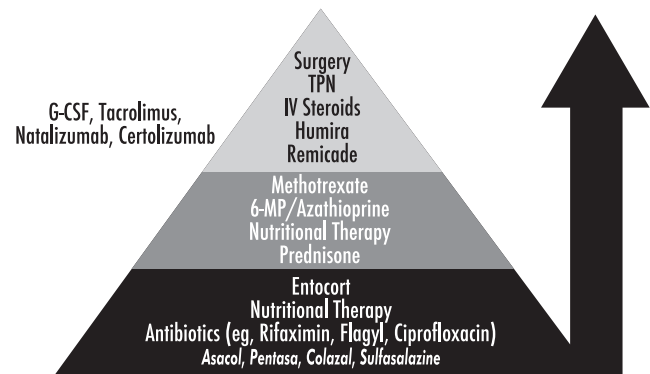


Figure 2 Typical treatment pyramid for children and teenagers with Crohn's disease



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CME QUESTIONS

1. Videocapsule endoscopy (VCE) can be used as an independent tool for diagnosing which of the following?
 - a. Initial diagnosis of Crohn's disease in a child with symptoms suggestive of IBD
 - b. Diagnosis of disease recurrence in a child with known CD
 - c. Diagnosis of UC in a child too sick to undergo colonoscopy
 - d. Diagnosis of esophageal CD
2. Which of the following statements is true regarding the commercial availability of the serological marker test for IBD?
 - a. Positive serological markers are more predictive of IBD as compared to Hemoglobin and erythrocyte sedimentation rate
 - b. Greater number of positive markers has correlated with a more severe disease course in young adults with CD
 - c. IBD serological markers are always negative in IBS
 - d. Serological markers become negative with treatment of disease
3. Each of the following are adverse effects of azathioprine or 6-mercaptopurine except
 - a. Pancreatitis
 - b. Leukopenia
 - c. Increase risk of lymphoma with cumulative use of the drug
 - d. Gum hyperplasia
 - e. Hair loss
4. Which of the following vaccinations is contraindicated in a malnourished girl with CD on infliximab maintenance therapy presently being treated with 30 mg oral prednisone daily for a flare of disease?
 - a. Varicella booster
 - b. Hepatitis B booster
 - c. Influenza shot
 - d. Hepatitis A vaccine

Questions? Comments?

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ACUTE DISSEMINATED ENCEPHALOMYELITIS



By Gogi Kumar, MD

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OBJECTIVES

After completing this article, the reader should be able to:

1. Distinguish the diagnostic criteria and the presenting features of ADEM.
2. Understand the differential diagnosis, treatment options and long term prognosis of ADEM.

Acute disseminated encephalomyelitis (ADEM) is a monophasic immune mediated inflammatory demyelinating disorder of the central nervous system (CNS) more commonly diagnosed in children following a viral infection or vaccination.

The International Pediatric Multiple Sclerosis (MS) Study Group¹ has proposed the following definition for ADEM:

A first clinical event with polysymptomatic encephalopathy with acute or subacute onset showing focal or multifocal hyperintense lesions predominantly affecting the CNS white matter, no evidence of previous white matter changes and no evidence of previous clinical episode with features of a demyelinating event.

Epidemiology

The mean age at presentation in children ranges from 5 to 8 years. The estimated incidence is from 0.4 to 0.8/100,000 population per year. In contrast to MS no sex preponderance exists in ADEM. A seasonal distribution in the winter and spring months has been found in studies conducted in the United States.

Clinical Features

The onset of symptoms of ADEM usually occurs seven to 14 days after a viral infection or immunization. The clinical features include a prodromal phase characterized by fever, malaise, headache, nausea and vomiting followed by encephalopathy. Encephalopathy may range from excessive drowsiness to coma, while in younger children it may simply manifest as irritability. Encephalopathy is accompanied by neurologic symptoms determined by the location of the lesions. The most common presentations include hemiparesis, ataxia, cranial nerve deficits, visual loss due to optic neuritis, sei-

zures, slurred speech and hemiparesis. Fever, headaches, seizures and ataxia are more commonly found in children while sensory deficits predominate in adults. Occasionally rapid progression of symptoms and signs including progression to coma and decerebrate rigidity may occur.

Differential Diagnosis

The differential diagnosis of acute encephalopathy in children in the context of an acute illness includes acute bacterial or viral infection of the CNS. A gadolinium enhanced MRI of the brain and a lumbar puncture is recommended as soon as possible.

