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The need for Evidence-Based Practice (EBP) at the point of care has been well emphasized and identified by the Institute of Medicine (IOM) as a core competency for bedside clinicians.\(^1\) More than research utilization, EBP is a clinical problem-solving process that begins with a spirit of inquiry. It continues with appropriately formatting a clinical question, allowing a productive literature search. Once the evidence is critically appraised, it is integrated into clinical experience and relevancy to a patient population. Finally, the clinician evaluates the outcome and, when appropriate, disseminates the findings.\(^2\)

EBP empowers nurses to act as agents of change by giving them the tools to offer the highest-quality patient outcomes. Nursing baccalaureate and residency programs have made substantial progress in addressing the IOM’s call for EBP-competent clinicians by integrating EBP into their curriculums. Novice nurses, however, are adjusting to a new practice setting and lack context for the final steps of the EBP process. The expert in this area is the experienced nurse, but thus far they have not been targeted as rigorously as graduate nurses in use and relevancy of EBP. Recent surveys highlight this deficit, indicating that bedside nurses are still not consistently utilizing EBP.\(^3\)

If practicing nurses are not routinely utilizing evidence to inform their care, then novice nurses are not received into a system that supports the skills gained in their education. This discontinuity between academia and clinical practice threatens to weaken the momentum gained in educating the newest generation of nurses. An integral component in sustaining the paradigm shift called for by the IOM is the cohort of experienced nurses, and it is here where there is work to be done.

The host of new practices in a new practice setting can overwhelm a novice nurse and may temper their enthusiasm for EBP. To carry their skill set to the point of care, novice nurses need reinforcement and guidance in reconciling theory and implementation of EBP. Practicing nurses the key facilitators, but they need both belief in the value of EBP and the skills to engage in the process. If these factors remain unaddressed, there is risk for losing the investment made in EBP-competent graduate nurses. Take, for example, the common practice of inline suctioning an endotracheal tube. A new nurse may question when it is appropriate to lavage the airway with normal saline, and an experienced nurse who lacks proficiency in EBP is more likely to defer to anecdotal experience or collective opinion for the answer. The two parties in this conversation are hindered by lack of a shared mental model; both bring valuable insight, but a nurse without an EBP skill set cannot effectively mentor the novice nurse in exploring a clinical inquiry. Conversely, when the experienced nurse is also proficient in EBP, the dynamics of the interaction change.

The decision about use of saline with inline suctioning will be supported by both evidence and clinical expertise, illustrating the applicability of EBP at the point of care and developing the capacity built in nursing education. There are innumerable opportunities for dialogue about care guided by evidence within any practice setting, but they cannot be capitalized upon without a common language. The necessity of a cadre of EBP-competent nurses understood, the question that remains is how to best reach them?

Garnering support for EBP can be a challenge, as it has propensity to feel like another obligation to a population whose practice has already adapted to a host of changes. Additionally,
its message is often cloaked in the idea that it contrasts the judgment crafted throughout a career. Furthermore, a lack of confidence in the ability to find the evidence-based answer to a clinical question is a significant barrier to EBP use. One key strategy for addressing both misconceptions and feasibility is to train and establish EBP mentors. When clinicians at the point of care are proficient in EBP, they reinforce the message that EBP compliments nursing experience. Ideal candidates to act as mentors are clinical preceptors, as they have already identified themselves as having the desire and aptitude to mentor novice nurses. Clinical educators are also well suited to the role of EBP mentors, as they are resources for best practice and continuing education. Many institutions have structured training in place for these roles, into which additional EBP training could be incorporated. Preceptors and educators work alongside experienced colleagues daily and are also key contacts for new nurses. Their unique position brings significant opportunity for facilitating the movement of EBP from academia to the bedside. Other opportunities for bringing experienced nurses into an EBP culture exist in EBP-focused nursing grand rounds and the development of clinical practice councils to serve as resources. Each of these strategies requires investment on the organization’s part, but they optimize use of resources by building upon infrastructure already in place in many institutions.

Building and sustaining an EBP culture is imperative in ensuring high-quality patient outcomes. The efforts in educating graduate nurses in use of EBP are necessary to establish a new baseline in care, but they are a poor investment if not well bridged to experienced nurses. Providing experienced nurses the insight and skills to be proficient in EBP is the most reliable way to assure that the transition from graduate to bedside nurse supports the adaptation of EBP to health care systems. To achieve an effective paradigm shift with EBP as a functional component of care delivery, organizations must diligently pursue their current bedside clinicians to act as EBP champions.

REFERENCES


Enhancing Child Health and Welfare Following Disasters and Public Health Emergencies in Schools and University Health Centers

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ABSTRACT

Our nation’s families trust schools to protect the health and welfare of their children while in the educational setting. This task has become increasingly difficult to accomplish given the multitude of hazards that threaten our schools and the people in them on a daily basis. The frequency and intensity of natural disasters such as hurricanes, earthquakes, tornadoes, and floods is increasing. Human-made disaster events such as active shooters, bomb threats, and other acts of terrorism are persistent challenges for preparedness and response and have been in the light of media attention with increasing frequency in the past several years. The role of the nurse working in a school or university health center as a member of the disaster response team is critical to the successful management of disasters.

KEYWORDS: Child health; Health emergencies in schools; School-based nurses.


INTRODUCTION

Schools and universities across the United States are entrusted to provide a safe and healthy learning environment for students, faculty, and staff who live, work, and study on campus. More than 50 million children were enrolled in over 98,000 public elementary and secondary schools in 2014 and 21 million students were enrolled in a college or university.1 Faced with emergencies ranging from active shooter situations to fires, tornadoes, floods, hurricanes, earthquakes, and pandemic influenza; school-based nurses must maintain a level of situational awareness and readiness to respond to situations that threaten our nation’s children.2 Many of these emergencies occur with little to no warning. Therefore, it is critical for educational institutions and the nurses who work with them to plan ahead in order to help ensure the safety and general welfare of all members of the campus community.

In 2010, the National Commission on Children in Disasters (NCCD) was established to evaluate the nation’s level of disaster preparedness for children.3 The commission found that many schools and school districts had disaster plans but few aligned with federal recommendations.2 There was a general lack of plans for accommodating children with special needs and plans for continuing education if the school was closed for an extended period of...
time. Schools seem to be struggling with prevention programs; only 57.2% of superintendents surveyed said their school district had disaster or emergency prevention plans. Recent studies echo these findings and indicate that improvement in comprehensive and all-inclusive disaster plans for schools are still needed. Out of 1,997 school nurses surveyed from 26 states only 2.2% of respondents said their school had a mandatory influenza vaccination policy for students and staff. The same study evaluated school districts on their level of preparedness for pandemic influenza on a scale of 0 to 10 and the average score was only 4.3.

REVIEW OF SCHOOL HAZARDS AND IMPLICATIONS FOR STUDENT HEALTH SERVICES

Schools and universities (school systems) are subject to the same disasters as the local community but also additional hazardous situations unique to a school setting due to the congregation of children who have their own unique needs and vulnerabilities. School systems need to prepare for natural disasters that commonly affect their local and regional community (tornadoes, hurricanes, floods, etc.) but must focus preparedness efforts to address situations that have emerged as a threat to students and the educational campus as well.

Natural/Weather-Related Disasters

When planning for natural disasters, schools need to prepare for those events that come with and without warning. For example, tornadoes and earthquakes often strike with no or very short warning systems whereas hurricanes, blizzards, and other inclement weather events may be known well in advance. In either case, the school system needs to have written emergency response plans for preparedness, response, and recovery from these events as they pose serious immediate risk of injury and death along with lasting damage and destruction to the community. A review of recent natural disasters in the US indicates the need to not only strengthen plans for immediate disaster response, but also in providing care for students after these events.

After the destruction brought on by hurricane Katrina and Rita in 2005 school/university nurses and mental health experts became instrumental in disaster response and recovery efforts. Even with advanced warning systems in place, students still faced a wide array of physical and psychological injuries and damages. School based-nurses and mental health experts in surrounding areas served to coordinate care, provide mental health services, and facilitate a transition back to pre-disaster functioning. In 2011, an EF-5 tornado struck Joplin, Missouri and severely damaged half of the area’s schools. Luckily, it occurred on a Sunday afternoon and schools were not in session at the time, but administrators and school officials still had to plan to resume school services. School-based nurses were called upon to provide their expertise in integrating children back into schools while tending to the psychological and physical needs of the community’s children.

Fire, Explosion, and Building Collapse

Fires and other events that compromise the structural integrity of school buildings are rather frequent events. An average of nearly 5,700 fires in academic buildings and nearly 4,000 in collegiate housing have been reported to fire officials every year. Advances in preparedness efforts have drastically reduced deaths from fires in schools to an average of only 1 per year in educational building and 2 per year in collegiate housing while also reducing the costs of damage from fires. However, since these are high-frequency events with potential to affect any school building, school-based nurses must remain vigilant in preparedness for these events. Consider reviewing fire drill procedures and evacuation protocols for the school paying close attention to students with special needs or those who will need assistance with evacuation (see sections later in this publication for more information). In addition to assistance with evacuation planning, the school nurse may need to prepare to assist students who were injured during any fires including the potential management of smoke inhalation injuries, exacerbation of pulmonary disease (e.g. asthma attacks), and the provision of first aid until emergency responders arrive.

Pandemic Influenza

According to the Centers for Disease Control and Prevention (CDC), only 44.6% of school aged children (5-12 years) and 31.8% of adolescents (13-17 years) received the flu vaccine in 2014. Despite the heightened awareness of the severity of communicable diseases with the Ebola epidemic, immunization rates for influenza remain largely unchanged from the previous year. Children in schools are particularly susceptible to influenza due to relatively low immunization rates and the high number of individuals who remain within the schools. Nurses need to be prepared for large numbers of sick children and to rapidly institute standard disease containment strategies. School and universities may be asked to become point of distribution clinics or mass immunization centers. By applying their medical knowledge and leveraging the trust of the community, school-based nurses may become key players in slowing the spread of pandemic influenza.

Active Shooters

Shootings at the elementary, secondary, and university level have increased significantly. Deaths from gun-related violence within schools have been so high that communities now refer to some of the events as “massacres”. The 2012 shooting at Sandy Hook Elementary that resulted in the death of 20 children and 6 adults sparked national debates on gun control and discussions on how children can be kept safe at schools. It was the second worst school-related shooting in history, second only to what is now known as the Virginia Tech massacre that took the lives of 32 only six years earlier. Since 2010, there have been more than 106 gun-related shooting at schools or universities resulting in the death of more than 110 children.
Nuclear Power Plant and Chemical Plant Failures

Schools located near industrial facilities, such as nuclear power plants or chemical and oil refineries, must prepare for incidents at these sites. While these events are extremely rare, they can have massive impact on schools and communities. The Fukushima Daiichi nuclear disaster of March 2011 serves as an example. An earthquake and resultant tsunami led to structural damage to the power plant; several reactors exploded and released colossal amounts of radiation into the surrounding environment. Massive evacuation, economic losses, widespread panic, and loss of life resulted from the nuclear meltdown. The incident was so devastating that it sparked international discussion on disaster prevention and preparedness efforts for nuclear events.

