

Providence College

DigitalCommons@Providence

Annual Undergraduate Conference on Health
and Society

Fourth Annual Undergraduate Conference on
Health and Society

Mar 23rd, 9:30 AM - 10:45 AM

The Effects of Pre-existing Illnesses on Pediatric Acute Respiratory Infections in South Africa

Haley Dumke
Connecticut College

Follow this and additional works at: <https://digitalcommons.providence.edu/auchs>



Part of the [Health Policy Commons](#), and the [Policy Design, Analysis, and Evaluation Commons](#)

Dumke, Haley, "The Effects of Pre-existing Illnesses on Pediatric Acute Respiratory Infections in South Africa" (2013). *Annual Undergraduate Conference on Health and Society*. 1.
<https://digitalcommons.providence.edu/auchs/2013/panela1/1>

This Event is brought to you for free and open access by the Conferences & Events at DigitalCommons@Providence. It has been accepted for inclusion in Annual Undergraduate Conference on Health and Society by an authorized administrator of DigitalCommons@Providence. For more information, please contact dps@providence.edu.

**The Effects of Pre-existing Illnesses on Pediatric
Acute Respiratory Infections in South Africa**

Haley Dumke
Connecticut College
New London, CT
November 2012

Abstract

The intent of this study was to explore the effect of pre-existing illnesses on acute respiratory infections, focusing on HIV and malnutrition as infection development risk factors in South African children. It investigates the economic burden imposed by these infections and analyzes how the country's current socio-economic situation plays a major part in propagating infection development. Pneumonia and RSV were individually examined for their current role in the disease burden and potential methods for reducing incidence of pediatric respiratory infections were evaluated based on effectiveness and affordability for the country of South Africa.

Data for this paper was compiled mainly from secondary sources, with a small number of informed consent, formal interviews with experts in this field. Information from current global, and South African, respiratory infection studies was synthesized with the opinions of experts to form a complete analysis.

The study found that because pediatric HIV and malnutrition cause deterioration of the immune system, this results in higher incidence of acute respiratory infection developments and increased risk of mortality. The findings showed that the large burden of respiratory illness in South Africa could be helped through the use of Vitamin A and Zinc supplements, immunizations, exclusive breastfeeding, and increasing nutrition to effectively reduce the burden of disease.

Table of Contents

| | |
|--|----|
| Acknowledgements..... | 4 |
| Frequently Used Acronyms..... | 4 |
| Introduction..... | 5 |
| Methodologies..... | 6 |
| Literature Review..... | 9 |
| Findings and Analysis..... | 12 |
| The Burden of Acute Respiratory Infections in the Recent Past and Now..... | 12 |
| The Effects of Infection Burdens on South African Economics and Health Care System..... | 14 |
| Socio-Economic Status and Attempts to Change..... | 15 |
| The Affected Demographic..... | 17 |
| Health Policies for Provision of Children’s Health Care in South Africa..... | 19 |
| Basis for Studying the Effects of HIV and Malnutrition on Pediatric Acute Respiratory Infections..... | 21 |
| The Effects of HIV on Acute Respiratory Infections..... | 22 |
| The Effects of Malnutrition on Acute Respiratory Infections..... | 25 |
| Common Acute Respiratory Infections in South Africa..... | 28 |
| Protocols and Proposed methods for Decreasing Acute Respiratory Infections..... | 30 |
| Conclusions..... | 34 |
| Recommendations for Further Study..... | 35 |
| Bibliography and List of Sources..... | 36 |
| Appendix A: Consent Form for Adult Respondents in English..... | 39 |
| Appendix B: WHO clinical staging of HIV/AIDS for children with confirmed HIV infection..... | 40 |

Acknowledgements

The author would like to thank her home institution Connecticut College for the experience to participate in SIT: Community Health and Social Policy Fall 2012. Special thanks is given to the coordinators and professors Zed, Clive, Zandi and Hlobsile for their efforts in arranging all of these invaluable learning experiences that will not soon be forgotten. Warm thanks are extended to Thula and Sdu for helping to make South Africa feel a little bit more like home. And finally, an enormous thank you goes to the fellow SIT students for their friendships and support during this new and exciting experience.

Frequently Used Acronyms

ARI – Acute respiratory infection

HIV – Human immunodeficiency virus

AIDS - Acquired immune deficiency syndrome

RSV - Respiratory syncytial virus

WHO - World Health Organization

IMCI - Integrated management of childhood illness program

PCP - Pneumocystis Pnuemonia

LRI – Lower respiratory infection

PCV – Pneumococcal pneumonia vaccine

Introduction

The objective of this paper is to extensively look at the issue of pediatric acute respiratory infections as a health burden in the country of South Africa. The study will identify the economic burden of these infections on the South African health care system and will delve into and how the socio-economic status of the country's population affects and hinders attempts to reduce the incidence of disease. It will explore the effects of the common children's health issues of HIV and malnutrition on the contraction and severity of these infections, and will also look at the country's explicit guarantee for children's health care. Two of the common acute respiratory infections in South African pediatric cases, Pneumonia and Respiratory syncytial virus (RSV), will be individually examined for their current health impacts and disease burden both globally and in South Africa. And finally, potential methods for overall reducing South Africa's incidence of pediatric acute respiratory infections will be proposed and analyzed for effectiveness and affordability for the modern health care system.

The data for this study was compiled mainly from secondary sources, with a small number of informed consent, formal interviews with South African experts in this field. The arguments pull directly from published studies and information was collected from the verified data and opinions. The information from these studies was synthesized with the opinions of current experts in order to provide a thorough and up-to-date analysis of the burden of pediatric acute respiratory infections in South Africa.

The prevalence of pediatric acute respiratory infection is a worldwide health issue and this class of illnesses has a high mortality rate that is exacerbated in populations with pre-existing immune suppressing illnesses like HIV and malnutrition. Both globally and

within South Africa, the populations most at risk for developing acute respiratory infections are young children, and particularly those that are immunocompromised and suffer from other health issues. South Africa is currently battling against extremely high prevalence rates for pediatric HIV and also sees wide ranges of malnutrition. These two health factors greatly contribute to the country's prevalence of infections as they hinder the immune system.

The high prevalence of infections also takes a considerable toll on the economies and health care systems of the countries where the infections are rampant. More frequent and longer hospital stays are characterized by these infections when they are coupled with another infection or health issue, and this leads to increased resource use and the necessity for more funding. The impact of these infections further influences learning and education by accounting for a large number of missed school days and also often calls parents away from jobs, affecting family incomes. The prevalence of pediatric acute respiratory infections in South Africa extensively affects the health and economic status of the population countrywide.

For the remainder of the paper, the terminology "acute respiratory infections" and its abbreviation "ARI" will be used interchangeably out of convenience to both the reader and the author.

Methodologies

Primary Sources

The primary data from the project was gathered through a formal interview with a single expert. The formal structure of the interview and use of the interview guide

(Appendix A) benefited the data collection process by keeping the questions direct and helping to maintain focus on the topic of study. However, as there as only one primary source used, this may provide a bias in opinions and data collected. The source’s status as a South African citizen may also give a bias to the information that was collected. The short time period of this study served as a limitation for finding and conducting interviews with experts on this topic.

Secondary Sources

Journals

Scholarly articles were searched through PubMed Central database and Google Scholar using a combination of the keyword: “acute” “respiratory infection” “children” “South Africa” “HIV” and “malnutrition”. Using these databases also had limitations as there were many articles that were not open access publications. As a student, the author did not have the resources to purchase these articles even if they pertained to the area of study.