Neuroimaging is very important in establishing the diagnosis of ADEM. The typical lesions in ADEM are large, multiple and asymmetric. They involve subcortical and central white matter and the cortical gray-white junction of both cerebral hemispheres, cerebellum, brainstem and spinal cord. Other conditions to be considered when diagnosing ADEM are brain tumors, MS and vasculitis. Spinal cord involvement in ADEM has been described in 11 to 28% of patients.² Sequential MRI during the follow up period is important in establishing the diagnosis. Complete or partial resolution of the lesions favors the diagnosis of ADEM.

Investigations

MRI is the diagnostic modality of choice. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) may be elevated. Cerebrospinal fluid (CSF) examination may show lymphocytosis. Oligoclonal bands in the CSF, which are an indicator of a demyelinating process, may be positive in a median of 12.5% patients while they are present in 40% to 67% patients with MS.³

Treatment

High dose steroids are the most widely used therapy for an established case of ADEM. IV methylprednisolone (10 to 30mg/kg/day up to a maximum dose of 1g/day) or dexamethasone (1mg/kg/day) for three to five days followed by oral steroid taper for four to six weeks is used. Methylprednisone treated patients had better outcome than dexamethasone patients in morbidity as assessed by the Expanded Disability Status Scale (EDSS).⁴

Provide gastric ulcer prophylaxis for the patient who is on steroids and monitor blood pressure, urine glucose and serum potassium. In patients with recurrent or multiphasic ADEM, intravenous immunoglobulin (IVIG) is useful. Plasmapheresis is used mostly as a rescue therapy for steroid resistant cases.

The natural history of ADEM in most patients is of gradual improvement over several weeks. Complete recovery is experienced in 50 to 70% of patients. Symptom resolution is more rapid in steroid or IVIG treated patients, but the impact of treatment on long-term outcome is not clear. Residual deficits include focal motor deficits ranging from mild clumsiness and ataxia to hemiparesis and blindness. Behavioral and cognitive problems are being recognized increasingly especially in younger patients.

Figure 1

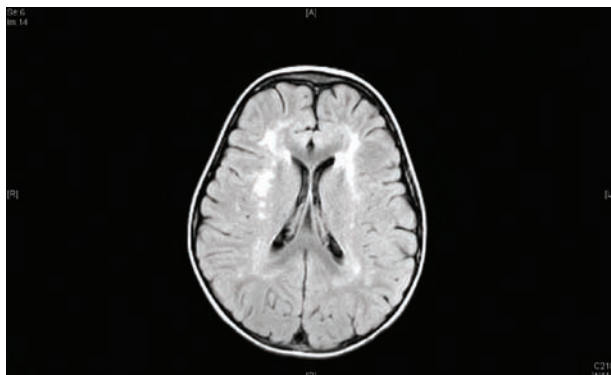


Figure 1. 5-year-old girl presenting with acute encephalopathy which persisted for 36 hours. CSF studies and toxicology screen was negative. Her MRI showed multiple areas of T2 prolongation throughout the white matter bilaterally, slightly more prominent on the left than the right. An increased signal within the basal ganglia and pons also presented.

ADEM versus MS

No reliable markers exist to predict the development of MS in a patient with a first episode of ADEM. In general, factors found more commonly in patients with MS than with ADEM include those age 10 or older, absence of flu-like illness, encephalopathy and seizures, presence of oligoclonal bands and periventricular MRI lesions, involvement of corpus callosum and long axis perpendicular lesions (Dawson's fingers).

In one study, 29% (34 of 119) children with a prior diagnosis of ADEM developed MS.⁵ Serial MRIs show complete or partial resolution of lesions in ADEM while new lesions present in MS.

Multiphasic ADEM

This is defined as a new clinical event meeting criteria for ADEM but involving new anatomic areas as confirmed by history, neurologic exam and neuroimaging. The subsequent event occurs at least three months after the onset of the initial ADEM and at least one month after completing steroid therapy.¹ IVIG is often used to treat multiphasic ADEM and the long-term prognosis remains unchanged.

Future directions

Further studies are required to develop reliable biochemical and radiographic markers for differentiation between ADEM and MS.

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CME QUESTIONS

5. Which of the following clinical features is essential for the diagnosis of ADEM?
 - a. Optic neuritis
 - b. Ataxia
 - c. Encephalopathy
 - d. Headache
6. Which of the following is the most commonly used treatment for ADEM?
 - a. Intravenous solumedrol
 - b. IVIG
 - c. Plasmapheresis
 - d. Dexamethasone

Questions? Comments?

Contact Gogi Kumar, MD at kumarg@childrensdayton.org.

DECREASING THE INCIDENCE OF VENTILATOR-ASSOCIATED PNEUMONIA IN THE PEDIATRIC INTENSIVE CARE UNIT



By Jodi E. Mullen, MS, RN, BC, CCRN, CCNS

Jodi Mullen is a clinical nurse specialist in the pediatric intensive care unit (PICU) at The Children's Medical Center of Dayton. She completed her undergraduate and graduate degrees at Wright State University College of Nursing and Health. She began in the PICU as a new graduate nurse and has now been with Dayton Children's for 19 years.