STUDENTS WITH SPECIAL NEEDS

Today’s school/university nurse must be constantly aware and vigilant of children enrolled at the school who have chronic medical conditions (e.g., asthma, diabetes, seizure disorders, mental health disorders, etc), special healthcare needs, developmental disabilities, and those who are technology-dependent (e.g., ventilators, need for suction or tube feedings, wheelchair bound, etc). These students should be identified early as they will be more vulnerable to a disaster situation. When unforeseen events strike, these children, adolescents and young adults may have difficulty in independently seeking safety or protecting themselves; their lives can be heavily dependent on the actions of those around them. Plans for the evacuation or sheltering of these children must be discussed with their primary caretaker or teacher as well as with the child if appropriate. Using developmentally-appropriate means to discuss their role during disasters with children allows them ease their tensions about disasters and discuss their own concerns. The nurse should facilitate the discussion and planning for these children with school officials, special education teachers, school aids, and others involved in the day-to-day care of these children to ensure that their needs are not overlooked during a disaster.

ROLE OF THE SCHOOL/UNIVERSITY NURSE IN DISASTERS AND PUBLIC HEALTH EMERGENCIES

The daily functions of the school/university nurse center around health promotion, education, and ensuring safety. During an emergency or disaster, the nurse’s focus must immediately shift to keeping the children, adolescents, and young adults under his or her care alive and safe. As such, the nurse must be a partner in planning for disasters and emergencies as recommended by National Association of School Nurses (NASN). The role that the school nurse will play in disaster response and mitigation may vary based upon their individual state’s scope of practice and other governing bodies. It is the responsibility of the school/university nurse to understand their role or advocate for their position to be heavily involved in planning and responding to disasters that affect the children and young adults under their care. Resources for the school/university nurse to use in disaster planning are included at the end of this article.

Communities trust school-based nurses and desire their participation in disaster preparedness and response activities. During the H1N1 outbreak, parents in Massachusetts became worried, even panicked, about allowing their children to attend school. Calls flooded the schools and community health departments with inquiries regarding safety but the community panic was controlled once the school-based nurses entered the discussion. Parents trusted the expertise of the nursing staff and shortly thereafter calls on the topic ceased completely.

The National Association of School Nurses (NASN) 2014 official position statement on the role of the school nurse in emergency and disaster preparedness states “as healthcare providers, nurses must be involved in all phases of disaster or emergency preparedness and response”. Nurses are trained experts in using and applying the nursing process of assessment, diagnosis, planning, implementation, and evaluation. Their educational and clinical expertise is built upon the foundation of applying this system to a multitude of situations.

The nursing process closely aligns with Federal Emergency Management Agency (FEMA) disaster preparedness cycle. Nurses, as experts in applying the nursing process in multiple clinical situations, can approach disasters with a well-established and useful framework. School-based nurses are often the first healthcare professional to respond to an emergency or disaster on school grounds and must be knowledgeable of their role and responsibilities to manage the disaster until support services arrive. They must be involved in preparation of plans to handle events that may affect one person or the entire student body and faculty/staff at the school.

Preparedness

Nursing has long-stood as a field dedicated to making a difference in healthcare by collecting data and applying it to clinical situations. Surveillance, data collection, and assessment are crucial components to the nursing theory. Recent studies suggest that school-based nurses working in disaster and emergency preparedness save lives. School-based nurses need to participate in ongoing assessments aimed to identify all hazards that may threaten the school. For example, the nurse may identify that the school is threatened by the same inclement weather patterns that affect the community (tornado season, hurricane season, etc.) but also recognizes that the threat of infectious disease, violent persons, and acts of terrorism are unique threats to his or her school. Nurses, with their holistic approach to treating individuals, are well-equipped to recognize the unique threats to groups of children. They are well attuned to preparing for and responding to behavioral or mental health events or in planning for the special needs of children with disabilities in disaster. Whatever the case, the school-based nurse must be involved in disaster preparedness and planning efforts and should also be a member of community-wide planning groups. Part of maintaining a constant level of preparedness also means that the nurse
must remain attentive to local warning systems, maintain relationships with appropriate community organizations, and stay educated on their responsibilities as a school-based nurse.

Prevention and Mitigation

Planning for disasters and public health emergencies and strategies to mitigate the damaging effects of these events is dependent upon the strength of school and community partnerships. In turn, the establishment and nurturing of these partnerships will be dependent upon the degree of Collaboration, Coordination, and Ongoing communication (referred to as the “3 C’s” of disaster management) that is established between the partners. Nurses can establish and conduct school safety programs that educate the students and community about disaster preparedness efforts and steps they can take to prevent disasters.6,22 By participating in school safety assessments and environmental assessments, school-based nurses can identify potential hazards and risks and develop plans to reduce their potential for harm.6,23

Procurement of Emergency Equipment

As part of the school crisis team, school/university nurses must assess the medical equipment and supplies required to respond to a wide variety of emergencies and disasters for children and adolescents.24 The Emergency Medical Services for Children (EMSC) National Resource Center (NRC) and the NASN have jointly compiled a list of medical supplies that are necessary for emergencies in all schools.25 The NASN also maintains a list of emergency resources, equipment, and supplies as a guideline for emergency equipment recommendations for school-based nurses.4 Nurses need to not only obtain enough supplies required to tend to the school population, but also ensure that the items are age appropriate and the necessary staff is knowledgeable on equipment usage. School-based nurses should recognize that the supplies required to handle day-to-day emergencies will not be sufficient in the case of a large-scale disaster.24 The school may also become a shelter for the community in times of a disaster and will need to have a stockpile of supplies and equipment to appropriately handle such a situation.24

Collaboration & Communication with Parents

Communication remains a mainstay during preparedness, mitigation, response, and recovery efforts. Incorporating advanced warning systems into new technologies, such as text message alerts for students on college campuses, affords more time for preparation for disasters including the need to shelter in place or evacuate. Schools and universities must focus communication to include means by which they can contact emergency responders, local hospitals, and other key players in disaster response.24 During times of disaster, communication should continue to be provided by whatever means the community uses most frequently; changing from one modality to another during a disaster is not recommended.23 Disasters themselves may inhibit normal means of communication due to electrical outages or damaging cellular towers. School systems must therefore inform families and the community of their plans far before any disaster strikes. Breakdown in normal daily communication can be accounted for by letting families know where their children will be located in the case of an evacuation, protocols for school lockdowns, and who is approved to pick up their children and adolescents after such events.

Response

During a disaster or emergency the nurse will function as a key leader in all response efforts.4 The nurse will triage victims, direct first aid and emergency care, provide mental health care, and coordinate with first responders when they arrive. Nurses will play a role in the incident command system and establish treatment areas.22 In order to effectively carry out this role, the school-based nurse must be intimately familiar with all disaster response plans and be comfortable as a leader. Mock exercises, drills, and tabletop exercises can help prepare responders and school-based nurses for their role.25 Lives are saved when all members of the response team can carry out their tasks efficiently. Typical hazards and threats to safety along with their respected response strategies and the role of the school-based nurse in responding to these events are displayed in table 1 and further discussed in the next section of this paper.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Current Guidelines for Response Strategy</th>
<th>Role of the School-Based Nurse</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire</td>
<td>Evacuation</td>
<td>• Ensure evacuation plans are comprehensive and complete&lt;br&gt;• Educate staff and students on their roles during evacuation&lt;br&gt;• Conduct regular drills&lt;br&gt;• Coordinate plans with school transportation officials and local emergency response agencies&lt;br&gt;• Ensure children with disabilities are accounted for and staff can accommodate their needs&lt;br&gt;• Evaluate plans annually or any time new students with disabilities are enrolled in the school</td>
<td>FEMA Guide for Developing High-Quality School Emergency Operations Plans&lt;br&gt;<a href="http://www.dhs.gov/sites/default/files/publications/REMS%20K-12%20Guide%2050508_0.pdf">http://www.dhs.gov/sites/default/files/publications/REMS%20K-12%20Guide%2050508_0.pdf</a></td>
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<td>Bomb Threat</td>
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<td>Structural Compromise</td>
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<td>Event</td>
<td>Shelter-in-Place</td>
<td>Lockdown</td>
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<tr>
<td>Tornado</td>
<td>- Listen to emergency television and radio broadcasts for instructions</td>
<td>- Draft plans for evacuation and lockdown procedures</td>
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<tr>
<td>Inclement Weather</td>
<td>- Provide first aid as indicated</td>
<td>- Identify a means to communicate the need for a lockdown</td>
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<td>Earthquake</td>
<td>- Ensure all students and staff can move to a pre-determined safe location inside the school</td>
<td>- Ensure staff and students know the signal for a lockdown and their associated responsibilities</td>
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<tr>
<td>Blizzard</td>
<td>- Initiate contact means to notify families that sheltering has begun</td>
<td>- Discuss responses with faculty including the potential to aggressively fight back</td>
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<td></td>
<td>- Ration and provide food, clean water, toilet, and bathroom facilities</td>
<td>- Assess environmental factors (door/window locks, items to use as weapons, etc.)</td>
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<tr>
<td></td>
<td>- Manage student medications as needed</td>
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</table>

Sources:
- CDC Emergency Preparedness and Response Learn How to Shelter in Place
  - [http://emergency.cdc.gov/preparedness/shelter/](http://emergency.cdc.gov/preparedness/shelter/)
- Ready.gov Shelter
  - [http://www.ready.gov/shelter](http://www.ready.gov/shelter)
- Readiness and Emergency Management for Schools Active Shooter Situations: Responding to an Active Shooter Situation
  - [http://rems.ed.gov/IHERespondToActiveShooter.aspx](http://rems.ed.gov/IHERespondToActiveShooter.aspx)
- U.S. Department of Justice Federal Bureau of Investigation Active Shooter Event: Quick Reference Guide
- Centers for Disease Control and Prevention Guide for School Administrators to Help Reduce the Spread of Seasonal Influenza in K-12 Schools
  - [http://www.cdc.gov/flu/school/guidance.htm](http://www.cdc.gov/flu/school/guidance.htm)
- Center for Disease Control and Prevention Influenza School-Located Vaccination (SLV): Information for Planners
  - [http://www.cdc.gov/flu/school/slv/index.htm](http://www.cdc.gov/flu/school/slv/index.htm)
- U.S. Department of Health and Human Safety School District (K-12) Pandemic Influenza Planning Checklist
- Colleges and Universities Pandemic Influenza Planning Checklist
Disaster/Mass Casualty Triage

Triage models change drastically during times of disasters. In mass casualty incidents, the goal of triage is to sort students and staff by the needs for immediate care while also considering and recognizing the needs of the greater group.22 The nurse must realize that the needs of those affected greatly outweigh available resources. Triage is performed in 2 basic steps; first assess the scene and make basic observations and rapid decisions, and secondly to match the victim’s needs with resources at hand while beginning treatment and setting priorities for transport.22 The nurse can accomplish this secondary portion of triage by labeling individuals according to their condition. Traditionally, this correlates with color; black for those who are deceased or death is imminent, red for correctable but immediately life-threatening injuries, yellow for the serious but not life-threatening injuries, and green for anyone with non-emergent needs.22

Recovery

The goal after a disaster or emergency is to reunite families with their children and facilitates a transition back to normal daily activities. In the time immediately after a disaster, the nurse may be involved in maintenance of student health, building family partnerships, addressing staff wellness concerns, and providing mental health services for students.22 In regards to long-term recovery efforts, the nurse will be involved in ongoing injury and illness care management, psychological responses to the disaster, and evaluation of the response capacity and activities to the disaster.22 Mental health needs of all individuals involved in a disaster have emerged as a main focus of recovery efforts. School-based nurses may find themselves coordinating mental health services for the entire school, networking or collaborating with school counselors/psychologists and community mental health providers.24 Nurses may be fulfilling these roles even if their school is not directly affected by the disaster or if the school is enrolling students who cannot return to their original campus.