The articles used in the study focused on pediatric acute respiratory infections, both specifically in South Africa and also as a worldwide health issue. The articles which pertained to respiratory infections in HIV positive or malnourished children most often had a focus in sub-Saharan Africa. Since many other countries do not have similar populations of HIV infected children, there were few studies that compared their national prevalence of respiratory infections in HIV positive children to that of South Africa.

Numerous publications by the World Health Organization were used as standards for investigating the current conditions, guidelines, and goals for respiratory infections in

South Africa. The WHO is a renowned international organization and the author trusts that their publications and the fact and statistics stated within them are accurate.

The information in the secondary sources may carry biases because the majority of the sources were published by authors in other countries and not in South Africa itself. Being an outsider and conducting research may cause these studies to form assumptions and insinuations about the data they collect. International researchers may also be harshly critical of the data collected because they do not identify in any way with the nation and culture being studied and may lack certain understandings.

Books

The book used in this project was accessed online through the NCBI database. It was originally printed and copyrighted in 2006 by The International Bank for Reconstruction and Development/The World Bank and has been published for open access online through the database. There were limitations for finding books that pertain to the combination of pediatric respiratory infections and HIV or malnutrition. Most sources only focused on one of these pediatric health conditions and took a general global view of the issue and did mention conditions specifically in South Africa.

Statistics

The statistics used in the paper come from a variety of different sources. While the sources are trusted as valid publications there were some inconsistencies found regarding specific statistics and conflicts between sources. The author was critical of the data and used the most current sources and the statistics that they provided in order to confidently include the most accurate data.

Literature Review

1. Madhi SA, Klugman KP. Acute Respiratory Infections. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. Disease and Mortality in Sub-Saharan Africa. 2nd edition. Washington (DC): World Bank; 2006. Chapter 11. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK2283/>

Chapter 11: Acute Respiratory Infections. This is an extremely comprehensive publication by the World Bank about acute respiratory infections in general and with an emphasis in developing countries. It extensively explains the epidemiology of acute respiratory infections, confounding development risk factors, and current global approaches and policies to reducing acute respiratory prevalence, incidence rates, and mortality rates for children worldwide

2. Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. South African Health Review 2011. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

This source is a compilation of data collected within South Africa during 2011. It gives an extremely current analysis of the South African population statistics regarding the present health issues. The data in the Health Review regarding child mortality less than 5 years old, pertains to the population of interest and acute respiratory infections. The data about the current malnutrition is also relevant regarding pre-existing health conditions that decrease the activities and abilities of the immune system of the child. This source also extensively analyzes the prevalence and issues with pediatric HIV present in South Africa.

- Williams, Brian G., Eleanor Gouws, Cynthia Boschi-Pinto, Jennifer Bryce, and Christopher Dye. "Estimates of World-wide Distribution of Child Deaths from Acute Respiratory Infections." *Lancet Infectious Diseases* 2 (2002): 25-32. *The Lancet*. Web. 20 Sept. 2012.

This source analyzes the issue of co-morbidity in acute respiratory infections confounded with other diseases and discusses the effect of increasing infection contraction and symptom severity. It describes the issue of pre-existing diseases causing a higher potential to develop acute respiratory infections and also mentions the issue of these infections being masked by the other, pre-existing condition (e.g. malaria, measles, malnutrition, HIV). It explores how often the relationship between pre-existing diseases and acute respiratory infections is cyclic where each one can both cause the other to occur and also be caused by the other condition. This source recognizes that the younger the child, the higher the rate of mortality and that data suggests that acute respiratory infections may even be far more fatal and under reported.

- Sanders, David, Louis Reynolds, Tony Westwood, Brian Eley, Max Kroon, Heather Zar, Mary-Ann Davies, and Phumza Nongena. *Decreasing the Burd. Western Cape Burden of Disease Reduction Project*. Vol. 7. University of the Western Cape, 2007. http://www.westerncape.gov.za/Text/2007/6/cd_volume_7_childhood_diseases_overview.pdf (accessed October 24, 2012).

This report, released by the University of the Western Cape, analyzes child health in South Africa as a whole. It identifies risk factors for child mortality and includes a

section detailing the current issue of acute respiratory infections and their main causes. It also proposes a set of several approaches to help decrease the burden of acute respiratory infections and improve the general child mortality rate in South Africa, including more extensive immunizations.

5. "The Patient Rights Charter." *Department of Health Republic of South Africa.*

Department of Health, 14 Nov. 2007. Web. 9 Sept. 2012.

<<http://www.justice.gov.za/VC/docs/policy/Patient%20Rights%20Charter.pdf>>.

The charter, released and upheld by the South African Department of Health, states that child-specific service and attention must be available to all children and infants in the country. It places the responsibility of the provision of these services upon facilities and the doctors in order to make sure that children can obtain adequate and accurate pediatric care. It also states the responsibilities of the patient, or guardian, and their obligation to give the doctors all information that could affect the diagnosis and the decided course of treatment.

6. Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

This article analyzes the effects of malnutrition on the development of many infectious diseases. It notes the cyclic relationship of malnutrition and infection and explores the underlying causes of how malnutrition weakens the immune system to make it more

susceptible to opportunistic infections like acute respiratory illnesses. The article analyzes these issues from a public health view and focuses on the disproportionate burden of these infections found in developing countries. It analyzes the socio-economic status of lower and middle-income countries and its relation to infection and malnutrition.

Findings and Analysis

The Burden of Acute Respiratory Infections in the Recent Past and Now

In 1994 the annual worldwide burden of acute respiratory infections caused over four million deaths in children less than five years of age¹. Nearly twenty years later, the annual mortality due to these infections has almost been halved and stands at two million deaths per year. Although there has been significant forward progress in battling acute respiratory infections, they are still the leading cause of child deaths worldwide and are the global leading cause of child disability-adjusted life-years that are lost each year².

According to the Child Health Epidemiology Reference Group (CHERG), developed by the World Health Organization (WHO), the 2008 child mortality report attributed the highest number of deaths to respiratory infections, accounting for 18% of the nearly 9 million deaths³. South Africa follows this global trend as its highest percent of pediatric mortalities is also due to ARIs and they currently account for 28.9% of child

¹ Stanek, Edward J., Ezekial M. Wafula, Francis E. Onyango, and Janet Musia. "Characteristics Related to the Incidence and Prevalence of Acute Respiratory Tract Infection in Young Children in Kenya." *Clinical Infectious Diseases* 18.4 (1994): 639-47. *JSTOR*. Web. 20 Sept. 2012. <<http://www.jstor.org/stable/4457766>>.

² "Acute Respiratory Infections (Update September 2009)." *Initiative for Vaccine Research (IVR)*. World Health Organization, Sept. 2009. Web. 07 Oct. 2012. <http://www.who.int/vaccine_research/diseases/ari/en/index.html>.

³ Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

deaths each year⁴. An important factor that causes such a high number of pediatric mortalities due acute respiratory infections is that a single child can develop an infection anywhere from three to eight times per year⁵. This number of annual incidence typically decreases as the child ages; however this puts very young children at the highest risk for infection.

In 2000, when the World Health Organization released the Millennium Development Goals, they aimed to reduce the current 11 million annual child deaths by two thirds by 2015; however, currently 6.9 million children still die annually worldwide⁶ and two million of these are attributed to acute respiratory infections. Much of the efforts and progress towards achieving this goal have been set back by the continuing global spread of HIV and the persistence of pediatric malnutrition in countries all over the world. South Africa, as the epicenter of the global HIV/AIDS epidemic and a country where up to 25% of children experience stunting due to malnutrition⁷, has consistently been struck hard by the burden of pediatric acute respiratory infections and still suffers as nearly 30% of childhood deaths are attributable to these infections.

