Improving Pediatric Resident Awareness of Inborn Errors of Immunity (IEI): A Quality Improvement Initiative

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INTRODUCTION

Inborn Errors of Immunity (IEI), formerly known as Primary Immune Deficiencies (PID), are a group of rare, yet profoundly impactful, conditions that compromise immune function, leading to recurrent infections, autoimmunity, and malignancies. Early recognition and diagnosis are essential for improving patient outcomes, but remain challenging due to the wide spectrum of clinical presentations.

While early diagnosis is critical to improving outcomes, awareness of the Jeffrey Modell Foundation's "10 Warning Signs of PID" remains insufficient among healthcare professionals. Despite their importance, studies conducted outside the United States have consistently shown poor PID awareness among healthcare providers; yet data on knowledge within U.S. pediatric residency programs—particularly in urban academic centers—remain limited.

This study explores the knowledge and preparedness of pediatric residents at SUNY Downstate Health Sciences University to identify and manage IEIs.

Objectives

•Assess baseline knowledge of IEI among pediatric residents •Identify key knowledge gaps in recognizing warning signs and

understanding management

•Implement and evaluate the impact of targeted educational interventions

•Promote sustained knowledge retention through follow-up assessments

1- A 2-year-old has been treated for ear infections 3 times in the past year, despite completing appropriate antibiotics each time.

2- A 4-year-old child has been diagnosed with sinusitis requiring antibiotics three times since last year

- 3- A 3-year-old has been hospitalized twice this year for pneumonia, requiring oxygen therapy both times.
- 4- An 18-month-old has been on amoxicillin-clavulanate for recurrent otitis media for 3 months with no improvement
- 5- Failure of a child to gain weight normally may be a sign of Primary Immunodeficiency.
- 6- A 2-year-old presents with his third liver abscess requiring drainage within the past year.
- 7- A 1-year-old has persistent oral thrush that hasn't cleared despite multiple courses of oral antifungal medication.
- 8- A 4-year-old requires IV antibiotics in hospital every time she gets a skin infection as oral antibiotics never seem to work.
- 9- A 3-year-old has had sepsis twice in the past year, once from Streptococcus and once from Staphylococcus.
- 10- A 3-year-old develops recurrent cold sores after starting daycare
- 11- A 15-month-old presents with recurrent infections; family history reveals her older brother died at age 2 from severe infections
- 12- Common variable immunodeficiency (CVID) is most often diagnosed in children
- 13- All patients with primary immunodeficiency diseases require immunoglobulin replacement therapy to prevent infections
- 14- Live vaccines are contraindicated for patients with Primary Immunodeficiency
- 15- Primary immunodeficiency diseases are incurable.
- 16- The absence of thymus confirms Di George
- 17- A 2-week-old presents with tetany and seizures
- 18-8-year-old has severe periodontitis with loss of multiple teeth.
- 19- When Primary Immunodeficiency is suspected, the first set of laboratory tests should include lymphocyte surface markers such

20- In the initial evaluation for Primary Immunodeficiency, measuring quantitative levels of immunoglobulins (IgG, IgM, IgA) is

MATERIALS & METHODS

This study was conducted in two phases at SUNY Downstate Health Sciences University:

Pre-Intervention Phase:

Residents completed a baseline anonymous questionnaire evaluating their awareness of the 10 warning signs, general PID knowledge, and common misconceptions.

Intervention Phase:

A series of scheduled educational interventions—including smallgroup lectures and interactive workshops—were delivered to pediatric residents. These sessions focused on:

- Recognition of the 10 warning signs
- Overview of common IEIs and clinical red flags
- Clarifying frequent misconceptions regarding diagnosis, treatment, and vaccines

Educational posters were also distributed in outpatient and inpatient clinical areas to reinforce learning.

Post-Intervention Phase:

The same questionnaire was re-administered following the interventions.

Data were collected and analyzed using SPSS to assess knowledge improvement, stratified by training level and prior Allergy/Immunology rotation.

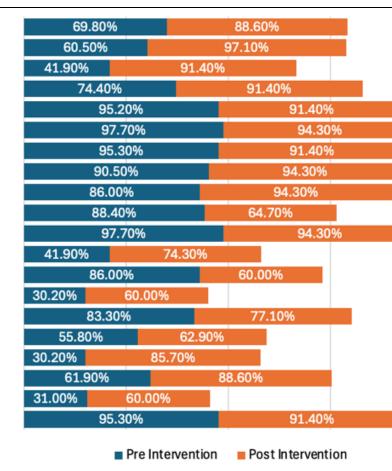


Figure 1: Comparison of correct responses to Primary Immunodeficiency knowledge questions before and after the intervention, showing significant improvements in understanding.

Results

Prior to the intervention, correct answer rates improved progressively with residency level: PGY-1 residents answered 67.5% of questions correctly, PGY-2 residents 71%, and PGY-3 residents 79%. Residents with previous Allergy/Immunology (AI) rotations demonstrated higher accuracy (79.5%) compared to those without (69%). Common misconceptions identified during the pre-intervention phase included live vaccine safety (only 30.2% answered correctly) and universal need for immunoglobulin therapy (correct in just 18%).