CURRENT RESPONSE STRATEGIES

It is imperative that the school-based nurse be heavily involved in all aspects of disaster planning to be well aware of their roles and responsibilities during a disaster. It is the responsibility of the school-based nurse to be involved in networking with local emergency response teams, disaster preparedness agencies, the local Red Cross Chapter, school board, department of education, or other key players in preparedness to ensure that the school and its community are working synchronously to protect its children. During any disaster response the school-based nurse needs to make sure that the school’s emergency plan is activated and that all steps are being carried out and followed by appropriate staff. The nurse will also be the go-to reference for any medical need and will become the leader in providing first aid, triage, mental health services, and any other medical intervention.

Evacuation

The need for evacuation arises when situations within the school are no longer safe because of terrorism, bomb threats, fires, or structural compromise (i.e. after an earthquake). During planning, the disaster preparedness team must consider several situations; how to safely move students, how to communicate the need for evacuation, secondary evacuation routes in case the primary route is compromised, safe sites for evacuation based on the hazard, evacuation of students without teachers or staff, to use a bus or walk, transport of students with disabilities, and how to account for students after evacuation.26 Consultation with the fire department, Emergency Medical Services (EMS), and police departments is indicated to develop evacuation plans.27

Table 1: Response strategies and roles of the school-based nurse during hazards.

<table>
<thead>
<tr>
<th>Hazards</th>
<th>Response Strategies</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Exposure</td>
<td>• Perform a risk assessment for the potential of mass chemical exposure</td>
<td>Ready.gov Shelter <a href="http://www.ready.gov/shelter">http://www.ready.gov/shelter</a></td>
</tr>
<tr>
<td></td>
<td>• Network with local agencies to develop plans</td>
<td>CDC Emergency Preparedness and Response <a href="http://emergency.cdc.gov/planning/evacuation-facts.asp">Chemical Agents: Facts About Evacuation</a></td>
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<tr>
<td></td>
<td>• Contact nearby chemical refineries or plants to discuss means of communicating the need to take action</td>
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<tr>
<td></td>
<td>• Monitor for signs and symptoms of chemical exposure in children and staff on campus during and after critical events</td>
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<tr>
<td>Radiation Exposure</td>
<td>• Educate staff and students on their roles during a response to nuclear or radiation exposure</td>
<td>Ready.gov Nuclear Power Plants <a href="http://www.ready.gov/nuclear-power-plants">http://www.ready.gov/nuclear-power-plants</a></td>
</tr>
<tr>
<td></td>
<td>• Maintain communication with local response agencies and nearby nuclear plants</td>
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<tr>
<td></td>
<td>• Perform decontamination of staff and students if indicated</td>
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Conducting regular evacuation drills ensures that all students and staff know how to safely exit the building and allows the school-based nurse to evaluate the effectiveness of the plans.

Shelter-in-Place

Shelter-in-place is a situation where individuals seek shelter where they are, in this case the school, because the threat of leaving outweighs the benefit of staying. Situations requiring shelter include inclement weather, tornadoes, and tropical storms. Earthquakes require a modified sheltering (hiding under desks) and sometimes mass radiological or chemical exposures may require shelter-in-place. These last two situations are discussed in their own section.

When the need to shelter arises, the responsible party activates the school’s emergency plan including the notification to shelter via an alarm system or announcement. All students, staff, and visitors must report to pre-determined safe areas within the building. These areas are typically rooms or hallways in the center of the school that are free of windows or doors to the outside. Sheltering plans must include a means to maintain communication (via telephone or cellular phone) or monitoring warning systems by television or battery operated radio. The school-based nurse may be asked to be in charge of essential supplies including bottled water and food stores to sustain those in the school for an extended period of time. Even if not asked to be in charge of all supplies, the nurse should be in charge of all medical supplies including essential medications for students, first aid kit, and defibrillator. Once officials announce that the situation is safe and sheltering is no longer necessary, normal daily functions can begin. The nurse should then ensure that all medical needs of the children and staff are met and provide any interventions as needed.

Lockdown

In the situation that there is an unsafe person on campus, including an active shooter, schools must enter a lockdown mode to protect the lives of the students and staff on campus. Previous events with active shooters on school grounds, as discussed above, have shown us that the shooter’s general goal is to take the lives of as many individuals as possible and then commit suicide. Therefore, the response plans are built upon the assumptions of these actions. Upon discovery of a dangerous person on campus, officials must immediately notify the school of the need for a lockdown and call 911.

The role of the students and staff is to immediately respond with a run-hide-fight approach. The first response strategy is to run and get as many people out of harm’s way as possible. This requires a planned escape route, the need to leave all belongings behind, and helping others escape if possible. If running is not an option, individuals should hide in an area out of the dangerous person’s view, lock all classroom doors, turn off the lights, stay out of sight to make the classroom appear empty, and remain absolutely silent. In the case where running and hiding are not viable options, responding with brute and aggressive force if confronted is indicated. The choice to physically confront a dangerous person is up to the individual and cannot be included in their employment requirements but utilization of aggressive force and classroom items as weapons (fire extinguishers, chairs, etc.) has stopped attackers in past events.

The role of the school-based nurse in these instances is to ensure that students and staff know the plans for responding to dangerous persons, facilitate drills and assessments of response, and pay careful attention to special education classrooms and children with disabilities when plans are being drafted. The school-based nurse may also play a role in prevention of some of these incidences as he or she may be tending to the psychological needs of children at the school and can help identify children who show aggressive or dangerous actions and may pose a threat to others on campus.

Social Distancing and Immunization

Nurses must also work to help inform the department of health of increasing signs and symptoms of influenza or infectious diseases. The school-based nurse must leverage the trust the community has in them and act as an appropriate educator on the importance of immunization, hygiene, and treatment modalities for influenza. Holding immunization clinics in the school setting can combat influenza outbreaks in the community because it allows for the immunization of large numbers of children. Schools can recruit the assistance of the health department to run immunization clinics. During times of pandemic influenza outbreaks the school may also serve as a Point of Distribution (POD) clinic and begin immunization of high risk individuals, of which children are included. School-based nurses may also be asked for input regarding non-pharmacological means by which influenza can be controlled. Directing sanitation and disinfection throughout the school buildings may be one way the school-based nurse reduces future infections. Social distancing may also be implemented in order to reduce the contact students have with each other and therefore restrict the ability for communicable diseases to spread throughout the community. Social distancing includes cancellation of mass events, restricting individuals from entering areas with close contact of others, and possible school cancellations.

Chemical Exposure Responses

In the case of a mass chemical exposure, the school/university may need to either prepare to shelter-in-place with extra precautions or evacuate the children and staff immediately. Directions for which action to take will be provided by the local officials or the emergency operations manager from the chemical facility depending on the source of the offending agents. If sheltering-in-place is indicated, preparations follow aforementioned steps of sheltering with a few additional precautions. In addition to moving all persons to a safe location, outside air must be sealed out of the building or area housing people. By turning off all fans, closing windows and vents, and sealing windows or...
The need for evacuation during chemical exposure will be communicated via local police, emergency coordinators, or government officials through television and/or radio broadcast systems. Local officials will direct evacuees to pre-determined shelters appropriate for the hazard. Otherwise, school evacuation should continue via standard evacuation procedures as described above.

Radiation Exposure Responses

Schools and universities located within 50 miles of nuclear plants may be subjected to radiation exposure in the event of a large release of nuclear or radioactive material. Similar to chemical exposures, responses to radiation exposures fall into two categories; evacuate or shelter-in-place; the directions for which action to take will come from the emergency alert system. In the case of evacuation, actions should be carried out in alignment with previously mentioned principles of evacuation. Keeping the windows and vents of school busses closed is important when evacuating due to radiation exposure to minimize contamination of the inside of the vehicle. Sheltering principles are the same as previously discussed with some added concepts. Sealing all windows, doors, and outside vents in a similar fashion to chemical emergencies is indicated. Students and staff should be sheltered in the basement of the school if available or in the center of the building. Increasing the number of walls or objects between people and the outside environment will reduce radiation exposure. Ground water may be contaminated and should not be consumed until experts agree it is safe. The school-based nurse may find themselves faced with the need to decontaminate children or staff that may have been exposed to airborne radiation particles, i.e. if they were outside during the time of a nuclear blast. Removing clothing, storing them in a thick plastic bag away from all individuals, and showering/washing the hair and skin with mild soap while avoiding scrubbing or scraping the skin can remove up to 90% of contamination. Transfer to the emergency department as soon as possible for further evaluation is indicated for these individuals. Potassium iodide (KI) is used to prevent the thyroid from taking up radioactive iodine by saturating the thyroid gland with iodine, any additional iodine substances will then be eliminated from the body. The US Food and Drug Administration recommend prophylactically treating children with KI in the event of radiation exposure as quickly as possible. Schools should therefore stock KI in sufficient quantities to treat all students and staff and also understand the usage of KI in such an event. Table 2 outlines proper dosage of KI as provided by the Food and Drug Administration (FDA).

CONCLUSION

Our world is not a safe place to live and yet each day school and university systems are charged with creating and maintaining safe environments for children to learn. During disaster events the responsibility for responding and protecting the health and well-being of children will fall to the nurse. Knowledge of the hazards schools and universities face allows the nurse to prepare for these events. Nurse participation in planning and preparedness efforts can influence the development of disaster response plans that will accommodate all students enrolled in the school or university setting. Finally, awareness of and the skills and abilities to implement appropriate disaster response strategies can improve student health outcomes and save lives.

CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

Resources and Tools

American Red Cross
Prepare your School
http://www.redcross.org/prepare/location/school
Preparedness Education
http://www.redcross.org/prepare/location/school/preparedness-education

CDC Emergency Preparedness and Response
Caring for Children in a Disaster

<table>
<thead>
<tr>
<th></th>
<th>KI Dose (mg)</th>
<th>Number of 130mg Tablets</th>
<th>Number of 65mg Tablets</th>
<th>Milliliters of Oral solution (65mg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adolescent of Adult Size</td>
<td>130mg</td>
<td>1</td>
<td>2</td>
<td>2mL</td>
</tr>
<tr>
<td>(&gt;150 pounds)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Child or Adolescent</td>
<td>65mg</td>
<td>½</td>
<td>1</td>
<td>1mL</td>
</tr>
<tr>
<td>(3 – 18 years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Young Children</td>
<td>32</td>
<td>Use Solution</td>
<td>½</td>
<td>0.5mL</td>
</tr>
<tr>
<td>(1month – 3 years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Dosage of potassium iodide (KI).
Federal Emergency Management Agency
Guide for Developing High-Quality School Emergency Operations Plans

International Finance Corporation
Disaster and Emergency Preparedness: Guidance for Schools

Readiness and Emergency Management for Schools (REMS) Technical Assistance Center
http://rems.ed.gov/

Ready.gov
School Emergency Plans
http://www.ready.gov/school-emergency-plans

Be A Hero! Training Program for Students
http://www.ready.gov/kids

U.S. Department of Education
Practical Information on Crisis Planning: A Guide for Schools and Communities

Readiness and Emergency Management for Schools
http://www2.ed.gov/programs/dvpemergencyresponse/index.html

Lead and Manage my School: Emergency Planning
http://www2.ed.gov/admins/lead/safety/emergencyplan/index.html

U.S. Department of Homeland Security
School Safety
http://www.dhs.gov/school-safety

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16. NAS Committee on Lessons Learned from the Fukushima Nuclear Accident for Improving Safety and Security of US Nuclear Plants. Lessons learned from the Fukushima nuclear accident for improving safety of US nuclear plants. National...