⁴ Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. South African Health Review 2011. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

⁵ Zhang, Guocui, Yunwen Hu, Hongping Wang, Zhang Lu, Yixi Bao, and Xiaoming Zhou. "High Incidence of Multiple Viral Infections Identified in Respiratory Tract Infected Children under Three in Shanghai, China." *Plos One*. 7. no. 9 (2012): 1-6.

⁶ World Health Organization, "MDG 4: reduce child mortality." Last modified 2012. Accessed October 24, 2012.

⁷ Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. South African Health Review 2011. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

The Effects of Infection Burdens on South African Economics and Health Care

System

In addition to the direct health impacts of acute respiratory infections, the worldwide burden of pediatric ARIs depletes resources and becomes a huge encumbrance on health care facilities. Globally, acute respiratory infections are the leading cause for utilization of health care resources and account for up to 40% of pediatric hospital admissions and up to 50% of all pediatric medical consultations⁸. Cases of co-infections between acute respiratory infections and other pre-existing illnesses also commonly result in longer hospitalization stays and require more antibiotics for longer periods of time⁹.

These issues create large economic burdens for the South African government as it funds all of the hospitals and clinics in the public sector, and thus is responsible to provide all monetary support for these facilities. According to South African pediatrician, Dr. Merrilee Sayers, “when there are chronic underlying conditions, like malnutrition, with infectious diseases there are prolonged hospitals stays. And most of these patient are in the public sector which means that economic burden is placed there.”¹⁰ The extended stays and need for additional medicines and care that results from ARIs and cases of co-infection, puts increased stress on these public health care facilities. Hospitals have to

⁸ Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

⁹ Calvo, Cristina, Maria Luz Garcia-Garcia, Carolina Blanco, Carmen Vazquez, Elena Frias, Pilar Perez-Brena, and Immaculada Casas. "Multiple simultaneous viral infections in infants with acute respiratory tract infections in Spain." *Journal of Clinical Virology*. 42. : 268-272. 2008.

¹⁰ Dr. Merrilee Sayers, female South African pediatrician. Personal communication. Durban, South Africa. 21 November 2012.

adjust to keeping these patients for longer periods of time, leading to a shortage of resources and a decrease in the speed at which the facility can admit, treat, and discharge patients; thus overall lowering the number of people receiving care.

Socio-Economic Status and Attempts to Change

The current South African socio-economic conditions play a major role in the persistence of the huge national disease burden and prevalence of respiratory infections. Factors like unemployment, income instability, under education, and the consequential poor living conditions are ever-present in South African communities and wreak havoc on health of the populations. In 2010, The National Planning Committee (NPC) released the Initial Diagnostic Overview which identified the issues that are most influential in the long-term development of the country. This statement reported the major factors holding back the country's current society and future development are the constant high rate of unemployment, concurrent substandard quality of education for poor black South Africans, and the struggling public health system overridden by the country's disease burden¹¹. The combination of these issues has resulted in 48% of the country's population living below the poverty line as of the last poll in 2008¹². The consistent presence of these factors in South Africa has had detrimental repercussions by contributing to the high prevalence of pediatric acute respiratory infections nationwide.

¹¹ Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. South African Health Review 2011. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

¹² Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. South African Health Review 2011. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

The issues of unemployment and inadequate education lead to poor nutrition and decreased standards of living conditions, which have a direct effect on the development of ARIs. According to Dr. Sayers, “ because of the high unemployment rate many families don’t have enough money for things like basic nutrition and they lack necessary amenities like sanitation and clean water.”¹³ As families cannot afford food with substantial nutritional qualities or enough food in general, malnutrition rises and the risk for respiratory infection development increases. Pediatric nutritional status affects every aspect of their health and as nutrition deficiencies arise when socio-economic conditions decline, a child’s immune system weakens, making them severely more susceptible to infectious diseases. In South Africa also as a result of lack of a steady family income there is commonly overcrowding in the home. As more family members are unable to afford their own home due to unemployment and lack of education, the number of people living in one home increases causing sanitation and hygiene issues, and thus promoting an environment conducive to the spread of these infectious diseases.

While the current socio-economic status greatly impacts the health of South Africans, its relationship with infectious diseases is bi-directional. While the burden of infectious diseases is constant and the population’s infection status increases, the educational opportunities and employment numbers severely decrease. When infected, pediatric respiratory illnesses can have lasting detrimental effects on the physical and mental development of a child and can also cause many missed days of school¹⁴. As the

¹³ Dr. Merrilee Sayers, female South African pediatrician. Personal communication. Durban, South Africa. 21 November 2012.

¹⁴ Selwyn, B. J. "The Epidemiology of Acute Respiratory Tract Infection in

child's ability to learn is hindered and they are unable to go to school due to poor health or hospitalization, their educational opportunities are jeopardized as they fall behind their peers. In the vicious cycle of socio economic status and infectious diseases, obtaining a inferior education as a result of ARI health complications also reinforces the national issues of substandard education and unemployment

The lack of parental employment and attainment of a steady family income is also propagated by pediatric respiratory infections. As children become sick, parents must miss work opportunities in order to care for the child, and this results in the loss of incomes and sustained employment¹⁵. This cyclic nature of the socio-economic status and infectious disease burden in South Africa has created conditions that hamper attempts to make sustained improvements in either sector.

The Affected Demographic

The prevalence of acute respiratory infections is a major global health issue, however the burden of infection is disproportionately distributed over different population age groups and global locations. The populations with the highest prevalence of acute respiratory infection development are very young children and individuals who are immunocompromised; those with diseases or health factors that suppress the abilities of the immune systems¹⁶. The pediatric risk factor for the development of acute

Young Children: Comparison of Findings from Several Developing Countries." *Reviews of Infectious Diseases* 12 (1990): 870-88. *JSTOR*. Web. 20 Sept. 2012. <<http://www.jstor.org/stable/4455724>>.

¹⁵ Jara-Perez, Jaime V., and Arturo Berber. "Primary Prevention of Acute Respiratory Tract Infections in Children Using a Bacterial Immunostimulant: A Double-Masked, Placebo-Controlled Clinical Trial." *Clinical Therapeutics*. 22. no. 6 : 748-759.

¹⁶ "Acute Respiratory Infections (Update September 2009)." *Initiative for*

respiratory infections is highest at birth and decreases as the child grows to five years of age¹⁷. Premature babies and infants under the age of one make up the population age group that is at the highest risk for respiratory infection. Because many ARIs are opportunistic infections, they target the immune systems of these young children that are not fully developed and thus more susceptible to infections.

Individuals are considered “immunocompromised” when they have pre-existing conditions that impair the functioning of their immune systems for a long period of time. Immunocompromised individuals are at a high risk for developing respiratory infections because many of the pathogens involved in these illnesses are opportunistic and take advantage of a weakened immune system¹⁸. These long-term health issues, like HIV and malnutrition, make a huge impact on weakening the immune systems of the affected individuals and are common chronic illnesses across the globe. Consequently, young children who are also affected by pre-existing, immune suppressing illnesses are at an extremely high risk for developing acute respiratory infections.

The distribution of acute respiratory infections is also geographically based. Infection development occurs more severely in certain global areas and less socio-economically developed countries. Developing countries have consistently been the hardest hit by the issue of pediatric acute respiratory infections, with 151 million cases

Vaccine Research (IVR). World Health Organization, Sept. 2009. Web. 07 Oct. 2012. <http://www.who.int/vaccine_research/diseases/ari/en/index.html>.

¹⁷ Williams, Brian G., Eleanor Gouws, Cynthis Boschi-Pinto, Jennifer Bryce, and Christopher Dye. "Estimates of World-wide Distribution of Child Deaths from Acute Respiratory Infections." *Lancet Infectious Diseases* 2 (2002): 25-32. *The Lancet*. Web. 20 Sept. 2012.