OBJECTIVES

After completing this article, the reader should be able to:

1. Understand the significance of ventilator-associated pneumonia in pediatric patients.
2. Describe elements of a ventilator-associated pneumonia prevention bundle.

Ventilator-associated pneumonia (VAP) is the second most common nosocomial infection occurring in children hospitalized in the pediatric intensive care unit (PICU). VAP is defined as pneumonia that develops more than 48 hours after intubation and mechanical ventilation, which was not incubating at the time of admission. Children who develop VAP have longer stays in the PICU and longer hospitalizations in general, as compared to children who do not.¹ Reported mean pediatric VAP rates range from 2.9 to 11 per 1000 ventilator days.²⁻⁵ *Pseudomonas*

aeruginosa is the most common organism responsible for VAP, followed by *Staphylococcus aureus* and *Klebsiella pneumoniae*.² Risk factors for VAP include aspiration of oropharyngeal secretions and/or gastric flora, inhalation of aerosolized bacteria, duration of mechanical ventilation, reintubation and transport while intubated.

Historically, VAP has been considered an unfortunate, but somewhat tolerable, complication of mechanical ventilation. Since the Institute for Healthcare

Figure 1 Bundle Compliance Toon-RN

6:00 AM (for the past 12 hour shift):

1. HOB is at ____ degrees.
Method of verification: _____
If not 30° or more, indicate why: _____
2. Oral care was performed ____ times.
If not at least 3, indicate why: _____
3. Oral care was performed with chlorhexidine at least once.
If not, indicate why: _____
4. Suction line was rinsed after each use and is clean. Yes No
5. Mouth/hypopharyngeal area was suctioned:

a. repositioning patient	Yes	No	NA
b. before suctioning ETT	Yes	No	NA
c. repositioning ETT	Yes	No	NA
d. before ETT cuff deflation	Yes	No	NA
e. before extubation	Yes	No	NA
6. Was the suction canister changed? Yes No
If no, why not: _____
7. Was the covered yankauer changed? Yes No
If no, why not: _____
8. Were there any times when meticulous hand hygiene was not performed? Yes No
If yes, describe: _____
9. Did you have to intervene at any time to maintain bundle compliance? Yes No
If yes, describe: _____

Improvement (IHI) has drawn attention to implementing evidence-based interventions to save lives, focus has shifted to preventing and even eliminating nosocomial infections including VAP. While increasing evidence exists that supports interventions to reduce VAP, most evidence has been generated in adult health care settings.⁶ Child Health Corporation of America (CHCA) and National Initiative for Children's Healthcare Quality (NICHQ) proposed a package of pediatric-specific interventions. Known as a bundle, when applied together these interventions result in even greater improvement than when instituted in isolation.

Methods

In 2007 the PICU at Dayton Children's sought to significantly decrease the incidence and prevalence of VAP. Because consistent application of a pediatric VAP prevention bundle had not been studied, staff in the PICU

needed to select those interventions that appeared most effective and feasible. After reviewing potential interventions to include in the prevention bundle, specific areas of care were selected:

- ▶ Head of bed elevation to 30°
- ▶ Oral care using 2.5% chlorhexidine oral rinse for patients over age 2 months
- ▶ Mouth/hypopharyngeal suctioning
- ▶ Ventilator tubing drainage
- ▶ Daily discussion about the patient's readiness to wean or extubate
- ▶ Suction line rinsed after each use
- ▶ Daily change of the suction canister and Yaunker catheter

Education was provided to the nursing staff, respiratory care staff and intensivists, and included information on VAP and the specific targeted areas of care. Because multidisciplinary providers care for patients in the PICU, impacting VAP rates required a team approach. While some of the interventions

in the prevention bundle were discipline-specific, the entire team worked collectively to assume accountability for improving practice and patient outcomes.

To measure compliance with the bundle interventions, a compliance-monitoring tool was created. The patient's nurse and the respiratory therapist each independently completed a tool every 12 hours (Figure 1). Data were tabulated monthly and the average compliance with each intervention and the bundle as a whole were calculated. As part of the usual PICU quality-monitoring program, data were collected on the incidence and prevalence of VAP.