The Spectrum of Malignant Solid Childhood Tumors in the Age Group of 0-12 Years

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ABSTRACT

Objective: To document general baseline data on the patterns of childhood malignant tumors in a surgical pathology department.

Design, Setting and Participants: This is a retrospective analysis of 35 cases of pediatric tumors in surgical pathology department of tertiary care hospital excluding neurosurgery, cardiothoracic and haematolymphoid malignancies. (Age group 0-12 years) encountered over a period of 5 years.

Results: 35 children were diagnosed with malignant tumors. The commonest tumor was Wilms tumor (9 out of 35 cases) followed by neuroblastoma (4 out of 35 cases). The common age of presentation was 1-5 years with male predominance. In the renal tumors only Wilms tumors (9 cases) was seen, with classical triphasic tumors were more common. The mean age of presentation was 3 year with commonest age group of presentation (8 cases out of 9) in the age group 1-5 years. Three of them had showed unfavorable histology. In the adrenal gland, adrenal medullary tumors were more common than adrenal cortex with neuroblastoma (4 of 6 cases) as common individual tumor. Immunohistochemistry performed on 10 of 11 round cell tumors revealed five cases of lymphoma, three cases of Rhabdomyosarcoma (RMS) & two cases of Ewing sarcoma-primitive neuroectodermal tumor (EWS/PNET).

Conclusion: Histological type is important for understanding etiology and progression of disease. The likelihood of a given type of tumor being present in a particular age or sex group or particular site may heighten the index of suspicion and ultimately influences etiology, biology, and natural history, relative incidence and distribution frequency, clinical presentation and manifestations, and response to therapy and outcome.

KEYWORDS: Neuroblastoma; Rhabdomyosarcoma; EWS/PNET.

INTRODUCTION

Incidence of childhood malignant tumors is on the rise all over the globe, though it is a small fraction of the overall global tumor burden. Yet for children and their families it can be deeply distressing. Although childhood malignant tumors occur infrequently, they present a challenging diagnostic and therapeutic problem. Unfamiliarity with these conditions may lead to the erroneous diagnosis and unnecessarily aggressive therapy.

Malignancy is the second most common cause of childhood mortality in the developed world, accounting for 12.3% of all childhood deaths in USA. Although major cause of childhood mortality in the developing world is still malnutrition and infections, childhood malignant tumors are also rising in number. About 1/650 children develops malignancy before their 15th birthday. Malignancies accounts for the major cause of death in Indian children next only to infection and malnutrition. Approximately 35,000 to 40,000 children develop malignancies...
each year in India.2

Thus, the appropriate management of pediatric tumors requires detailed clinical history, tumor site, and precise histopathological diagnosis, accurate grading & staging wherever possible along with other clinical investigations. Histological type is important for understanding etiology and progression of disease. No histological diagnosis can be accurate without a clinico-radio-pathological correlation.

MATERIALS AND METHODS

This was a retrospective analysis of 35 cases of pediatric tumors in surgical pathology department excluding neurosurgery, cardiothoracic and haematolymphoid malignancies. (Age group 0-12 years) encountered over a period of 5 years: January 2004-December 2008. Surgical specimens and biopsy tissues received were fixed overnight in 10% buffered formalin and submitted for processing. Paraffin sections were cut at 4-6 microns thickness and routine H & E staining was performed. All cases were re-evaluated histologically on sections from routinely processed formalin fixed, paraffin embedded blocks. Special stains & Immunohistochemistry were studied wherever necessary. The clinical, radiological and therapeutic data was obtained from patients case paper records. Pattern of childhood malignancies was studied with a focus on tumor incidence, age and sex distribution, environmental and other etiological factors, demographic pattern, and histological type.

RESULTS

A total of 3149 pediatric surgical specimen presented over a five years. Of this, 35 were diagnosed with malignant tumors. Average incidence of malignant pediatric tumors was 1.11%. The commonest tumor was Wilms tumor (9 out of 35 cases) followed by neuroblastoma (4 out of 35 cases). The common age of presentation was 1-5 years with male predominance. In the renal tumors only Wilms tumors (9 cases) was seen, with classical triphasic tumors were more frequent. The mean age of presentation was 3 years with commonest age group of presentation (8 cases out of 9) in the age group 1-5 years. Three of them had showed unfavorable histology. In the adrenal gland, adrenal medullary tumors were more common than adrenal cortex with neuroblastoma (4 of 6 cases) as common individual tumor. Among the gonadal germ cell tumors, there were noted one immature teratoma, two yolk sac tumors of ovary & one yolk sac tumor in testis. Immunohistochemistry performed on 10 of 11 round cell tumor revealed five cases of lymphoma, three cases of rhabdomyosarcoma & two cases of EWS/PNET.

DISCUSSION

In literature, differences have been demonstrated in the incidence rates of pediatric malignant tumors as they are studied by anatomic site, age, race or gender. They are also studied in reference to total pediatric population. Total pediatric hospital admissions or total autopsy study or total surgical pathology sample received. The present study comprises of 35 cases (1.11%) of childhood malignant tumors from a total of 3149 pediatric surgical specimens received over a period of 5 years. It is difficult to compare incidence data because of the difficulties associated with retrieving demographic data for previously studied pediatric populations.

Most of the childhood malignant tumors occur below the age of eight years, although wide age variability exists in children.3 In the present study, 12 years was considered as the pediatric age with infancy as a separate age group. Neuroblastoma, Wilms tumor, retinoblastoma and hepatoblastoma were strikingly more in children younger than 5 years of age, similar to that observed by Kusumakumary P, et al. However, round cell tumors, non-neuroblastic adrenal tumors presented commonly in the age group of 5-10 years. Age also has strong prognostic relevance in certain tumor. It has observed that, infants with neuroblastoma seemed to have better prognosis than older children even after minimal therapy.4 However, the age <1 year at diagnosis has been associated with a worse prognosis in rhabdomyosarcoma (RMS).5 Male predominance is a salient feature of many childhood tumors.6 There is higher incidence in males with male to female ratio of 2.2:1. Male preponderance was seen in Wilms tumor, round cell tumor. There were equal incidence of Neuroblastic tumors in males & females.

Childhood malignant tumors account for no more than 2% of all cancers. The tumors encountered by Sebastian, et al.9 were lymphomas 44.3%, Wilms tumor 20.1%, sarcomas 11.5%, neuroblastoma 8.6%, retinoblastoma 8.0%, teratomas 4.6% and hepatoma 2.9%. In the present study, Wilms tumor with 9 cases (25.71%) was the largest group.

All pediatric renal tumors were Wilms tumor i.e. 100% as compared to the 78.4% by Louisa Paul, et al.7 This difference may be due to small sample size in the present study. All the cases in this study presented with abdominal mass. Eight out of 09 cases were presented in an age group 1-5 years & 01 case was seen in an age group 0-1 year, which was comparable to the study done by Louisa Paul, et al.7 The median age of presentation was 3 years. Thus, the age distribution was consistent with other studies.7,9 Wilms tumor presenting in infancy when treated appropriately has a good outcome. Age 4 years at first diagnosis is clearly an adverse prognostic factor probably that due to adverse biologic features. There were seven cases in males & two in females giving a ratio of male to female ratio of 3.5:1. This was slightly on higher side as compared to study done by Louisa Paul, et al.7 Patel A. A., et al.10 in their study of 11 infantile Wilms tumor found the male to female ratio was 2.3:1. Husain A. N., et al.8 found Wilms tumor slightly more common in girls in whom it tends to present at an older age.

The mean tumor size in present study was 8 cm with a range of 4cm to 15 cm. One of the poles of kidney was commonly affected. This was in accordance to the study done in the literature.8 Eight cases (88.89%) were classical (Triphasic) composed of epithelial, blastemal, and stromal elements and one
case was monophasic type with predominantly epithelial component. Four other types of renal tumors can occur in childhood with sufficient frequency are mesoblastic nephroma, clear cell sarcoma of the kidney, rhabdoid tumor, and renal cell carcinoma. Congenital mesoblastic nephroma is the most common renal tumor in infants.8

It has observed that, infants with neuroblastoma seemed to have better prognosis than older children even after minimal therapy.12 About 37% are diagnosed as infants, and 90% are younger than 5 years at diagnosis, with a median age at diagnosis of 19 months.11 In the present study, four of neuroblastoma cases were presented at the age of 11 months, 18 months, 3 years & 5 years with male & female ratio of 1:1. In several large series, no overall sex predominance has been reported.13 All were presented with suprarenal or retroperitoneal mass & pain. Uncommon manifestations of NB related to unusual clinical behavior or to paraneoplastic syndromes were not seen in any case. Pathologically, tumor cells forming the typical Homer-Wright rosettes arranged around the central fibrillar matrix without a central lumen or canal also seen. Mitotic activity was low in two of surgically resected neuroblastic tumors and absent in two of biopsy material. Calcification was noticed in all cases. The bone marrow biopsy record was not available in any case, which is also important in the monitoring of the disease activity.

Some neuroblastosmas have substantial internal morphologic variability about the degree of neuroblastic differentiation, ganglion cell maturation and Schwannian stroma. Differentiation in neuroblastic cells is recognized as neuropil formation and the acquisition of gangliocytic features. The phenomenon of differentiation has been codified by use of the term Ganglioneuroblastoma to denote intermediate differentiation and Ganglioneuroma to denote the fully mature neuroblastic neoplasm. One case of ganglioneuroblastoma at the age of 4 years in females was documented presenting as suprarenal mass.

Adrenocortical carcinoma (ACC) are rare tumors that have a bimodal distribution, the first peak is in children less than five years and the second around the fifth decade.13 A single case of Adrenocortical carcinoma at an age of 7 years in a female child, grossly have shown size of 15*12 cm, weight 650 gm, nodular mass with solid, cystic & necrotic areas. Microscopically the growth pattern was diffuse sheets of tumor cells with bright pink cytoplasm & broad mitotically active pleomorphic cells separated by broad fibrous bands and capsular invasion. Cagle, et al.8 specifically studied the adrenal cortical neoplasms in children; they found that only size (expressed as weight) was a reliable predictor of malignancy, with a weight greater than 500 g indicative of a carcinoma.8 The macroscopic features, presence or absence of necrosis and microscopic features, such as broad fibrous bands in the tumor, increased mitotic activity, capsular invasion, and a diffuse growth pattern helped to differentiate between adenoma & carcinoma.

The usual age at diagnosis of retinoblastoma is between 12 and 24 months, with an average age of 18 months.8 Children diagnosed in first 3 months are usually seen because of a family history of retinoblastoma.14 There is no significant sex or race predilection, and 20 to 35% cases are bilateral.9 In present study, there were three cases of retinoblastoma, all seen in the age group of 1-5 years with male to female ratio as 2:1. All three cases presented with white reflex in the pupil i.e. leukocoria. Enucleation was done in all cases. Common pattern of presentation was endophytic growth. Microscopically they had shown sheets of round cells with hyperchromatic nuclei; arise from retina & Homer Wright rosettes and necrosis. Optic nerve was free of tumor in all three cases. Children with retinoblastoma may have other congenital abnormalities such as 13q-deletion syndrome, other trisomies, Persistent Hyperplastic Primary Vitrious (PHPV), and congenital cataracts.