¹⁸ AVERT, "HIV Related Opportunistic Infections: Prevention and Treatment." Last Modified 2012. Accessed October 24, 2012. <http://www.avert.org/hiv-opportunistic-infections.htm>.

reported in 2009. Of the 2 million global pediatric deaths attributable to acute respiratory infections, 42% of these mortalities occurred in Africa¹⁹. First world countries are not immune to this pediatric health issue as they tallied 5 million infections in the same year²⁰. However, the difference in annual prevalence rates of these two groups is enormous and depicts a clear disparity in the infection burden between the two groups. According to the International Monetary Fund's World Economic Outlook Report released in April 2012, the continent of Africa holds 33% of all socio-economically developing countries globally, with only two African nations out of 53 being classified as developed²¹. With a largely disproportionate amount of developing countries located in Africa, the continent struggles from an atypically severe burden of respiratory infections compared other global regions.

Health Policies for Provision of Children's Health Care in South Africa

The Patient Rights Charter, published by the South African Department of Health, mandates that there be provision of pediatric services to specifically address children's health issues, offered in the health care system at all times²². Pediatrics requires specialized care and these services must be comprehensive, available, affordable, and

¹⁹ Madhi SA, Klugman KP. Acute Respiratory Infections. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. *Disease and Mortality in Sub-Saharan Africa*. 2nd edition. Washington (DC): World Bank; 2006. Chapter 11. Available from:

<http://www.ncbi.nlm.nih.gov/books/NBK2283/>

²⁰ "Acute Respiratory Infections (Update September 2009)." *Initiative for Vaccine Research (IVR)*. World Health Organization, Sept. 2009. Web. 07 Oct. 2012. <http://www.who.int/vaccine_research/diseases/ari/en/index.html>.

²¹ *World Economic Outlook April 2012*. Washington D.C.: International Monetary Fund, 2012.

²² "The Patient Rights Charter." *Department of Health Republic of South Africa*. Department of Health, 14 Nov. 2007. Web. 9 Sept. 2012.

<<http://www.justice.gov.za/VC/docs/policy/Patient%20Rights%20Charter.pdf>>.

accessible to all children in South Africa. However, because a child cannot access health care services on their own, the responsibility to seek services is placed on the parent or guardian and the extent to which the guardian pursues care for the child can vary greatly.

The facilities and doctors maintain the responsibility of ensuring that the pediatric services be available, affordable and comprehensive and thus complete the provisional requirements of child health care per South African standards. Another policy of the Patient Rights Charter also states the responsibilities of the patient to the health system. It necessitates the patient's obligation to give health care providers all information that could affect their diagnosis and the decided course of treatment to help them successfully obtain the greatest care possible²³.

The global approach to managing acute respiratory infections adopted by the World Health Organization is treatment through primary health care, in order to ensure quick and effective access to care²⁴. By calling for treatment for these infections at the first level of health care, this management scheme reduces the duration of the infection and ultimately reduces the infection development rate by shortening the amount of time it takes to actually access care. Because these infections move from person-to-person by droplet transmission through the infection's symptoms of coughing and sneezing, if the period of when the individual is contagious and trying to seek care can be reduced, then the period of possibly transmitting the infection is also shortened. This primary health

²³ "The Patient Rights Charter." *Department of Health Republic of South Africa*. Department of Health, 14 Nov. 2007. Web. 9 Sept. 2012. <<http://www.justice.gov.za/VC/docs/policy/Patient%20Rights%20Charter.pdf>>.

²⁴ Madhi SA, Klugman KP. Acute Respiratory Infections. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. *Disease and Mortality in Sub-Saharan Africa*. 2nd edition. Washington (DC): World Bank; 2006. Chapter 11. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK2283/>

care approach to treatment was adopted into the general integrated management of childhood illness (IMCI) program as a guideline for health services in developing countries in order to ensure available and accessible treatment for all children where higher tier treatment centers are scarce²⁵.

Basis for Studying the Effects of HIV and Malnutrition on Pediatric Acute Respiratory Infections

Acute respiratory infections are extremely taxing on the health of young children and can cause long term health issues like growth and learning delays. When these infections are coupled with pre-existing immune system suppressing illnesses, the chance of morbidity rises as the child's ability to fight infections decreases. While otherwise, healthy children have the ability to fight acute respiratory infections, children whose immune systems are weakened by other health factors, like HIV and malnutrition, are at higher risk of developing the infections and face higher mortality rates²⁶. HIV infected children are more susceptible to these opportunistic infections because they have a severely reduced number of CD4 cells, which are a main defense mechanism of the immune system so it functions more weakly. Malnutrition, which originates from nutrient deficiencies, also creates immune system abnormalities because the body is not receiving enough nutritional support for its defense mechanisms to respond appropriately to

²⁵ Madhi SA, Klugman KP. Acute Respiratory Infections. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. *Disease and Mortality in Sub-Saharan Africa*. 2nd edition. Washington (DC): World Bank; 2006. Chapter 11. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK2283/>

²⁶ "Pneumonia Fact Sheet." *Media Centre*. World Health Organization, Aug. 2012. Web. 07 Oct. 2012. <<http://www.who.int/mediacentre/factsheets/fs331/en/index.html>>.

threatening pathogens²⁷. Along with increased susceptibility of infection contraction, individuals with these pre-existing illnesses suffer worse damage to the body, more severe symptoms, and longer recovery periods.

Another major problem faced in dealing with acute respiratory infections is that the deaths are often confounded with other illnesses and the direct cause of death can be unclear and incorrectly documented²⁸. Because factors like malnutrition and HIV degrade the abilities of the immune system and increase the rate of developing acute respiratory infections, many deaths are caused by the extremely harmful synergistic relationship of the two factors.

The Effects of HIV on Acute Respiratory Infections

HIV is an illness that severely depresses the immune system of the host individual and causes them to become extremely vulnerable to infectious diseases. Even in early stages of the disease, infected individuals are dangerously susceptible to opportunistic acute respiratory infections like Pneumocystis Pneumonia (PCP) and other bacterial pneumonias. With HIV weakened immune systems, individuals are unanimously subject to both higher contraction rates and longer recovery periods than uninfected people²⁹.

²⁷ Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

²⁸ . Williams, Brian G., Eleanor Gouws, Cynthia Boschi-Pinto, Jennifer Bryce, and Christopher Dye. "Estimates of World-wide Distribution of Child Deaths from Acute Respiratory Infections." *Lancet Infectious Diseases* 2 (2002): 25-32. *The Lancet*. Web. 20 Sept. 2012.

²⁹ AVERT, "HIV Related Opportunistic Infections: Prevention and Treatment." Last Modified 2012. Accessed October 24, 2012. <http://www.avert.org/hiv-opportunistic-infections.htm>.

Many respiratory illnesses are caused by opportunistic infection pathogens that attack and thrive in individuals with compromised immune systems. Opportunistic infections occur in people with normal immune systems but attack HIV infected individuals at a much higher rate and cause dangerously higher risks of mortality. In the concurrent development of an opportunist infection in an individual with HIV, the HIV virus attacks and destroys the body's CD4 cells while the infection takes advantage and simultaneously spreads and replicates throughout the body. The extreme danger of these infections is that once they are established in the body, they spread to a number of different organs and cause entire systemic disease, which is often deadly³⁰. The co-infection relationship of these two illnesses is so strong that the diagnosis of HIV in most patients occurs when they develop and seek health care for an opportunistic infection³¹. Once a confirmed HIV diagnosis is made, the synergistic relationship of HIV and opportunistic infections is used by WHO as criteria for the clinical staging of HIV based on which infections are also present (Appendix B). In Dr. Sayers' pediatric HIV/AIDS work in South Africa, "the clinical staging is based solely on the development of the infectious diseases"³² and actual HIV diagnoses most often occur when a patient presents with one of these infectious diseases, unknowing of the underlying cause. Respiratory opportunistic infections can occur at any stage of HIV infection but produce such a

³⁰ AVERT, "HIV Related Opportunistic Infections: Prevention and Treatment." Last Modified 2012. Accessed October 24, 2012. <http://www.avert.org/hiv-opportunistic-infections.htm>.