Results

For the previous two years, the incidence of VAP in the PICU was two and six cases, respectively. Prevalence rates were 2.97 and 4.03 per 1000 ventilator days. Since implementation of the care bundle, the incidence of VAP has been zero (Figure 2). As of September 30,

Figure 2 Infection Rate

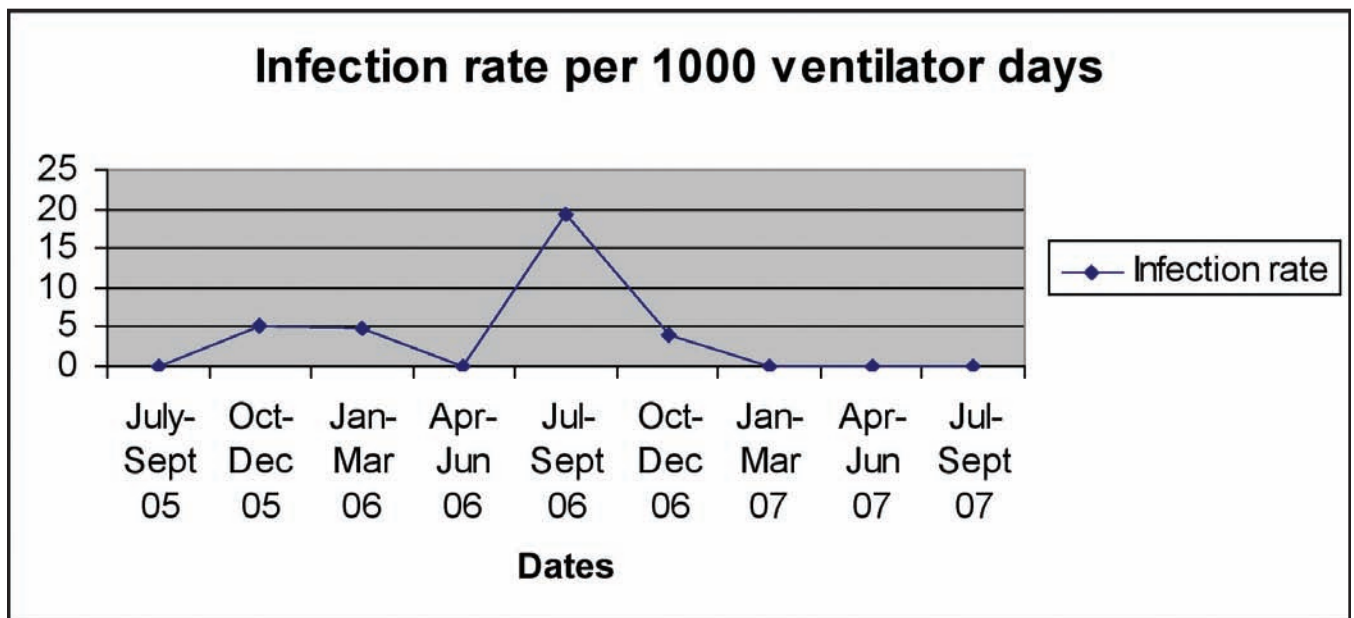


Figure 3 Selected Bundle Compliance Monitoring (January – September 2007)

Indicator	Compliance (%)	Range (%)
HOB elevated 30°	85	61 – 100
Oral care every four hours	77	81 – 100
Chlorhexidine used once/shift	86	60 – 100
Daily discussion about readiness to wean/extubate	89	64 – 100
HOB = head of bed		

2007, 333 days have passed since the last case of VAP. The last infection occurred November 1, 2006. Selected elements from nine months of bundle compliance-monitoring data are summarized in Figure 3. Cochran-Armitage tests for trend showed a statistically significant decrease in compliance with the head of bed elevation ($p=0.006$). Compliance with the remaining elements of the care bundle did not significantly change over time.

Discussion

Despite not always having excellent compliance with all elements of the VAP prevention bundle, the incidence of VAP has been zero since the initiation of this project. The decrease may not be attributed to any specific therapy, but instead to an increased awareness of the problem and a more methodical approach to prevention.

Conclusion

Compliance with education and a focused care initiative is easily achievable. A collaborative bedside approach to preventing VAP is effective in reducing the incidence and prevalence of this nosocomial infection in the PICU environment.

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CME QUESTIONS

7. VAP is the second most common nosocomial infection in PICU patients.
 - a. True
 - b. False
8. A multidisciplinary approach to VAP prevention is essential.
 - a. True
 - b. False
9. Elements of the pediatric VAP prevention bundle for this project included
 - a. Head of bed elevation
 - b. Oral care
 - c. Discussion about readiness to wean/extubate
 - d. All of the above

Questions? Comments?

Contact Jodi E. Mullen, MS, RN, BC, CCRN, CCNS at mullenj@childrensdayton.org.

TYPE 2 DIABETES IN CHILDREN AND ADOLESCENTS



By Susan P. Almazan, MD

Dr. Almazan is a pediatric endocrinologist

at The Children's Medical Center of Dayton and assistant professor of pediatrics at Wright State University Boonshoft School of Medicine. She completed her fellowship in diabetes and pediatric endocrinology at Children's Hospital of Buffalo. Dr. Almazan is board certified in pediatrics and pediatric endocrinology.