Post-intervention analysis showed statistically significant improvements in several key areas (figure 1). Recognition of recurrent ear infections improved from 69.8% to 88.6% (p = .045), recurrent sinusitis from 60.5% to 97.1% (p < .001), and pneumonia requiring hospitalization from 41.9% to 91.4% (p < .001). Knowledge about CVID diagnosis age improved from 41.9% to 74.3% (p = .004), CD markers as diagnostic tools from 31.0% to 60.0% (p = .011), and live vaccine contraindications from 30.2% to 60.0% (p = .008). However, knowledge decreased for the item on recurrent cold sores, dropping from 88.4% to 64.7% (p = .013).

Overall, PGY-3 residents and those with prior AI rotations performed better (figure 2). The intervention led to a statistically significant improvement in overall scores (p < .001), with the median increasing from 70% (IQR=60-75%) before intervention to 85% (IQR=70-95%) after intervention, indicating a meaningful increase in knowledge and diagnostic confidence.

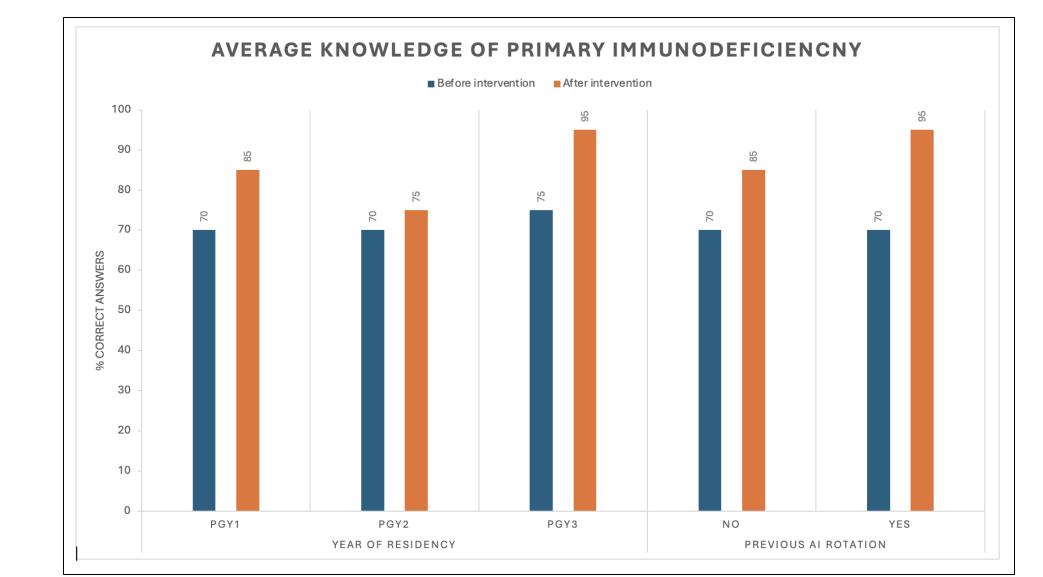


Figure 2: Knowledge of PID pre and post-intervention based on PGY and Previous AI rotation

While improvements were evident, some misconceptions persisted, emphasizing the need for sustained and structured educational reinforcement. Future phases of this quality improvement project will include repeated interventions at 2-, 4-, and 6-month intervals to assess knowledge retention and further enhance clinical competence.

Inborn Errors of Immunity (IEI), formerly known as PIDs, are rare yet serious conditions that require timely diagnosis to prevent longterm complications. Implementing a structured educational framework based on the 10 warning signs—combined with accessible resources and clinical decision support—can significantly empower trainees to identify these conditions earlier. Continued efforts in education and system-based support are essential for improving outcomes in children with immunodeficiencies.



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CONCLUSIONS

This study highlights important knowledge gaps among pediatric residents in identifying and managing Primary Immunodeficiencies (PIDs), particularly in recognizing subtle clinical signs and understanding diagnostic pathways. Following a focused educational intervention, residents demonstrated significant improvement in diagnostic awareness, particularly in recognizing common clinical indicators such as recurrent infections and the appropriate use of diagnostic markers. Self-reported confidence and perceived knowledge also improved, reflecting the value of brief, targeted educational sessions.

REFERECNES

Jeffrey Modell Foundation Medical Advisory Board. Consultation with Primary Immunodeficiency experts is strongly suggested. © 2024 Jeffrey Modell Foundation

nternational Union of Immunological Societies Expert Committee on Primary ImmunodeficienciesNotarangelo LD, Fischer A, Geha RS, Casanova J-L, Chapel H, et al. Primary immunodeficiencies: 2009 update. J Allergy Clin Immunol 2009;124:1161–78. Boyle JM, Buckley RH.

3. Population prevalence of diagnosed primary immunodeficiency diseases in the United States. J Clin I mmunol 2007;27(5):497–502.

4. Rubin Z, Pappalardo A, Schwartz A, Antoon JW. Prevalence and outcomes of primary immunodeficiency in hospitalized children in the united states. J Allergy Clin Immunol Pract 2018;6:1705–17010.e1.