³¹ Moosa, Yunus. "Management of Common OIs in Patients with HIV/AIDS." Address. Jan. 2006. *UKZN Department of Health*. Web. 7 Nov. 2012.

³² Dr. Merrilee Sayers, female South African pediatrician. Personal communication. Durban, South Africa. 21 November 2012.

severe mortality risk because they often attack when there is extreme immunosuppression and CD4 counts are extremely low, around 200-100³³.

South Africa is currently the epicenter of the worldwide HIV/AIDS epidemic, hosting 18% of the global disease burden. The nation's high prevalence of this life-long illness puts much of its population, particularly young HIV positive children, at extremely high risks for developing acute respiratory infections. Much of the previous progress made toward the reduction in childhood mortalities due to acute respiratory infections in Sub-Saharan Africa was significantly reversed after the HIV epidemic surged in the 1990s³⁴. Although both HIV and ARIs are significantly more prevalent in underdeveloped countries, data has shown that the influence of pediatric HIV infection unanimously increases the risk of developing ARIs regardless of one's socio-economic status³⁵.

In South Africa, the current burden of pediatric acute respiratory infections caused 28.9% of all annual child deaths in 2011³⁶. The impact of HIV co-infection on these infections is statistically unknown as only 42.3% of all annual child deaths had known HIV statuses. However, of the known HIV statuses, 28.2% of these children were HIV

³³ Moosa, Yunus. "Management of Common OIs in Patients with HIV/AIDS." Address. Jan. 2006. *UKZN Department of Health*. Web. 7 Nov. 2012.

³⁴ Madhi SA, Klugman KP. Acute Respiratory Infections. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. *Disease and Mortality in Sub-Saharan Africa*. 2nd edition. Washington (DC): World Bank; 2006. Chapter 11. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK2283/>

³⁵ Madhi SA, Klugman KP. Acute Respiratory Infections. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. *Disease and Mortality in Sub-Saharan Africa*. 2nd edition. Washington (DC): World Bank; 2006. Chapter 11. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK2283/>

³⁶ Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. *South African Health Review 2011*. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

positive³⁷ and taking into consideration the other 57.7% of deaths with unknown status, this identifies a large number of immunocompromised children, who are extremely vulnerable to infection development. The dangerous impact of HIV and ARI co-infection intensely undermines the attainment of the WHO Millennium Development Goal 4 to reduce global annual child mortality to 3.7 million by 2015³⁸.

The Effects of Malnutrition on Acute Respiratory Infections

Malnutrition is a health condition caused by an inadequate diet or insufficient intake of the essential nutrients the body needs in order to function properly. Malnutrition is a global pediatric health issue and is a direct or indirect cause associated with 54% of annual deaths in children under the age of five³⁹. Malnourished children suffer from a lack of sufficient nutrients for proper growth and development, which can lead to underdevelopment or weakening of the immune system, and thus increased susceptibility to infections. An individual suffering from malnutrition is at increased risk for pathogen invasion as their immune system is underperforming due to the insufficient supply of essential nutrients that needed for correct functioning. Globally there are 178 million

³⁷ Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. South African Health Review 2011. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

³⁸ Bbaale E. Determinants of diarrhoea and acute respiratory infection among underfives in Uganda. AMJ 2011, 4, 7, 400-409 <http://dx.doi.org/10.4066/AMJ.2011.723>

³⁹ Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

children who suffer from chronic malnutrition and 26% of all children in Sub-Saharan Africa experience this degree of under nourishment⁴⁰.

The increased susceptibility to infection development and increasing severity of symptoms associated with malnutrition is due to the deterioration of immune system capabilities. As similarly seen in HIV infections, there is a high incidence and strong relationship of co-infection between malnutrition and opportunistic infectious diseases. As malnutrition decreases the functionality of the immune system the infectious pathogen is able to enter and establish itself within the body in order to launch an attack on the body that can be extremely deadly to the host. Unlike HIV, malnutrition and infectious diseases share a bidirectional relationship as malnutrition increases infection development in the body and the infections can also cause the body to become malnourished. Infections affect nutrition because they increase the body's utilization of energy and nutrients, can severely deplete nutrient stores in the body, and can cause overall reduction of food intake⁴¹. Undernourished children suffer from the vicious malnutrition-infection cycle and endure hugely detrimental health effects and long-term development issues. In data recorded from 2006, malnutrition was associated with 56% of all the global pediatric deaths due to infections diseases⁴².

⁴⁰ Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

⁴¹ Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

⁴² Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health

Although the annual mortality rate for pediatric severe malnutrition in South Africa has decreased in recent years it is still a huge obstacle for the WHO target to reduce the annual pediatric deaths that are attributable to malnutrition. Of all the pediatric deaths in South Africa during 2011, 34% of the children were classified as having severe malnutrition and another 30% had low weight-for-age⁴³. This prevalent health issue directly causes the nation's extremely high pediatric infection rate and is largely responsible as to why acute respiratory infections are specifically dangerously rampant. South African pediatrician Dr. Sayers noted that when she sees patients who are malnourished "they are usually coming in for help for another infection and most often it is not for malnutrition"⁴⁴. In these cases, the infection may be causing the malnourishment or exacerbating the nutrient deficit if it was already a pre-existing problem in the patient.

The illnesses that fall under the classification of acute respiratory infections are largely composed opportunistic infectious pathogens. Globally, there is affixed trend for children who suffer from malnutrition to have higher rates of both ARI incidence and mortalities due to ARIs⁴⁵. Without the eradication of pediatric malnutrition acute

Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.

⁴³ Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. *South African Health Review 2011*. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

⁴⁴ Dr. Merrilee Sayers, female South African pediatrician. Personal communication. Durban, South Africa. 21 November 2012.

⁴⁵ Sanders, David, Louis Reynolds, Tony Westwood, Brian Eley, Max Kroon, Heather Zar, Mary-Ann Davies, and Phumza Nongena. *Decreasing the Burd. Western Cape Burden of Disease Reduction Project*. Vol. 7. University of the Western Cape, 2007. http://www.westerncape.gov.za/Text/2007/6/cd_volume_7_childhood_diseases_overview.pdf (accessed October 24, 2012).

respiratory infections will continue to target and kill millions of children in South Africa and the propagation of the deadly malnutrition-infection cycle will continue indefinitely.

Common Acute Respiratory Infections in South Africa

Pneumonia

Pediatric pneumonia cases are caused by numerous strains of opportunistic bacteria, viruses and fungi which attack the alveoli in the lungs and cause severe inflammation, inhibiting oxygen intake. The majority of the pathogens involved in pneumonia infections are opportunistic organisms that thrive in individuals with deteriorated immune systems. Pneumonia can progress very quickly to become a life threatening illness with up to 13% of all pneumonia cases requiring hospitalization⁴⁶. The majority of the burden of pediatric pneumonia occurs in low and middle income countries and it accounts for 20% of all annual child deaths under five years old, compared to only 4.3% of the deaths in high income countries⁴⁷.