OBJECTIVES

After completing this article, the reader should be able to:

1. Appreciate the impact of the increasing incidence of type 2 diabetes in the pediatric age group.
2. Recognize type 2 diabetes presentation; thus, aid in its early diagnosis and understand its treatment and management.

Introduction

The typical expectation 10 to 15 years ago was that type 2 diabetes occurs most often in the middle and elderly age group, while diabetes in children and youth was most likely type 1. This has not been the present case. Parallel to the increasing incidence of obesity is the increase of type 2 diabetes in pediatrics. One of the biggest challenges is prompt diagnosis and appropriate management of affected children and adolescents. The overall goals need to be to prevent type 2 diabetes, its complications and the comorbidities associated with it.

How serious is this problem

Type 2 diabetes accounts for 8 to 45% of new diagnosis of diabetes in children in the United States. In 1979, the incidence of diabetes mellitus was reported to be 0.9 percent of US Pima Indians population aged between 15 and 24 years. In 1992, among children aged 5 to 14 years in Canada, between 10 to 20% of new onset diabetes cases were type 2. In Cincinnati, Ohio, between 1982 and 1994, the yearly incidence of type 2 diabetes increased from 0.7 to 7.2 per 100,000 children. About one third of new cases of diabetes in the 10- to 19-year-old age group were classified as type 2 diabetes. Similar increase in prevalence were

reported by case series, clinic-based studies as well as population-based studies in the United States.

This increasing incidence has been reported worldwide. In Japan, the incidence of type 2 diabetes increased from 0.2 to 7.3 per 100,000 school children between 1976 and 1995. The same increasing incidence has been reported in the Middle East, Pakistan, Hong Kong, New Zealand and the United Kingdom.

Obesity

As reported by the 1976-80 and 1988-94 National Health and Nutrition Examination Surveys, the overweight prevalence among 6- to 17-year-old children in the United States almost doubled from 5.4 to 10.6% independent of gender and race. Obesity rates have increased in the economically progressive countries such as the United States, Canada, Europe and Australia. Increasing rates of obesity have occurred also in Africa and Asia, where the majority of the world population lives.

Strong genetic factors are leading to obesity, however, environmental influences are also associated with the cause. Environmental factors implicated as major contributors to obesity include a sedentary lifestyle

Table 1 Risk factors and markers of youth-onset type 2 diabetes mellitus

Obesity
Family history of type 2 diabetes mellitus
Minority ethnicity and race (African American, Mexican-American, Native Indian, Asian)
Puberty
Polycystic ovary syndrome
Maternal diabetes or gestational diabetes

and diets focusing on foods with high caloric density, saturated fats and beverages with high sugar content. Studies have established these changes in diet and activity level lead to increased body mass index (BMI) which is associated with the development of type 2 diabetes. Obesity leads to peripheral insulin resistance, which is implicated as the primary defect in type 2 diabetes. Obese children have been found to have 40% less insulin-stimulated glucose metabolism compared to nonobese children. Visceral fat has been found to be inversely correlated with insulin sensitivity.

Genetic factors

Familial clustering has been noted in individuals with type 2 diabetes. Siblings of affected individuals have 3.5 times more than the general population’s risk of developing type 2 diabetes. An 80 to 100% concordance rate exists among monozygotic twins with type 2 diabetes compared to a 50% concordance rate among monozygotic twins with type 1. So far, over 20 loci have been identified in adults linked to or associated with type 2 diabetes; thus, it is likely a polygenic trait.

Ethnicity/race

High prevalence of type 2 diabetes is reported in African Americans, Hispanic and Native Americans. High rates of type 2 diabetes among adults are reflected in higher rates in children and adolescents in these ethnic groups.

Puberty

Type 2 diabetes in the pediatric age group is usually diagnosed at the mean age of 13.5 years, about the time of puberty. Insulin resistance occurs during the onset of puberty and leads to hyperinsulinemia. The transient increase in growth hormone secretion during normal

puberty is the most probable cause of this transient insulin resistance. A pubertal individual with genetic risk factors in addition to the presence of environmental factors may be at increased risk to develop type 2 diabetes.

Maternal diabetes

Children of mothers with diabetes during pregnancy have been found to have increased tendency for obesity as well as increased incidence of diabetes compared to children of mothers who developed diabetes after pregnancy.