Hepatoblastoma accounts for 1.5% of all malignancies in children younger than 5 years of age and is the most common liver cancer in children. There was one case of hepatoblastoma located in the right lobe of liver in a 7-month-old male child. Nearly 90% of hepatoblastomas are seen in the first 5 years of life; with 68% discovered in the first 2 years and 4% present at the time of birth.4 A striking presentation of hepatoblastoma is seen in children (particularly young boys) whose tumors produce human Chorionic Gonadotropin (hCG), leading to precocious puberty with genital enlargement, the appearance of pubic hair and a deepening voice. Clinical presentation was of an abdominal mass with hepatomegaly. Serum Alpha fetoprotein (AFP) & Lactate dehydrogenase (LDH) levels were raised with normal liver function tests. Grossly it was solid, solitary, well circumscribed with a variegated appearance with areas of haemorrhage & necrosis. On histology, the tumor cells seen were of fetal & embryonal type cells arranged in lobules, sheets, nests separated by fibrous septae with capsular invasion.

The term “round-cell tumor” describes a group of highly aggressive malignant tumors of childhood with diverse histogenesis. These are composed of relatively small and monotonous undifferentiated cells with round nuclei & high nuclear to cytoplasmic ratios. A clear understanding of their clinicopathologic features usually allows for a confident diagnosis, especially if immunohistochemistry for individual protein markers is used.

In the present study, 11 cases of round cell tumors were documented. These were seen predominantly in males. The common age group was 5-10 years and most often were located in the head neck region. Their clinical presentations often overlap, thus making a definitive diagnosis a problem. Based on the immunohistochemistry, there were five cases of lymphoma, three cases of rhabdomyosarcoma & two cases of PNET/Ewing sarcoma. Non-Hodgkin lymphoma represents a multitude of discrete types of lymphoid neoplasia, each with its own molecular pathogenesis, distinctive pattern of clinical behavior, and therapeutic response. In the present study, out of five lymphoma cases, there were three cases of Burkitts type NHL, and one case each of B & T cell NHL. Burkitts type Non-Hodgkin lymphoma (NHL) presented at the age of 7 months, 4 years & 9 years. B cell & T cell NHL were at the age of 2.5 & 11 years respectively.
In contrast to equal incidence by Louic P, et al.¹ all in the present study were in the males. Three cases were located intra-abdominally. Most of them were presented with fever, lump, and weight loss. LCA positivity is seen in all cases. Burkitt's & B cell NHL had shown CD 20 & CD 10 positivity. T cell NHL had shown CD 3 Positivity (Table 1).

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Malignant tumor</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>I ) Leukemias</td>
<td>Excluded</td>
<td>-</td>
</tr>
<tr>
<td>II) Lymphomas and Reticuloendothelial Neoplasms</td>
<td>Excluded</td>
<td>-</td>
</tr>
<tr>
<td>III) CNS and Miscellaneous Intracranial and Intraspinal Neoplasms</td>
<td>Excluded</td>
<td>-</td>
</tr>
<tr>
<td>IV) Sympathetic Nervous System Tumors</td>
<td>6</td>
<td>17.15%</td>
</tr>
<tr>
<td>V) Retinoblastoma</td>
<td>3</td>
<td>08.57%</td>
</tr>
<tr>
<td>VI) Renal Tumors</td>
<td>9</td>
<td>25.71%</td>
</tr>
<tr>
<td>VII) Hepatic Tumors</td>
<td>1</td>
<td>02.86%</td>
</tr>
<tr>
<td>VIII) Malignant Bone Tumors</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>IX) Soft-Tissue Sarcomas</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>X ) Germ-Cell, Trophoblastic and other Gonadal Neoplasms</td>
<td>3</td>
<td>08.57%</td>
</tr>
<tr>
<td>XI) Carcinomas and other Malignant Epithelial Neoplasms</td>
<td>2</td>
<td>05.71%</td>
</tr>
<tr>
<td>XII) Other and Unspecified Malignant Neoplasms (Round cell tumors)</td>
<td>11</td>
<td>31.43%</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100.00%</td>
</tr>
</tbody>
</table>

Table 1: Paediatric malignant tumor according to international Classification of Childhood Cancer (ICCC).

Rhabdomyosarcoma is the most common soft tissue sarcoma in the childhood, accounting for about 50% of childhood soft tissue. Rhabdomyosarcomas are generally immunoreactive for vimentin, myogenic regulatory protein, myoD1, myogenin, muscle-specific actin, desmin, and myoglobin. A minority of cases express smooth muscle actin, and aberrant expression. In the present study, all three cases presented with fever, lump, and weight loss. LCA positivity is seen in all cases. Burkitt’s & B cell NHL had shown CD 20 & CD 10 positivity. T cell NHL had shown CD 3 Positivity (Table 1).

Ewing sarcoma-primitive neuroectodermal tumor is the second most common primary osseous or soft tissue malignancy in the first two decades of life, with one EWS-PNET for every three osteosarcomas. A biopsy specimen of a poorly marginated medullary lesion with permissive bone destruction and cortical loss, a soft tissue mass in the pelvis, or a paravertebral mass with an adjacent vertebral or rib lesion is the usual introduction of EWS-PNET to the pathologist. In the present study, two cases of EWS-PNET had been diagnosed after immunohistochemistry. They presented in an 11 years old male & 8 years old female located in the intrathoracic region & nasal maxillary sinus respectively. Microscopically they showed monotonous monolayered round cell neoplasm with non overlapping polygonal cells that have a distinct cell membrane, a uniform round to oval nucleus with finely dispersed granular chromatin, a small nucleolus, and clear to finely vaculated cytoplasm. Both cases were Mic2 positive but negative for LCA, CD2, CD3, CD10, Myoglobin, Myo D1, Neuron-specific enolase (NSE), Cytokeratin (CK), Epithelial Membrane (EMA), chromogranin & synaptophysin.

Other common round cell tumors in childhood are desmoplastic small round blue cell tumor, Mesothelioma, Neuroblastoma & Wilms tumor. Desmoplastic small round cell tumor has predilection for the abdomen and retroperitoneum. Desmoplastic small round cell tumor is considered a member of the PNET-EWS family of tumors but is much less common than EWS and PNET. Desmoplastic small round cell tumor exhibits a combination of mesenchymal, epithelial, and neural features. The immunophenotype includes reactivity for keratin, epithelial membrane antigen, vimentin, desmin, neuron-specific enolase, EWS-WT1 chimeric protein, and CD99. Rarely, desmoplastic small round cell tumor displays immunoreactivity for actin, other neural markers, and p53.⁸

Malignant germ cell tumors in the ovaries of very young children are exceedingly rare. In the present study one case was of immature teratoma, two cases of yolk sac tumor in ovary and one case of yolk sac tumor in the testis was documented. All three cases of the ovary presented at the age of 11 years & showed elevated levels of AFP. Yolk sac tumors are the second most common histological subtype (22%) of malignant ovarian germ cell tumor in children. Yolk sac tumors are the most common testicular germ cell tumor in childhood, representing in excess of 60% of cases and almost 50% of all testicular tumors in children.⁹ An asymptomatic scrotal mass in a child younger than 3 years of age is the common presentation. The histology and cytology of yolk sac tumors vary widely, often causing difficulty in diagnosis. The prototypic Schiller-Duvall bodies of endodermal sinus tumors are present in 50-75% of tumors.¹⁰ Yolk sac tumors are commonly associated with highly elevated serum AFP levels, which may be monitored clinically for recurrence and/or metastasis. In the present study, two of the yolk sac tumor was located at ovary & one at testis. All three had showed elevated levels of AFP. Both ovarian yolk sac tumors presented at the age of 11 years & one case of testicular yolk sac tumor at the age of 5 years. Grossly they have solid, yellow appearance. Microscopically polygonal tumor cells in reticular, trabecular & papillary pattern seen with Schiller-Duvall bodies. Microcystic change is seen in one ovarian yolk sac tumor (Tables 2 and 3).

All tumors of the bladder and urethra are rare in children. In the present study, one case of squamous cell carcinoma at the age of 10 years was documented and no any predisposing factor was elicited. In contrast to adults, most pediatric bladder carcinomas are low grade, superficial, and have a good prognosis following transurethral resection. Rare cases of, leiomyosarcoma, and secondary involvement of leukemia, lymphoma, and
Wilms tumor has been reported.8

So, to conclude, histological type is important for understanding etiology and progression of disease. The likelihood of a given type of tumor being present in a particular age or sex group or particular site may heighten the index of suspicion and ultimately influences etiology, biology, and natural history, relative incidence and distribution frequency, clinical presentation and manifestations, and response to therapy and outcome.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONSENT

The patient has provided written permission for publication of the case details.

REFERENCES


Estimation of Zinc Levels in Children With Lower Respiratory Tract Infections: A Prospective Observational Study from India

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5KDA Hospital, Mumbai, India

ABSTRACT

Aims: To assess the serum zinc levels in children aged 2 months to 5 years admitted with Lower Respiratory Tract Infections and to study the association between low zinc levels and other known risk factors LRTI.

Material and Method: This prospective, observational study enrolled 200 children in age group of 2 months to 5 years admitted with acute LRTI. Serum Zinc level were measured and its association was seen with other risk factors of LRTI.

Results: Mean serum zinc level of study population was 57.9±29.2 microgram/dL. There was significant difference in zinc level depending on severity of pneumonia, nutritional status, anemia, clinical vitamin A deficiency, breast feed infants and birth weight (p<0.05).

Conclusion: Low serum level of zinc were seen in severe pneumonia cases. Serum zinc levels were found to be lower in risk factors of LRTI like poor nutritional status, anemia, vitamin A deficiency, low birth weight and formula fed patients. Zinc supplementation is required in LRTI patients especially those with the above mentioned risk factors.

KEYWORDS: Serum zinc; Lower respiratory tract infections; Severity of pneumonia; Nutritional status; Anemia; Clinical vitamin A deficiency; Breast feed infants; Birth weight.


INTRODUCTION

Zinc is an essential mineral that is involved in numerous aspects of cellular metabolism. It is required for the catalytic activity of approximately 100 enzymes and it plays a role in immune function, protein synthesis, wound healing, DNA synthesis, and cell division. It is required for maintaining intestinal cells, bone growth and immune function. It is second to iron as the most abundant trace element in the body. Zinc deficient children are at increased risk of restricted growth and developing diarrheal diseases and respiratory tract infections. Zinc is thought to decrease susceptibility to Acute Lower Respiratory Tract Infection (ALRTI) by regulating various immune functions including protecting the health and integrity of respiratory cells during lung inflammation and injury. Supplementation of zinc could reduce the risk of pneumonia and the risk and duration of diarrhea, dysentery and malaria deaths among all infectious diseases, and they accounted for 3.9 million deaths worldwide. According WHO estimates respiratory infection cause about 987,000 deaths in India of which 969,000 are LRTI. ALRTI are the leading cause of mortality and a common cause of morbidity in children below...
five years of age. Most of these deaths are caused by pneumonia and bronchiolitis. Pneumonia kills more children each year than AIDS, malaria or measles combined with more than 2 million deaths per year. The need for the study was to establish that zinc deficiency may lead to LRTI. The study was planned to assess the serum zinc levels in children aged 2 months to 5 years admitted with lower respiratory tract infections and to study the association between low zinc levels and other known risk factors for lower respiratory tract infections.