Pneumonia pathogens thrive particularly well in individuals whose immune systems have been compromised by pre-existing health issues, like malnutrition and HIV. Pneumonia is the most common cause for hospitalization and mortality in HIV positive children worldwide and HIV increases a child's chances of developing pneumonia 6 fold

⁴⁶ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamscience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

⁴⁷ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamscience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

compared to HIV negative children⁴⁸. The epidemic of pediatric HIV in sub-Saharan Africa has severely increased the burden of pneumonia for this global location as 90% of all HIV positive children less than fifteen years of age live in this area⁴⁹. As the epicenter of the HIV epidemic and a country with significant pediatric malnutrition, South Africa hosts a considerable amount of immunocompromised children and as a result, pediatric pneumonia is exceptionally rampant and deadly.

Respiratory Syncytial Virus

Respiratory syncytial virus (RSV) is the most common pathogen involved in the development of viral lower respiratory tract infections⁵⁰. RSV is an opportunistic infection and the pathogen can cause a wide variety of illnesses and is particularly prevalent in the world's less developed countries. In a study conducted by Robertson *et al.* in 2004 at least 11% of all severe lower respiratory infections (LRIs) were attributable to the RSV pathogen⁵¹. However, the percent of LRIs caused by RSV in Indonesia in this same study was 45% and the authors suggest that they were underreported in South

⁴⁸ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamscience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

⁴⁹ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamscience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

⁵⁰ Robertson, Susan E.. "Respiratory syncytial virus infection: denominator-based studies in Indonesia, Mozambique, Nigeria and South Africa." *Bulletin of the World Health Organization* 82 (2004): 914-922. www.ncbi.nlm.nih.gov/pubmed/15654405 (accessed November 7, 2012).

⁵¹ Robertson, Susan E.. "Respiratory syncytial virus infection: denominator-based studies in Indonesia, Mozambique, Nigeria and South Africa." *Bulletin of the World Health Organization* 82 (2004): 914-922. www.ncbi.nlm.nih.gov/pubmed/15654405 (accessed November 7, 2012).

Africa due to illness misdiagnosis because the symptoms are very similar to those of malaria, which is also a disease prevalent in this location⁵².

The influence of HIV and malnutrition in increasing RSV infection developments has also been studied within South Africa. In a study conducted in Johannesburg, the presence of HIV infection concurrently influenced the rate of development of RSV, its symptoms, and the course of infection progression⁵³. The risk of RSV infection in HIV positive individuals is extremely high and these co-infections work together to attack and thrive in the host.

Protocols and Proposed methods for Decreasing Acute Respiratory Infections

Breastfeeding and Nutrition

One proposed method for reducing the prevalence of pediatric ARIs is increasing the use of exclusive breastfeeding for babies. In accordance with the World Health Organization's recommendations, the use of exclusive breastfeeding has been known to help babies defend themselves against infections at young ages and later in life as they continue to grow. A study conducted in Uganda in 2011 found that there was a 4-5% reduction in probability of ARI development in children who were exclusively breastfed compare to those who were not⁵⁴. There are numerous substantial health benefits for

⁵² Robertson, Susan E.. "Respiratory syncytial virus infection: denominator-based studies in Indonesia, Mozambique, Nigeria and South Africa." *Bulletin of the World Health Organization* 82 (2004): 914-922. www.ncbi.nlm.nih.gov/pubmed/15654405 (accessed November 7, 2012).

⁵³ Madhi SA, Schoub B, Simmank K, Blackburn N, Klugman KP. Increased burden of respiratory viral associated severe lower respiratory tract infections in children infected with human immunodeficiency virus type-1. *Journal of Pediatrics* 2000;137:78-84.

⁵⁴ Bbaale E. Determinants of diarrhoea and acute respiratory infection among underfives in Uganda. *AMJ* 2011, 4, 7, 400-409 <http://dx.doi.org/10.4066/AMJ.2011.723>

children who are breastfed and this feeding practice can greatly support children's resilience against diseases when they are young and extremely susceptible.

The treatment and eradication of infections cannot be successful without adequate nutrition given the issue that malnutrition and infectious diseases have a bidirectional relationship. Actions to decrease and eliminate malnutrition and nutrient deficiencies in South Africa will go a long way in reducing the prevalence and severity of pediatric ARIs in the country⁵⁵. With the expansion of food supplement schemes and increased utilization of these resources by parents and guardians, pediatric malnutrition and its resulting health issues can be significantly decreased.

Vitamin A and Zinc Supplements

Zinc and Vitamin A are two micronutrients that are particularly important in maintaining the capabilities of the immune system. Deficiencies in these nutrients are most common in developing countries and they can both cause and develop from acute respiratory infections⁵⁶. Zinc plays an important role in maintaining mucous membranes and immune system defense cells. Pediatric patients that experience zinc deficiencies and have been given daily or weekly supplementation have shown a decrease in pneumonia incidence⁵⁷. Deficiency in Vitamin A, a nutrient that is also vital for immune system

⁵⁵ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamsjournal.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

⁵⁶ Ambrus Sr., Julian L., and Julian L. Ambrus Jr.. "Nutrition and Infectious Diseases in Developing Countries and Problems of Acquired Immunodeficiency Syndrom." *Experimental Biology and Medicine* 229 (2004): 464-472. <http://ebm.rsmjournals.com/content/229/6/464> (accessed November 6, 2012).

⁵⁷ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010):

functionality and production of the body's defensive mucous barriers, propagates the development of acute respiratory infections as it weakens the immune system response and these deficiencies also develop significantly faster in children with infections⁵⁸. In response to these findings, an effective Vitamin A supplementation scheme was adapted into the South African pediatric health management scheme in accordance with the WHO supplement guidelines for improving child and maternal health⁵⁹. With the current Vitamin A supplements and the implementation of greater pediatric Zinc supplementation, respiratory infection prevalence can be controlled and decreased through the provision of these micronutrients to maintain and support healthy immune system function.

Immunizations

Reduction of the worldwide burden of acute respiratory infections has begun through the development of immunizations against common infection pathogens and their addition into the global Expanded Program on Immunization (EPI)⁶⁰. The pneumococcal pneumonia vaccine (PCV) has made a great impact in the reduction of pediatric bacterial pneumonia infections worldwide, and has also proven to be useful for those who are HIV

74-84. www.benthamscience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

⁵⁸ Ambrus Sr., Julian L., and Julian L. Ambrus Jr.. "Nutrition and Infectious Diseases in Developing Countries and Problems of Acquired Immunodeficiency Syndrome." *Experimental Biology and Medicine* 229 (2004): 464-472.

<http://ebm.rsmjournals.com/content/229/6/464> (accessed November 6, 2012).

⁵⁹ World Health Organization. "WHO Guideline Development: Effects and Safety of Vitamin A Supplementation in Populations." World Health Organization. www.who.int/nutrition/events/guideline_dev_vas/en/index.html (accessed November 15, 2012).

⁶⁰ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamscience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

positive⁶¹. The growth of pediatric HIV has significantly increased the prevalence of pneumococcal pneumonia and although the efficacy of PCV seems to be somewhat less effective for HIV positive children than those who are uninfected, the vaccine still gives them significant protection than if no vaccine is received at all⁶².

The use of vaccinations against acute respiratory infections is also an effective means for decreasing the economic burden of these infectious diseases. Lowering the prevalence of these illnesses through vaccination will reduce the tremendous need for medical attention, hospitalization, and antibiotics that is associated with these infections. Particularly in low and middle income countries, vaccination for prevention has shown to be a much more cost effective way to address ARIs rather than accept the larger expenditure of money and resources needed for treatments once infections have already developed⁶³. The development and expansion of vaccinations against respiratory infection pathogens will widely reduce the prevalence of these infections globally. Strict implementation of these vaccinations will protect the large number of immunocompromised children in South Africa who are at the highest risk for infection development, and will make significant improvements in the nation's annual child mortality rate.