Pathophysiology

Insulin resistance (IR) is the primary defect leading to the development of type 2 diabetes. The above mentioned factors contribute to IR. IR leads to increasing requirement for insulin; subsequently, insulin deficiency develops in individuals with limited secretory reserve of beta cells. Insulin deficiency is the main cause of hyperglycemia in type 2 diabetes. Insulin deficiency

causes reduction of insulin-mediated glucose uptake in the muscle, uncontrolled glucose production from the liver and increased free fatty acid mobilized from adipose tissue. Initially postprandial hyperglycemia occurs, followed by fasting hyperglycemia.

Management of type 2 diabetes

Goals of therapy for type 2 diabetes:

1. Attain healthy body weight
2. Eliminate symptoms of hyperglycemia
3. Management of comorbidities such as hypertension and hyperlipidemia
4. Decrease risk of acute and chronic complications associated with diabetes

Lifestyle Intervention

Lifestyle intervention includes medical nutrition counseling, exercise recommendations and comprehensive diabetes education. Individualized instruction by a registered dietitian fa-

Table 2 Diagnostic criteria for diabetes mellitus

Symptoms of diabetes and casual plasma glucose of > 200 mg/dl
Fasting plasma glucose of >126 mg/dl
Two hour post glucose load of > 200 mg/dl during an OGTT

Table 3 Screening recommendations for type 2 diabetes in children and youth

Overweight children: BMI > 85% for age and sex, weight for height > 85% or weight > 120% of ideal for height, PLUS
Any two of the following risk factors:
<ol style="list-style-type: none"> 1. Family history of type 2 diabetes in first- and second-degree relatives. 2. Race/Ethnicity (American Indian, African American, Hispanic, Asian Pacific Islander) 3. Signs of insulin resistance or conditions associated with IR (acanthosis nigricans, hypertension, dyslipidemia and polycystic ovary syndrome)
Age of initiation of screening: 10 years or at onset of puberty (if occurs at younger age)
Frequency: Every two years
Test: Fasting plasma glucose

miliar with diabetes nutrition therapy needs to be provided to any patient with diabetes. Diet advice needs to include appropriate intake of carbohydrate, protein and fat for nutritional requirements as well as to maintain good control of blood sugars.

Exercise has been found to improve glycemic control, insulin sensitivity and cardiovascular fitness. Gradual increase of exercise from 30 to 45 minutes of moderate aerobic activity, three to five days per week will result in a slow but progressive weight loss (one to two pounds per week).

Diabetes self-management education provided by a certified diabetes educator provides the knowledge and skill needed to perform self-care, manage crises and make lifestyle changes.

Pharmacologic therapy

Oral antidiabetic agents can be divided by mechanism of action into insulin sensitizers with primary action in the liver (metformin), insulin sensitizers with primary action in the peripheral tissues (thiazolidinediones), insulin secretagogues (sulfonylurea) and agents that slow the absorption of carbohydrates (alpha-glucosidase inhibitors). Insulin therapy is effective in supplementing endogenous insulin secretion.

The use of metformin, which reduces hepatic and peripheral insulin resistance, in combination with lifestyle intervention is recommended as initial pharmacologic therapy for type 2 diabetes. Addition of thiazolidinediones as well as insulin may be needed to achieve good glycemic control. The critical issue in long-term glycemic management is continuously reassessing with the patient and family the adequacy of control by examining glucose monitoring

logs and HbA1c values, then refining treatment regimens to achieve optimal control with the lowest dose of the fewest medications.

The following are the glycemic targets recommended by American Diabetes Association (ADA) and American College of Endocrinology (ACE):

Parameters	Normal	ADA	ACE
Premeal plasma glucose (mg/dl)	< 100	70- 130	<110
Postprandial plasma glucose (mg/dl)	<140	<180	<140
HbA1c	4-6%	<7%	<6.5%

Detection and treatment of hypertension, dyslipidemia, neuropathy and nephropathy (which may be present at diagnosis) must be a part of initial and long-term management.

Prevention of type 2 diabetes

Patients at risk for type 2 diabetes (fasting glucose > 100 ng/dl or IGT on OGTT) need to be counseled on nutritional approaches and instructed to increase physical activity in order to achieve weight loss. Follow up of progression of abnormal blood sugars is necessary. Treatment for other cardiovascular risk factors such as obesity needs to be considered if present. Long-term weight loss of 5 to 7% of starting weight may reduce risk.

Conclusion

Type 2 diabetes is becoming an important medical condition in the pediatric age group. Lifestyle modifications and pharmacotherapeutic agents are available for management. Controlling the increase of obesity in children will provide an effective preventive measure.

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CME QUESTIONS

10. The increasing incidence of type 2 diabetes in children is strongly correlated with the epidemic of obesity in the pediatric population.
 - a. True
 - b. False
11. Hispanic, Native American and African American children are at higher risk for type 2 diabetes compared to other ethnic groups.
 - a. True
 - b. False
12. Lifestyle changes and treatment of comorbidities are indispensable measures in the management of type 2 diabetes in children and adolescents.
 - a. True
 - b. False

Questions? Comments?