METHOD AND MATERIAL

This was a hospital based prospective, observational study done in Department of Pediatrics, Yenepoya Medical College, Mangalore, India between January 2012 to December 2012. The ethical committee approved the study protocol and the informed consent form. Prior to enrolment in the study informed consent of child’s care taker was obtained. Two hundred cases of ALRTI were enrolled in study.

Inclusion Criteria:
• Children admitted with ALRTI from 2 months to 5 years.

Exclusion Criteria:
• Children less than 2 months and more than 5 years are excluded.
• Children with clinical diagnosis of Reactive airway disease/asthma.
• Children associated with underlying chronic illnesses.
• Children with Inborn Errors of Metabolism
• Children on zinc supplementation

Children in age group of 2 months to 5 years admitted with acute lower respiratory tract infection during study period were enrolled as cases. All the cases are clinically diagnosed as acute lower respiratory tract infection as per World Health Organization (WHO), 1990 criteria. All cases are investigated and treated as per the protocol for treatment of LRTI.

WHO, 1990 criteria for acute lower respiratory tract infections (ALRTI) and Pneumonia.

Pneumonia:
• Symptoms : Cough or difficult breathing and
• Signs :
  ▪ Infants aged 2 months to <1 year: Breathing >50/minute
  ▪ Child aged 1 to 5 years: Breathing >40/minute and no chest in-drawing, stridor or danger signs

Severe Pneumonia:
• Symptoms: cough or difficult breathing and any danger sign or chest in drawing, stridor in a calm child.
• Danger signs: For children aged 2 months to 5 years: Unable to drink or breast feed, vomiting, convulsions, lethargic or unconscious

All cases were investigated and treated as per the protocol for treatment of LRTI.

All patients’ general information, clinical profile, socio-economic status, immunization status, perinatal history, nutritional status, history of receiving any additional nutritional supplements is noted in predesigned proforma. Associated risk factors for LRTI were identified and noted as per following criteria.

Socio-Demographic Conditions
• Socioeconomic status: Was classified according to modified Kuppuswamy classification.8
• Immunization status: Complete immunization was taken as age appropriate immunization according to Indian Academy of Pediatrics (IAP) schedule. Partial immunization was defined as incompletion of IAP schedule. Non-immunized child was defined as not received any vaccination
• Overcrowding: Overcrowding is considered to exist if two persons over 9 years of age, not husband and wife, of opposite sexes are obliged to sleep in the same room. Best expressed as number of persons per room. One room – 2 person, 2 room – 3 person, 3 room – 5 person, 4 room – 7 person, 5 room – 10 person. Children under 12 months not counted, children between 1-10 yrs. as half unit.
• Family history of LRTI – h/o respiratory tract infection in family members in preceding 2 weeks.

NUTRITIONAL CONDITIONS
• Nutritional status: Detailed anthropometry was done and malnutrition was graded according to IAP classification of malnutrition.9
• Feeding history/weaning history: Detailed account of breast feeding or formula feeding were recorded. Weaning was divided as early weaning (<4 months), proper (4-6 months) and late (>6 months.)
• Vitamin A deficiency: Was diagnosed clinically with features of delayed dark adaptation, night blindness, conjunctival xerosis, bitot spots, corneal xerosis, corneal ulceration, corneal scarring.
• Vitamin D deficiency: Was diagnosed clinically with features of frontal bossing, rachitic rosary, Harrison sulcus, widening
of wrists, genu valgus/varus deformities.

- Supplementation of nutrition: Whether child had received vitamin A supplementation as mega doses according to Vitamin A prophylaxis schedule. Also whether child had any recent iron supplementation.

- Anemia: If Hb was less than 12gm/dl it was considered as anemia.

- Birth weight: Child weighting less than 2.5 kgs was considered low birth weight and above 2.5-3.5 kgs appropriate for gestational age.

Environmental Factors

- Ventilation: Adequate ventilation was considered if 2 windows were present in one room facing different directions.

- Housing condition: Kachcha house was defined as walls/roof made of un-burnt bricks, bamboos, mud, grass, reeds, thatch, loosely packed stones. Pacca house has roof and walls made of Burnt bricks, stones (packed with lime or cement), cement concrete, timber. Semi pacca house has fixed walls but roof is made of kachcha material.

- Smoke exposure: Was taken in consideration with any h/o family member smoking and use of firewood for cooking

Principle of measuring serum zinc was by PHOTO-SPECTROMETRY-Nitro-PAPS2- [5-NITRO-2-PYRIDXY-LAZO]-[N- n PRO PYL- {3 SULFO PRO PYL;} AMINO PHENOL DISODIUM SALT]10 reacts with zinc in alkaline solution to form a purple colored complex, the absorption of which was measured at 575 nm. Interference from copper and iron were eliminated by pH and chelating agents. Taking aseptic precaution, 2ml of blood from venepuncture using 22 gauge sterile needles, was collected within 24 hours of contact of patient. The sample was then centrifuged for 3-4 minutes at 3000-4000rpm; serum thus obtained was collected and preserved at 2-8 °C in sterile deionised plain vials. Estimation of Zinc was carried out within 7 days of collection. Normal range of serum zinc was taken as 70-110 mg/dl.

All statistical procedures were performed using SPSS v 17.0. All results were expressed as number (percentage) or Mean±Standard Deviation (SD)/median (range) as appropriate. One way Analysis of variance (ANOVA) was used to compare the difference in mean values of zinc and assess the correlation with risk factors. The result were measured in terms of significance of association at 95% confidence level i.e. “p” value less than 0.05.

RESULTS

Two hundred cases aged between 2 months to 5 years admitted with clinical diagnosis of LRTI were enrolled in study. The demographic distribution showed fever was the most common presentation (Table 1).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of sex of patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>116</td>
<td>58</td>
</tr>
<tr>
<td>Distribution of socio economic status of patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper middle</td>
<td>36</td>
<td>18.0</td>
</tr>
<tr>
<td>Middle</td>
<td>60</td>
<td>30.0</td>
</tr>
<tr>
<td>Upper lower</td>
<td>92</td>
<td>46.0</td>
</tr>
<tr>
<td>Lower</td>
<td>12</td>
<td>6.0</td>
</tr>
</tbody>
</table>

| Clinical profile of children of LRTI                       |        |                |
| Fever                                                      | 176    | 88             |
| Breathlessness                                             | 132    | 66             |
| wheeze                                                     | 120    | 60             |
| Refusal to feed                                            | 12     | 6              |
| Immunization status                                        |        |                |
| Complete                                                   | 132    | 66.0           |
| Partial                                                   | 56     | 28.0           |
| Non Immunized                                             | 12     | 6.0            |

| Distribution of family history of LRTI of patients         |        |                |
| Yes                                                       | 112    | 56.0           |

| Distribution of overcrowding status of patients at home    |        |                |
| Present                                                   | 152    | 76.0           |

| Ventilation in house of patients                           |        |                |
| Inadequate                                                | 33     | 66.0           |

| Distribution of house condition of patients                |        |                |
| Pacca                                                     | 32     | 16.0           |
| Semipacca                                                 | 56     | 28.0           |
| Kachcha                                                   | 112    | 56.0           |

| Distribution of smoke exposure of patients                 |        |                |
| Yes                                                       | 76     | 38.0           |

| Distribution of nutrition status of patients               |        |                |
| Normal                                                    | 60     | 30.0           |
| Grade I                                                   | 52     | 26.0           |
| Grade II                                                  | 40     | 20.0           |
| Grade III                                                 | 28     | 14.0           |
| Grade IV                                                  | 20     | 10.0           |

| Distribution of vitamin A deficiency of patients with clinical features |        |                |
| Present                                                   | 8      | 4.0            |

| Distribution of vitamin D deficiency of patients with clinical features |        |                |
| Present                                                   | 56     | 28.0           |

| Distribution of birth weight of patients                   |        |                |
| Low birth weight (<2.5kgs)                                 | 76     | 38.0           |

| Distribution of feeding history of patients                |        |                |
| Breast Feeding                                            | 104    | 52.0           |
| Distribution of anemia of patients                        |        |                |
| Present                                                   | 144    | 72.0           |

Table 1: Table showing various demographic distribution of the population.
The mean age of the study population was 24.9±16.3 months (4.0-60 months). The mean duration of illness was 9.6±2.3 days (5.0-16.0 days) whereas mean White blood cell (WBC) counts was 15.7±2.9*10^9/L (10.0-22.9*10^9/L).

The majority of the patient had bronchopneumonia as clinical diagnosis and pulmonary infiltrates were most common X-ray findings (Table 2).

The mean serum zinc level of all patients of LRTI was 57.9±29.2 microgram/dL (13.0-121.7 microgram/dL). The normal level being 70-110 microgram/dl.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Frequency</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity of pneumonia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>168</td>
<td>84.0</td>
</tr>
<tr>
<td>Severe Pneumonia</td>
<td>32</td>
<td>16.0</td>
</tr>
<tr>
<td>Clinical diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bronchopneumonia</td>
<td>80</td>
<td>40.0</td>
</tr>
<tr>
<td>Bronchiolitis</td>
<td>32</td>
<td>16.0</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>8</td>
<td>4.0</td>
</tr>
<tr>
<td>Lobar pneumonia</td>
<td>28</td>
<td>14.0</td>
</tr>
<tr>
<td>Interstitial pneumonia</td>
<td>16</td>
<td>8.0</td>
</tr>
<tr>
<td>Wheeze associated lower respiratory infection</td>
<td>36</td>
<td>18.0</td>
</tr>
</tbody>
</table>

Radiological distribution of LRTI

<table>
<thead>
<tr>
<th>Characteristics</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulmonary infiltrates</td>
<td>92</td>
<td>46.0</td>
</tr>
<tr>
<td>Consolidation</td>
<td>48</td>
<td>24.0</td>
</tr>
<tr>
<td>Normal</td>
<td>32</td>
<td>16.0</td>
</tr>
<tr>
<td>Hyperinflation</td>
<td>16</td>
<td>8.0</td>
</tr>
<tr>
<td>Atelectasis</td>
<td>8</td>
<td>4.0</td>
</tr>
<tr>
<td>Pleural effusion</td>
<td>4</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 2: Table showing the respiratory morbidities and clinical diagnosis of the study population.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean± Std. Deviation</th>
<th>Range</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc level distribution age wise (months)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 5</td>
<td>43.8±20.3</td>
<td>17.3-64.0</td>
<td>0.846</td>
</tr>
<tr>
<td>6 - 15</td>
<td>60.0±26.7</td>
<td>13.7-113.0</td>
<td></td>
</tr>
<tr>
<td>16 - 25</td>
<td>53.1±22.2</td>
<td>16.6-90.0</td>
<td></td>
</tr>
<tr>
<td>26 - 35</td>
<td>63.8±37.7</td>
<td>26.6-109.0</td>
<td></td>
</tr>
<tr>
<td>36 - 45</td>
<td>52.6±32.0</td>
<td>15.4-118.0</td>
<td></td>
</tr>
<tr>
<td>≥ 46</td>
<td>63.6±30.1</td>
<td>34.0-121.7</td>
<td></td>
</tr>
</tbody>
</table>

| Zinc levels distribution sex wise     |                       |               |         |
| Female                                | 57.8±27.8             | 18.0-113.0    | 0.987   |
| Male                                  | 57.9±30.7             | 13.0-121.7    |         |

There was no significant difference on the level of zinc depending on age, sex, socio-economic status, immunization and family history of LRTI. (Table 3)

No significant difference was noted in the serum zinc level depending on housing condition, ventilation of house, smoking exposure.