⁶¹ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamsience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

⁶² Visser, A, D P Moore, A Whitelaw, W Lowman, and G Kantor. "Part VII: Interventions." *South African Medical Journal* 101, no. 8 (2011): 587-595. <http://www.samj.org.za/index.php/samj/article/view/5106/3377> (accessed November 8, 2012).

⁶³ Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84. www.benthamsience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

Conclusions

Acute respiratory infections impose both a health and economic burden upon the country of South Africa. These infections are the leading cause of annual pediatric deaths and are often coupled with HIV infection and malnutrition and consequentially become increasingly deadly. The current socio-economic status of the country plays a large role in propagating the spread and prevalence of ARIs as a large percent of the population is unemployed and under educated. Resulting from lack of education and steady family incomes, children are under fed and endure poor living conditions. However, the current relationship of these socio-economic issues and respiratory infections in South Africa is also bidirectional. This is evident as the burden of respiratory infections causes many missed days of school and lasting developmental and learning deficits for the child as well as accounts for parental absenteeism from work and missed employment opportunities. Although there are many socio-economic barriers inhibiting the reduction and eradication of these infections, South Africa explicitly promises to ensure comprehensive care and health services for all children in the country free of charge to combat the large burden of disease.

As extensively discussed in the paper, the deterioration of the immune system due to HIV infection and malnutrition has made South African children at a disproportionately higher risk for ARI development compared to much of the rest of the world. With the largest pediatric HIV population and high rates of malnutrition occurring in sub-Saharan Africa, the respiratory infection prevalence has boomed and takes a devastating number of children's lives annually. With a large burden of pneumonia and RSV in South Africa, there are both preventative and affordable measures that can be

utilized to reduce mortalities caused by these illnesses. Efforts to support the use of Vitamin A and Zinc supplements, immunizations, exclusive breastfeeding practices, and increasing nutrition will effectively reduce the burden of pediatric acute respiratory infections in South Africa.

Recommendations for Further Study

Pediatric acute respiratory infections are an important set of illnesses to focus on as the global HIV/AIDS epidemic continues to surge and affects people of any age or race worldwide. A particularly interesting and important aspect of ARIs to continue to study in South Africa is the socio-economic propagation of diseases and infections. Since South Africa is a second world country with a majority of the population living in third world conditions and a small number in first world, there are extremely different health and living conditions for the two economically distinct populations living in the same country. Further studies could more extensively examine the societal and economic characteristics of South Africa's vastly different sub-populations and how the difference in socio-economic statuses directly influence the incidence rate of infections like ARIs, tuberculosis, and HIV/AIDS. As a country with numerous languages, sub-cultures, and socio-economic groups, the South African population contains many different health and healthcare seeking behavior norms. An investigation of readiness to spend money on accessing healthcare services may depict how different group values healthcare and healthy lifestyles and would shed great light on why acute respiratory infections and other infectious diseases are so prevalent in this country.

Bibliography and List of Sources

Primary Sources

Dr. Merrilee Sayers, female South African pediatrician. Personal communication.
Durban, South Africa. 21 November 2012.

Secondary Sources

"Acute Respiratory Infections (Update September 2009)." *Initiative for Vaccine Research (IVR)*. World Health Organization, Sept. 2009. Web. 07 Oct. 2012.
<http://www.who.int/vaccine_research/diseases/ari/en/index.html>.

Ambrus Sr., Julian L., and Julian L. Ambrus Jr.. "Nutrition and Infectious Diseases in Developing Countries and Problems of Acquired Immunodeficiency Syndrom." *Experimental Biology and Medicine* 229 (2004): 464-472.
<http://ebm.rsmjournals.com/content/229/6/464> (accessed November 6, 2012).

AVERT, "HIV Related Opportunistic Infections: Prevention and Treatment." Last Modified 2012. Accessed October 24, 2012. <http://www.avert.org/hiv-opportunistic-infections.htm>.

Bbaale E. Determinants of diarrhoea and acute respiratory infection among underfives in Uganda. *AMJ* 2011, 4, 7, 400-409 <http://dx.doi.org/10.4066/AMJ.2011.723>

Calvo, Cristina, Maria Luz Garcia-Garcia, Carolina Blanco, Carmen Vazquez, Elena Frias, Pilar Perez-Brena, and Immaculada Casas. "Multiple simultaneous viral infections in infants with acute respiratory tract infections in Spain." *Journal of Clinical Virology*. 42. : 268-272. 2008.

Gray A, Vawda Y, Jack C. Health Policy and Legislation. In: Padarath A, English R, editors. *South African Health Review 2011*. Durban: Health Systems Trust; 2011. URL: <http://www.hst.org.za/publications/south-african-health-review-2011>

Gray, D., and H.J. Zar. "The Open Infectious Diseases Journal." *Childhood Pneumonia in Low and Middle Income Countries: Burden, Prevention and Management* 4 (2010): 74-84.
www.benthamscience.com/open/toidj/articles/V004/.../74TOIDJ.pdf (accessed November 7, 2012).

Jara-Perez, Jaime V., and Arturo Berber. "Primary Prevention of Acute Respiratory Tract Infections in Children Using a Bacterial Immunostimulant: A Double-Masked, Placebo-Controlled Clinical Trial." *Clinical Therapeutics*. 22. no. 6 : 748-759.

- Madhi SA, Klugman KP. Acute Respiratory Infections. In: Jamison DT, Feachem RG, Makgoba MW, et al., editors. *Disease and Mortality in Sub-Saharan Africa*. 2nd edition. Washington (DC): World Bank; 2006. Chapter 11. Available from: <http://www.ncbi.nlm.nih.gov/books/NBK2283/>
- Madhi SA, Schoub B, Simmank K, Blackburn N, Klugman KP. Increased burden of respiratory viral associated severe lower respiratory tract infections in children infected with human immunodeficiency virus type-1. *Journal of Pediatrics* 2000;137:78-84.
- Moosa, Yunus. "Management of Common OIs in Patients with HIV/AIDS." Address. Jan. 2006. *UKZN Department of Health*. Web. 7 Nov. 2012.
- "Pneumonia Fact Sheet." *Media Centre*. World Health Organization, Aug. 2012. Web. 07 Oct. 2012. <<http://www.who.int/mediacentre/factsheets/fs331/en/index.html>>.
- Robertson, Susan E.. "Respiratory syncytial virus infection: denominator-based studies in Indonesia, Mozambique, Nigeria and South Africa." *Bulletin of the World Health Organization* 82 (2004): 914-922. www.ncbi.nlm.nih.gov/pubmed/15654405 (accessed November 7, 2012).
- Rodriguez, Leonor, Elsa Cervantes, and Rocio Ortiz. "Malnutrition and Gastrointestinal and Respiratory Infections in Children: A Public Health Problem." *International Journal of Environmental Research and Public Health* 8 (2011): 1174-1205.
- Sanders, David, Louis Reynolds, Tony Westwood, Brian Eley, Max Kroon, Heather Zar, Mary-Ann Davies, and Phumza Nongena. *Decreasing the Burd. Western Cape Burden of Disease Reduction Project*. Vol. 7. University of the Western Cape, 2007. http://www.westerncape.gov.za/Text/2007/6/cd_volume_7_childhood_diseases_overview.pdf (accessed October 24, 2012).
- Selwyn, B. J. "The Epidemiology of Acute Respiratory Tract Infection in Young Children: Comparison of Findings from Several Developing Countries." *Reviews of Infectious Diseases* 12 (1990): 870-88. *JSTOR*. Web. 20 Sept. 2012. <<http://www.jstor.org/stable/4455724>>.
- Stanek, Edward J., Ezekial M. Wafula, Francis E. Onyango, and Janet Musia. "Characteristics Related to the Incidence and Prevalence of Acute Respiratory Tract Infection in Young Children in Kenya." *Clinical Infectious Diseases* 18.4 (1994): 639-47. *JSTOR*. Web. 20 Sept. 2012. <<http://www.jstor.org/stable/4457766>>.
- "The Patient Rights Charter." *Department of Health Republic of South Africa*. Department of Health, 14 Nov. 2007. Web. 9 Sept. 2012. <<http://www.justice.gov.za/VC/docs/policy/Patient%20Rights%20Charter.pdf>>.