Contact Susan P. Almazan, MD at almazans@childrensdayton.org.

NEWS AND UPDATES

THE CHILDREN'S MEDICAL CENTER OF DAYTON

Medical imaging provides kid-sized doses

Since children are more sensitive to radiation, equipment in Dayton Children's medical imaging department has been reviewed and approved by a medical physicist as emitting a low dose of radiation per test. The pediatric radiologists at Dayton Children's individualize each CT examination to take into account the child's weight and size to insure the minimum radiation to each child while acquiring high quality images. They also work closely with referring physicians to recommend appropriate alternatives (such as MR or ultrasound) to avoid the risk of radiation. Dayton Children's Outpatient Testing Centers – Beavercreek and Springboro and the Specialty Care Center — Warren County also provide low radiation imaging. For more information, call 937-641-3811.

Cutting-edge technology at Dayton Children's

- ▶ Dayton Children's Regional Level III Newborn Intensive Care Unit (NICU) is the only facility in the region with two Olympic Cool-Cap Systems, used for treating hypoxic-ischemic encephalopathy (HIE) in newborns. This equipment is proven to reduce neurological injury in seriously ill infants. Our newborn transport team is available to pick up seriously ill infants 24 hours a day, seven days a week by calling 1-800-855-PEDS (7337).
- ▶ Thanks to a generous donation Dayton Children's was able to purchase a new device called a VeinViewer. This state-of-the-art piece of equipment allows



VeinViewer. State-of-the-art technology helps see veins clearly under skin.

veins to be quickly located and clearly viewed using infrared light to project the vein's location directly on the surface of the skin. The VeinViewer can be used on patients of any age, body or skin type, making blood draws easier and less uncomfortable for our pediatric patients of all sizes.

Specialists join Dayton Children's

Dayton Children's has added several new specialists. Below is a list of our newest additions:

- ▶ David Meagher, MD, medical director, surgery, trauma and burns
- ▶ Moira Pfeifer, MD, endocrinology
- ▶ Chandler Parker, DO, anesthesiology
- ▶ Paul Potter, MD, anesthesiology
- ▶ Patrick Sobande, MD, pulmonary medicine
- ▶ Mark Warren, DO, medical imaging

Please join us in welcoming these physicians to Dayton Children's.

Continuing medical education opportunities

Mark your calendars for Dayton Children's pediatric symposiums

– this year on October 11, at Brown's Run Country Club in Middletown and November 1 at St. Rita's Medical Center in partnership with the Lima Area Medical Education Development. Pediatric experts from pulmonary medicine, developmental pediatrics, infectious disease, neurology and other specialties will provide insight into common and complex problems in infants, children and teens.

Grand rounds online more convenient

We have added a new feature to make our grand rounds online even more convenient. You are now able to complete the post-test and evaluation online – you no longer need a fax machine. Dayton Children's offers free continuing medical education credits throughout grand rounds online program. One grand rounds session is recorded each month for you to watch conveniently from your home or office computer. Visit the *for health care professionals* section of our website, www.childrensdayton.org for more information. For questions or feedback, call 937-641-3618.

Two new orthopedic clinics

Dayton Children's and The Orthopaedic Center for Spinal and Pediatric Care are pleased to be able to now provide two new pediatric orthopedic services - a daily fracture and weekly sports injury clinic. These new clinics are designed to treat children in need of orthopedic injury care – simple to severe. Remember, images taken at any of Dayton Children's off-site locations can be accessed directly in the clinics. For more information on these new services, contact the orthopedics department at 937-641-3010.

PROGRAM EVALUATION

PEDIATRIC FORUM,
VOLUME 20,
NUMBER 2

1. Did the material presented in this publication meet the mission to enhance health care delivery in our region through education based on the essentials and policies of the Accreditation Council for Continuing Medical Education? (Circle one response.)

Strongly agree Agree Neutral Disagree Strongly disagree

2. Did the material presented in this publication meet the educational objectives stated?

_____ Met the stated objectives

_____ Did not meet the stated objectives

3. Please rate the contents of this issue using the following scale:

1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, 5 = Excellent

(Circle one response for each.)

	Poor		Excellent		
Timely, up-to-date?	1	2	3	4	5
Practical?	1	2	3	4	5
Relevant to your practice?	1	2	3	4	5

4. Please describe any changes you plan to make in your clinical practice based on the information presented in this program.

5. Are there any other topics you would like to have addressed in this publication?

_____ Yes

_____ No

If yes, please describe: _____

6. Any other comments/suggestions for future educational programs for health care providers? _____

Physician accreditation statement and credit designation

Wright State University (WSU) Boonshoft School of Medicine is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians. WSU Boonshoft School of Medicine designates this educational activity for a maximum of 2.0 AMA PRA Category 1 Credit(s)TM. Physicians should only claim credit commensurate with the extent of their participation in the activity.