Significant difference in serum Zinc level was seen depending upon the severity of pneumonia, nutritional status, Vitamin A deficiency and anemia (p<0.05). (Table 4)
Characteristics | Mean± Std. Deviation | Range | P value
--- | --- | --- | ---
Lower | 55.7±30.3 | 37.7-67.0 | 0.285
Upper Lower | 58.2±30.9 | 13.0-121.7 | 
Middle | 59.0±35.4 | 16.6-116.8 | 
Upper Middle | 60.4±25.8 | 28.0-113.0 | 

Serum zinc level and severity of pneumonia

| Characteristics | Mean± Std. Deviation | Range | P value |
--- | --- | --- | ---
Pneumonia | 57.6±31.2 | 13.0-121.7 | 0.031
Severe Pneumonia | 32.6±11.7 | 17.7-47.0 | 

Serum zinc level and nutrition status of patients

| Characteristics | Mean± Std. Deviation | Range | P value |
--- | --- | --- | ---
Normal | 78.1±24.7 | 54.0-113.0 | 
Grade I | 58.8±29.1 | 17.7-121.7 | 
Grade II | 65.7±30.5 | 30.9-118.8 | 
Grade III | 51.3±16.5 | 23.0-73.0 | 
Grade IV | 48.2±32.5 | 13.0-108.9 | 

Serum zinc level and anemia

| Characteristics | Mean± Std. Deviation | Range | P value |
--- | --- | --- | ---
Yes | 50.7±27.0 | 13.0-113.0 | 0.004
No | 76.4±27.2 | 37.0-121.7 | 

Serum zinc level and clinical vitamin A deficiency of patients

| Characteristics | Mean± Std. Deviation | Range | P value |
--- | --- | --- | ---
Yes | 44.3±23.5 | 27.7-61.00 | 0.025
No | 57.1±27.8 | 13.0-121.7 | 

Serum zinc level and clinical vitamin D deficiency of patients

| Characteristics | Mean± Std. Deviation | Range | P value |
--- | --- | --- | ---
Yes | 49.0±19.2 | 13.0-78.0 | 0.226
No | 59.6±29.9 | 15.4-121.7 | 

Serum zinc level and birth weight of patients

| Characteristics | Mean± Std. Deviation | Range | P value |
--- | --- | --- | ---
Low birth weight (<2.5 kgs) | 32.6±12.0 | 13.0-58.0 | 0.000
Normal birth weight (2.5-3.5 kgs) | 73.4±25.5 | 17.0-121.7 | 

Serum zinc level and feeding history of patients

| Characteristics | Mean± Std. Deviation | Range | P value |
--- | --- | --- | ---
Breast feed | 70.0±26.1 | 46.6-121.7 | 0.005
Formula feed | 51.5±29.6 | 13.0-113.0 | 

Table 3: Table showing zinc association with socio-demographic conditions.

Table 4: Table showing association of serum zinc level with severity of pneumonia and nutritional status.
There was also significant difference based on birth weight and feeding as significant high zinc level was seen in breast feed infants and infants who were not low birth weight. (Table 4)

DISCUSSION

In our study the mean serum zinc levels of 57.9±29.2 mg/dL were found in patients, which is lower than normal range of (70-110 mg/dL).

One explanation for lower zinc level in severe respiratory tract infection can be pre-existing deficiency making these children susceptible to respiratory tract infection due to impaired immunity. In addition, LRTI are also known to result in lower zinc levels in response of cytokines Interleukin 6 (IL-6) which causes shifting of zinc from plasma to liver. The other hypothesis could be explained by the effect of zinc on the extent of inflammation and its resolution rate surrounding infection. Zinc supplementation may be protective to lung parenchyma against the inflammatory mediators and conditions, therefore its deficiency may increase airway damage, inflammation and cellular damage. It has also been seen that in the presence of zinc, there is decreased inflammation of other organ systems of the body with increased bacterial inhibition and cellular regeneration. Thus, zinc may have important role in reduction of inflammation and decrease lower airway obstruction, in supplemented children and thus leading to faster inflammation resolution time. This leads to shorter duration of chest in-drawing, tachypnea and hypoxia. This finding was also observed in previous studies in which serum zinc level was significantly higher at the discharge than at baseline which shows cessation of acute phase response. De Raeve HR et al have reported a decreased Zn-SOD activity airway and Zinc serum in children with lower respiratory tract infection.\(^\text{11,12}\) Further Meeks-Gardner J et al have shown a positive Zinc supplementation in these patients.\(^\text{13}\)

There was statistical significance between serum zinc and severity of pneumonia. We observed that mean serum zinc of patients with pneumonia 57.6±31.2 microgram/dL was statistically higher than patients with severe pneumonia 32.6±11.7 microgram/dL (p value 0.031). This was in conformity with the earlier reports. The study by Pushpa et al\(^\text{14}\) on the association of serum zinc level with severe pneumonia in children that the mean serum zinc level of group of patient’s severe pneumonia was lower than those with less severe pneumonia. The study by Arica et al\(^\text{15}\) on serum zinc levels in children of 0-24 months diagnosed with pneumonia reported that Zn values as determined in the control group enrolled in the study were significantly higher compared to the pneumonia patient group (p<0.01).

About 70% of the study patients were in different stages of malnutrition (grade I(26%), grade II(20%), grade III(14%) and grade IV(10%) respectively. We observed a statistical difference in the mean serum zinc level of the patients divided as per grades of malnutrition (p value 0.045). It was observed in present study that low serum zinc levels were present even in well-nourished children suffering from severe respiratory tract infection.

Singla PN et al\(^\text{16}\) studied the Serum zinc levels in children with protein energy malnutrition. The levels of serum zinc and copper were found to be significantly low in children with severe malnutrition (grades III and IV PEM). There was a significant positive correlation between serum zinc and height-for-age (p<0.001).

Anemia is a widespread problem among infants and children in many parts of the world, and it is often associated with some trace elements (iron, zinc, copper) and heavy metals (cadmium and lead). In our study 72% of the studied patients had anemia and we observed a statistical difference between serum zinc level of patients with and without anemia, where the mean of zinc with anemia was 50.7±27.0 microgram/dL and without anemia was 76.4±27.2 microgram/dL (p value is 0.004). It is similar to other reports. Turgut S, et al\(^\text{17}\) studied the Interaction between anemia and blood levels of iron, zinc, copper, cadmium and lead in children and reported that levels of copper, cadmium and lead in serum were significantly higher in children with IDA than those of controls.

De la Cruz-Gongora V et al\(^\text{18}\) reported the results from the 2006 National Health and Nutrition Survey in Mexican children under 5 years, found that anemia was not associated with low serum zinc levels.

In our study there is significance of vitamin A deficiency and serum zinc levels (p=0.025).

A community-based study by Hettiarachchi M et al\(^\text{19}\) on the coexisting micronutrient deficiencies among Sri Lankan pre-school children reported that 38.3% were deficient in both vitamin A and zinc.

Another study by da Silva R et al\(^\text{20}\) on the relationship between nutritional status, vitamin A and zinc levels and oxidative stress in patients with ataxia-telangiectasia. Authors reported that ataxia-telangiectasia patients showed high rates of malnutrition with reduced lean body mass when compared to the control group. However, serum zinc in Ataxia-telangiectasia (AT) patients was similar to those of the control group. The AT patients assessed showed no change in nutritional status for vitamin A and zinc.

There are variable reports on the association of the serum zinc levels with the vitamin A deficiencies. The effects of prenatal Zinc Deficiency (ZD) and Vitamin A Deficiency (VAD) on birth weight are controversial and their interaction has not been investigated. Enqueslassie F et al\(^\text{21}\) studied the effects of prenatal Zinc and Vitamin A Deficiencies on birth weight showed that the occurrence of the deficiencies either in the second or third trimester were associated to Low Birth Weight (LBW). The deficiencies did not show synergetic interaction in causing
LBW. LBW is of public health significance in the locality. The study did not witness any independent or interaction effect of prenatal Zinc Deficiency (ZD) and Vitamin A Deficiency (VAD) on birth weight.

We observed that 38% of study patients had deficiency of vitamin D but we did not observe any statistical difference in the mean serum zinc level of the patients with and without vitamin D deficiency (p value is 0.226).

In our study there is statistical correlation between breast feeding and serum zinc levels. (p=0.005), 52% were breast fed and 48% had addition of formula feeding. Van Biervliet S et al22 studied the role of serum zinc in healthy Belgian children. The median Zn value is lower in infants than in older children (respectively 11.6 micromole/L vs. 12.8 micromole/L). Authors reported that the type of infant feeding does not influence the serum Zn concentrations (breast-feeding, adapted, hypoallergenic, soy, or thickened).

In our study low birth weight (38%) had lower serum zinc levels of 32.6+/-12 microgram/dL compared to normal birth weight (62%) mean zinc levels of 73.4+/-25.5 microgram/dL and there is highly significant correlation. p=0.000.

Sharda B et al23 studied the zinc and copper in preterm neonates to assess copper and zinc levels in neonate’s serum, mother’s serum, neonate’s hair and urine and to ascertain association between them. Neonates between 26-30 wks. Gestational age and <2.5 kg birth weight had significantly low serum zinc and copper. Breast milk zinc was low in mothers delivering preterm and <2.5 kg neonates. Urinary copper and zinc levels were high in preterm appropriate for gestational age (Pre AGA) than term neonates. The effect of mother’s serum, breast milk, and neonate’s serum copper and zinc collectively was significant for and hair zinc. Preterm and low birth weight infants during subsequent growth and development should be supplemented with zinc and copper when on breast feeding.

STRENGTH OF THE STUDY
1. Large sample size with range of patients from 2 month age to 5 years.
2. Evaluation of multiple socio-economic conditions on the zinc level.
3. Evaluation of nutritional conditions and severity of pneumonia on the zinc level of the patients.

LIMITATION OF THE STUDY
1. Absence of follow up prevents us to access the long term impact of altered serum zinc level patients with LRTI.
2. Absence of control is responsible for non-availability of base line serum zinc level of the study population.
3. Association between clinical profile and serum zinc was not done due to variation in subjective evaluation.
4. Exclusion of patients of upper respiratory tract infection limits the clinical interpretation of result.
5. We did not include the assessment of dietary composition and intake of the child, which is an important confounding factor.

CONCLUSION
Serum zinc levels were found to be lower in risk factors of LRTI like poor nutritional status, anemia, vitamin A deficiency, low birth weight and formula fed patients. It is advised that zinc supplementation is required in LRTI patients especially those with the above mentioned risk factors. Although the present findings are promising and few recent studies have shown reduction of incidence of ALRTI with zinc supplementation,24 but there is currently no standard guidelines to use Zinc in all malnourished children to prevent respiratory tract infection and additional studies are needed to further investigate whether Zinc should be given to all malnourished children as standard of care and any other micronutrients also along with zinc to boost immunity.25,26

CONFLICT OF INTEREST
The authors declare that they have no conflicts of interest.

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DISCLOSURE
“There are no prior publications or submissions with any overlapping information, including studies and patients.”
“The manuscript has not been and will not be submitted to any other journal while it is under consideration by Clinical Pediatrics.”