- Visser, A, D P Moore, A Whitelaw, W Lowman, and G Kantor. "Part VII: Interventions." *South African Medical Journal* 101, no. 8 (2011): 587-595. <http://www.samj.org.za/index.php/samj/article/view/5106/3377> (accessed November 8, 2012).
- WHO Case Definitions of HIV Surveillance and Revised Clinical Staging and Immunological Classification of HIV-Related Disease in Adults and Children.* Geneva: World Health Organization, 2007.
- Williams, Brian G., Eleanor Gouws, Cynthis Boschi-Pinto, Jennifer Bryce, and Christopher Dye. "Estimates of World-wide Distribution of Child Deaths from Acute Respiratory Infections." *Lancet Infectious Diseases* 2 (2002): 25-32. *The Lancet*. Web. 20 Sept. 2012.
- World Economic Outlook April 2012.* Washington D.C.: International Monetary Fund, 2012.
- World Health Organization, "MDG 4: reduce child mortality." Last modified 2012. Accessed October 24, 2012.
- World Health Organization. "WHO Guideline Development: Effects and Safety of Vitamin A Supplementation in Populations." World Health Organization. www.who.int/nutrition/events/guideline_dev_vas/en/index.html (accessed November 15, 2012).
- Zhang, Guocui, Yunwen Hu, Hongping Wang, Zhang Lu, Yixi Bao, and Xiaoming Zhou. "High Incidence of Multiple Viral Infections Identifies in Respiratory Tract Infected Children under Three in Shanghai, China." *Plos One*. 7. no. 9 (2012):1-6.

Appendix A: Consent Form for Adult Respondents in English

I can read English. (If not, but can read Zulu or Afrikaans, please supply). If participant cannot read, the onus is on the researcher to ensure that the quality of consent is nonetheless without reproach.

I have read the information about this study project and had it explained to me, and I fully understand what it says. I understand that this study is trying to find out (Learner to state objectives):

The intent of this Independent Study Project is to explore how incidence rates and severities of acute respiratory infections in children are affected by pre-existing illnesses. The goals are to observe how health care workers determine when a pre-existing illness is present and the process of determining its influence on the development of the infection. The study will also make an effort to note the most common co-factor diseases in acute respiratory co-infection cases and observe the physical differences of children with pre-existing illnesses and patients who were otherwise healthy when they developed the infection. Overall, the study will try to qualitatively observe if there is a difference in the acute respiratory infection incidence rate between children with pre-existing illnesses and previously healthy children.

I understand that my participation is voluntary and that I have a right to withdraw my consent to participate at any time without penalty.

I understand and am willing for you to observe, take notes, and ask me questions about:

1. How do you notice, diagnose, and take previous illnesses into account during diagnosis?
2. At what stage of the patient in-take process are pre-existing illnesses disclosed?
3. Are there physical differences between children with an acute respiratory infection who had a pre-existing illness compared to those that didn't, in regards to symptoms and infection severity?
4. What are the most common co-factor illnesses with acute respiratory co-infection cases?
5. Generally, how many patients have a pre-existing illness and how many do not?
6. Are the patients who are diagnosed with Acute Respiratory Infections seeking treatment for a first-time infection or one that is re-occurring?
7. What kind of medication is used for treatment?
8. Are the patients treated through in-patient or outpatient services?
9. Is treatment for patients with pre-existing illnesses different for than those who are otherwise healthy?
10. Do you notice any specific trends regarding acute respiratory infections in this community?

*I do/ do not require that my **identity (and name)** be kept secret (**delete inapplicable**). I understand that, if requested, my name will not be written on any questionnaire and that no one will be able to link my name to the answers I give. If requested, my individual privacy will be maintained in all published and written data resulting from this study project.*

*I do/ do not (**delete inapplicable**), give permission for a **photograph** of me to be used in the writeup of this study or for future publication. I understand that the learner will not use or provide any photographs for commercial purposes or publication without my permission.*

I understand that I will receive no gift or direct benefit for participating in the study.

I confirm that the learner has given me the address of the nearest School for International Training Study Abroad Office should I wish to go there for information. (18 Alton Road, Glenmore, Durban). I know that if I have any questions or complaints about this study that I can contact anonymously, if I wish, the Director/s of the SIT South Africa Community Health Program (Zed McGladdery 0846834982).

I agree to participate in this study project.

Signature (participant) _____ Date: _____

Signature (learner) _____ Date: _____

Appendix B

WHO clinical staging of HIV/AIDS for children with confirmed HIV infection

| |
|--|
| Clinical Stage 1 |
| Asymptomatic Persistent generalized lymphadenopathy |
| Clinical Stage 2 |
| Moderate unexplained weight loss (<10% of presumed or measured body weight) ¹ Recurrent respiratory tract infections sinusitis, tonsillitis, otitis media and pharyngitis) Herpes zoster Angular cheilitis Recurrent oral ulceration Papular pruritic eruptions Seborrhoeic dermatitis Fungal nail infections |
| Clinical Stage 3 |
| Unexplained severe weight loss (>10% of presumed or measured body weight) Unexplained chronic diarrhoea for longer than one month Unexplained persistent fever (above 37.6°C intermittent or constant, for longer than one month) Persistent oral candidiasis Oral hairy leukoplakia Pulmonary tuberculosis (current) Severe bacterial infections (such as pneumonia, empyema, pyomyositis, bone or joint infection, meningitis or bacteraemia) Acute necrotizing ulcerative stomatitis, gingivitis or periodontitis Unexplained anaemia (<8 g/dl), neutropaenia (<0.5 Å~ 109 per litre) or chronic thrombocytopaenia (<50 Å~ 109 per litre) |
| Clinical Stage 4¹¹ |
| HIV wasting syndrome Pneumocystis pneumonia Recurrent severe bacterial pneumonia Chronic herpes simplex infection (orolabial, genital or anorectal of more than one month's duration or visceral at any site) Oesophageal candidiasis (or candidiasis of trachea, bronchi or lungs) Extrapulmonary tuberculosis Kaposi's sarcoma Cytomegalovirus infection (retinitis or infection of other organs) Central nervous system toxoplasmosis HIV encephalopathy Extrapulmonary cryptococcosis including meningitis Disseminated non-tuberculous mycobacterial infection Progressive multifocal leukoencephalopathy Chronic cryptosporidiosis (with diarrhoea) Chronic isosporiasis Disseminated mycosis (coccidiomycosis or histoplasmosis) Recurrent non-typhoidal Salmonella bacteraemia Lymphoma (cerebral or B-cell non-Hodgkin) or other solid HIV-associated tumours Invasive cervical carcinoma Atypical disseminated leishmaniasis Symptomatic HIV-associated nephropathy or symptomatic HIV-associated cardiomyopathy |

¹ Assessment of body weight in pregnant woman needs to consider the expected weight gain of pregnancy.

¹¹ Some additional specific conditions can also be included in regional classifications (such as reactivation of American trypanosomiasis [meningoencephalitis and/or myocarditis]) in the WHO Region of the Americas and disseminated penicilliosis in Asia)⁶⁴.

⁶⁴ WHO Case Definitions of HIV Surveillance and Revised Clinical Staging and Immunological Classification of HIV-Related Disease in Adults and Children. Geneva: World Health Organization, 2007.