ANSWER SHEET

PEDIATRIC FORUM,
VOLUME 20,
NUMBER 2

Instructions

To obtain CME credit you must:

- Answer the questions from each article and complete this answer sheet.
- Complete the program evaluation located on reverse side.
- Return your completed answer sheet and program evaluation by mail or fax to:

Sue Strader, coordinator
Department of Continuing Medical Education
The Children's Medical Center of Dayton
One Children's Plaza Dayton, OH 45404-1815

Fax: 937-641-5931

The answer sheet and program evaluation must be received by **July 30, 2009** for the credit to be awarded.

Upon completion of all requirements, Wright State University will issue a memorandum of credit to you for your permanent records.

Answers (Please circle the BEST answer.)

1. a b c d
2. a b c d
3. a b c d e
4. a b c d
5. a b c d
6. a b c d
7. True False
8. True False
9. a b c d
10. True False
11. True False
12. True False

Physician accreditation statement and credit designation

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THANK YOU!

Coming Fall 2008



WATCH US GROW!

Dayton Children's is continuing to meet the growing needs of the community by opening two new specialty facilities this fall. Dayton Children's outpatient centers are the only ones in the region devoted to children.

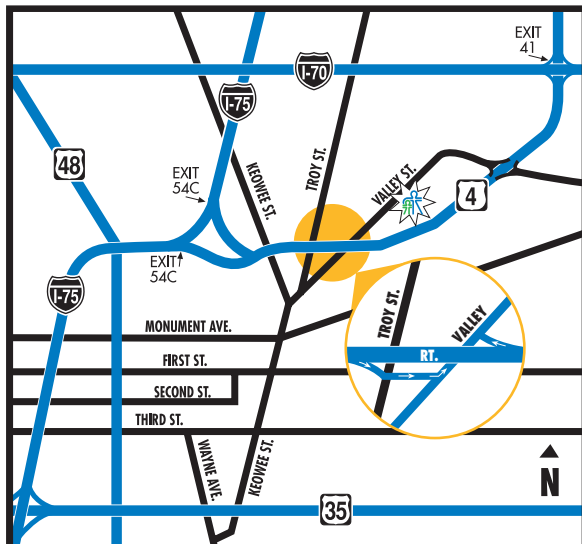
For more information on our new facilities, visit us at www.childrensdayton.org.

▶ **Springboro**
The Outpatient Care Center — Springboro will be conveniently located off Route 741 at 3333 West Tech Road. This new facility is the only one in the region to provide specialized pediatric care including urgent care, laboratory, medical imaging — including x-ray, EKG, ultrasound, CT and fluoroscopy — and rehabilitative services. This building is also under construction to be a LEED (Leadership in Energy and Environmental Design) certified “green” facility. For more information on the Outpatient Care Center, call 937-641-3618.

▶ **Vandalia**
The Outpatient Testing Center — Vandalia is modeled after the current Springboro and Beavercreek centers. This location will offer basic x-ray, ultrasound, echocardiograms, EKGs and full laboratory services. For more information about the new Outpatient Testing Center in Vandalia, call Melanie Wilson at 937-641-5701.



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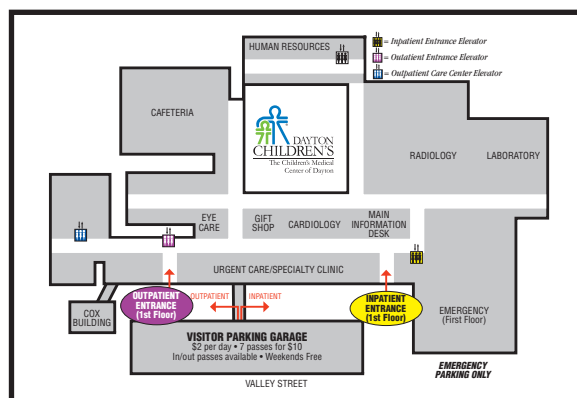
Street Directions

From the North:
I-75 south, Exit 54C to Rt. 4; stay left when exiting I-75; Rt. 4 north to Valley St./Troy St. exit. (Do not exit off at Webster St.) Go through first stop sign at bottom of exit ramp. Valley Street is the next stop sign. Turn left.

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From the East: Rt. 35 west to the Keowee St. exit; right on Keowee St. to Valley St.; right on Valley St. From I-70 Exit 41, take Rt. 4 south to Stanley Ave./Findlay St. exit. Turn right at bottom of exit, then left at the first light on Stanley Ave. This is Valley St.

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