CONTRIBUTIONSHIP STATEMENT
Dr. Ansar wrote the first draft of the manuscript.
Dr. Deepak, Dr Tariq, Dr. Aakash and Dr. Monika helped in writing manuscript and did primary corrections in the manuscript.
Dr. Prakash made final corrections of manuscript before submission.

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All the authors approved the submission of this version of the
manuscript and takes full responsibility for the manuscript.

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Mini Review

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ABSTRACT

Headache is defined as a somatic complaint. Incidence has increased in the last years probably due to children’s lifestyle changes. Headaches have a wide variety of causes, either primary or secondary ones. While the majority of headaches are self-limited and benign, headaches occasionally herald a life-threatening illness such as a brain tumor, intracranial hemorrhage or meningitis. The emergency department physician has to distinguish between “benign” and “serious” headaches and therefore must have an organized approach to the evaluation of these patients. Obtaining neuroimaging studies on a routine basis are not indicated in children with recurrent headaches. An extensive history and physical examination are crucial and must guide the differential diagnosis. Management in the ED must be addressed to establish an accurate diagnosis, ruling out secondary causes, by giving an effective treatment and by providing a discharge plan that includes treatment and follow up with their primary care physician.

KEYWORDS: Headache; Children; Emergency department; Migraine.

INTRODUCTION

Headache is a common complaint in children and the prevalence of childhood headache is reported to be as high as 75% in school-age and adolescent children. Headaches have been reported to occur in 10.6% of children aged between 5 to 15 years, and even more frequently in older children (28% in 15 to 19 year-old). The median age of children with headache is around 9.4 years. Literature shows that headaches increase throughout childhood, reaching a peak at about 11-13 years of age in both sexes.

Headache is one of the top three causes of referrals to a pediatric Emergency Department (ED). It is unusual as an isolated complaint and most often it is associated with other symptoms. The most common type of recurrent headache in childhood is migraine and tension headaches are in adolescence. Males are affected more frequently than females at preschool age, and in junior-high school age females have higher incidence. Several studies describing differential diagnosis of headache in the pediatric ED reported a varied number of causes as viral infections, sinusitis, migraine and post-traumatic headaches as the most common diagnoses. Burton et al described viral illness, sinusitis and pharyngitis in more than 60%, of patients.

The importance of this topic is that primary headache is under diagnosed in children, partly due to different clinical characteristics compared with the adult population. Secondary causes of headache can be associated with high mortality and morbidity and health personnel should be aware of the differential diagnosis (Table 1).

Stressful life events in childhood have an impact on the course of migraine and tension type headaches because they increase the possibility of a combined headache. Headache with an onset early in life increases the risk of an unfavorable clinical course. Genetic factors play an important role in the phenotypic expression of the disease.
PATHOPHYSIOLOGY

The major pain-sensitive structures inside the skull are the blood vessels, dura mater and meninges. The brain parenchyma and ependymal lining are insensitive to pain. The periosteum adjacent to the sinuses and the teeth is pain sensitive. Muscles attached to the skull can be a source of pain, usually secondary to prolonged contraction. The upper cervical and cranial nerves produce pain when injured, inflamed, or displaced by mechanical traction.

Pain originating from the cranial circulation as well as the intracranial structures above the tentorium travels primarily via the trigeminal nerve and is referred to the front of the head. Pain originating in the posterior fossa structures travels mainly via the first 3 cervical nerves and results in pain in the back of the head and neck. However, complex nerve relationships and unpredictable displacement of structures by mass lesions can cause unexpected paths of pain referral.

The extraocular muscles can cause pain in the orbits after an extended period of contraction; however, eyestrain or refractory error has not been reported as a significant cause of headaches in children.

CLASSIFICATION OF HEADACHES

The International Headache Society (IHS) published a standardized classification system that includes the following headache types: primary headaches, secondary headaches and cranial neuralgias, central and primary facial pain, and other headaches.12

Primary headaches include migraine, tension-type headache, cluster headache, other autonomic cephalgias and other primary headache disorders. Migraine is described as a group of heterogeneous disorders with variations in pain intensity, duration, pattern of associated features, and frequency of occurrence of the attacks.8 A modification of the ICHD-II criteria was made to improve sensitivity to 84.4% in the diagnosis. This modified criteria included bilateral headache, duration of 1-72 hours, nausea and/or vomiting plus two of five other associated symptoms (photophobia, phonophobia, difficulty in thinking, lightheadedness or fatigue), in addition to the usual description of moderate to severe pain of a throbbing or pulsating nature worsening or limiting physical activity.13 Some triggers have been described for primary headache like sleep deprivation, fatigue, hunger, weather changes and some foods.14

MIGRAINE HEADACHE

Literature refers to migraine as the most common cause of primary headache.15 Pediatric migraines are characterized by bilateral head pain and often of shorter duration than in adults. Headaches tend to last from 4 to 72 hours with at least 2 of the following: unilateral location, pulsating quality, moderate to severe pain, aggravation with physical activity; and at least one of the following: nausea/vomiting, photo or phonophobia.16 Martinez et al in their study described 127 children with migraine and found unilateral location in 44.4% of the patients, photophobia in 74.5% and aura in 14.3% with sensory and visual symptoms.3

Migraines can be with or without aura. Some rare migraine variants are found in childhood. These include ophthalmoplegic migraine and alternating hemiplegic migraine. Ophthalmoplegic migraine may involve the 3rd, 4th and/or 6th cranial nerves and generally presents with transient migraine-like headaches with associated neuropathy, such as diplopia.17 Alternating hemiplegic migraine (or alternating hemiplegia of childhood) is a rare syndrome of episodic hemiplegia lasting minutes to days, with accompanying dystonia, nystagmus, oculomotor abnormalities and cognitive impairment.18 “Alice in wonderland” syndrome is referred to visual illusions and spatial distortions before the headache.19 Acute confusional migraine is associated with an altered conscious state and focal neurological abnormalities like aphasia, anisocoria and memory deficits that will last up to 24 hours.20 There are other migraine equivalents in children like cyclic vomiting, abdominal migraine, benign paroxysmal vertigo and torticolis; which are exclusion diagnosis. These ailments and their associated neurologic deficits may present a diagnostic challenge in the emergency department.

TENSION TYPE HEADACHE

Tension-type headaches are common in children. They tend to be mild compared to migraines, and patients may not seek medical attention. Pain is usually bilateral, localized in the neck and occiput; and is normally associated with stressful episodes at home or school. They last from 30 minutes to 7 days.21 Pressure or tightness that wages and wanes is the common complaint, with no other symptoms associated. These headaches often become worse as the day progresses and may last for days.

CLUSTER HEADACHE

This type of primary headache is uncommon in children. Patients can have one or more headaches per day, lasting about 30 to 90 minutes at a time. The pain is unilateral, severe,
often around the eye, and usually accompanied by autonomic symptoms such as lacrimation, facial flushing, or nasal stuffiness on the same side as the headache.

**SECONDARY HEADACHES**

According to the International Headache Society (IHS), a new onset headache occurring with another disorder recognised to be capable of causing it is always diagnosed as secondary. Secondary headaches due to non-life-threatening diseases are the most frequently seen in the pediatric population (Table 2). In particular, respiratory tract infections and minor head trauma represent the majority of the cases. In a small minority of patients, headache is secondary to serious life-threatening intracranial disorders. Meningitis is the most common cause of headache due to a serious neurological condition.

**HISTORY**

The emergency physician should ask about a description of the headache (sudden first headache, frequency, severity, pattern over time, mode of onset, duration), warning signs (Table 3), location and quality of pain (pounding, squeezing, stabbing), triggers and exacerbating factors (stress, sleep changes, posture), alleviating factors (treatments already used with dose and frequency), associated symptoms (nausea or vomiting, weakness, visual symptoms, sensory changes, lacrimation or rhinorrhea) and family history.

**PHYSICAL EXAMINATION**

In most patients with primary headache the physical examination is normal. The first step is to assess patient’s appearance and determine how sick they look and severity of pain, because this may indicate a more serious underlying condition. Vital signs are important because an abnormality can raise suspicion of a life-threatening illness. A complete physical examination including a detailed neurologic examination is essential. In the neurologic examination, the clinician should look for mental status, cranial nerves, signs of intracranial pressure, integrity of the brainstem, motor and sensory evaluation, deep tendon reflexes, coordination problems and gait abnormalities.

**DIAGNOSTIC TESTING**

For few children who need further evaluation, the work-up should be directed at the underlying suspected etiology. Diagnostic testing are varied, including routine laboratory testing, Cerebral Spinal Fluid (CSF) examination, Electroencephalography (EEG), and neuroimaging with Computed Tomography (CT) or Magnetic Resonance Imaging (MRI). Routine neuroim-
aging is not indicated in children with recurrent headache and a normal neurologic examination. Guidelines recommend that this test must be ordered for children presenting with abnormal neurologic exam and a history of CNS disease. Lumbar puncture is not recommended in the evaluation of primary headache. It should be done when there’s suspicion of CNS infection, low pressure headaches, idiopathic intracranial hypertension and subarachnoid hemorrhage.

Neuroimaging should be considered in children with chronic progressive headaches, abnormal neurologic examination, worst headache of life (sudden, thunderclap headache), significant head trauma, presence of VP shunt, meningeal signs and focal findings/altered mental status. It should be considered, if the headache is associated with vomiting on awakening, unvarying location of headache (especially occipital), persistent headache with no family history of migraine, neurocutaneous syndromes and age less than 3 years old (limited verbalization skills).

In primary headaches the imaging modality recommended is an MRI, in secondary headaches – especially in the ED setting – the most appropriate imaging modality will be a head CT scan, specifically to rule out hemorrhage. EEG is not helpful in the evaluation of pediatric headache.

TREATMENT

The mainstay of ED management is to exclude secondary causes of headache and to initiate an appropriate treatment. There are many treatment options available for pediatric headaches, but the goal is to recognize and avoid triggers and to diagnose somatic/psychiatric comorbidities as well as educating the family and the patient about therapy. The clinician has to promote stress reduction techniques and encourage regular exercise and a good sleep. After that, an explanation should be given regarding the pharmacologic treatment.

Medical treatment should focus on abortive analgesics to alleviate the pain. Opioids and benzodiazepines have no role in the management of primary headaches. Clinicians often consider ibuprofen to be more effective than acetaminophen in the management of pain. It has been proven in several studies that Ibuprofen is safe and effective, although one investigation comparing acetaminophen (15 mg/kg) and ibuprofen (10 mg/kg) found no difference in pain relief. As an initial strategy, over the counter medications should be administered and if they result to be ineffective or not completely effective, migraine-specific therapy is often required. In this case, triptans may be added to the treatment plan.

Several authors have concluded that oral triptans are not as effective in children as in adults. However, nasal sumatriptan is promising. Most studies evaluating oral sumatriptan, oral rizatriptan and oral zolmitriptan found no effectiveness of these medications for pain relief in children.

Headaches can be increased in frequency in some patients and might produce some disability. When this happened, preventive therapy plan must be started. Some prophylactic medication apart from behavioral management is: antidepressant medications, especially the tricyclic antidepressants; antiserotonergic medications; and antihypertensive medications, including both beta-blockers and calcium channel-blockers. The initial goals of the preventive treatment are reduction of headache frequency and improvement of headache disability. Patients discharged from the ED should have an appropriate follow-up plan with their primary physician. Some of the patients will require admission to the hospital for further evaluation and treatment.

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CONFLICTS OF INTEREST

There are no conflicts of interest to declare.

REFERENCES


