

A Polynomial of Pulmonary Tuberculosis Patients Showing the Behaviour Using the Lagrange`S Method

Rajan Singh¹, B. K. Singh², Anshul Dubey³, Nidhi Tiwari⁴

¹Assistant Professor, Department of Mathematics, IFTM University, Moradabad, 244001, India.

²Professor, Department of Mathematics, IFTM University, Moradabad, 244001, India.

³Research Scholar, Department of Mathematics, IFTM University, Moradabad, 244001, India.

⁴Assistant Professor, Department of Mathematics, IFTM University, Moradabad, 244001, India.

Article Info

Page Number: 5568-5574

Publication Issue:

Vol. 71 No. 4 (2022)

Article History

Article Received: 25 March 2022

Revised: 30 April 2022

Accepted: 15 June 2022

Publication: 19 August 2022

Abstract

In the new modern society, Pulmonary Tuberculosis is a serious, chronic disease. Tuberculosis may infect any part of the body, but most commonly occurs in the lungs (known as pulmonary tuberculosis). Extrapulmonary TB occurs when tuberculosis develops outside of the lungs, although extrapulmonary TB may coexist with pulmonary TB. In this research paper, the aim of this study is to find the suitable polynomial equation of the pulmonary Tuberculosis patients with the variable (x) for the unequal interval of SPO₂ level.

Keywords: SPO₂ level of the pulmonary tuberculosis patients as x variable, levels of Pulses in bpm as $f(x)$, Lagrange`s Interpolation Formula for unequal intervals for two variables.

INTRODUCTION: Tuberculosis (TB) is an infectious disease usually caused by the bacterium *Mycobacterium tuberculosis* (MTB). Tuberculosis generally affected the lungs, but can also affect other parts of the body. Most infections do not have symptoms, in which case it is known as latent tuberculosis. About 10% of latent infections progress to active disease which, if left untreated, kills about half of those infected. The classic symptoms of active TB are a chronic cough with blood-containing sputum, fever, night sweats, and weight loss.

Tuberculosis is spread through the air when people who have active TB in their lungs cough, spit, speak, or sneeze. People with latent TB do not spread the disease. Active infection occurs more often in people with HIV/AIDS and in those who smoke. Diagnosis of active TB is based on chest X-rays, as well as microscopic examination and culture of body fluids. Diagnosis of latent TB relies on the tuberculin skin test (TST) or blood tests.

Prevention of TB involves screening those at high risk, early detection and treatment of cases, and vaccination with the bacillus Calmette-Guerin (BCG) vaccine. Those at high risk include household, workplace, and social contacts of people with active TB. Treatment requires the use of multiple antibiotics over a long period of time. Antibiotic resistance is a growing problem with increasing rates of multiple drug-resistant tuberculosis (MDR-TB) and extensively drug-resistant tuberculosis (XDR-TB).

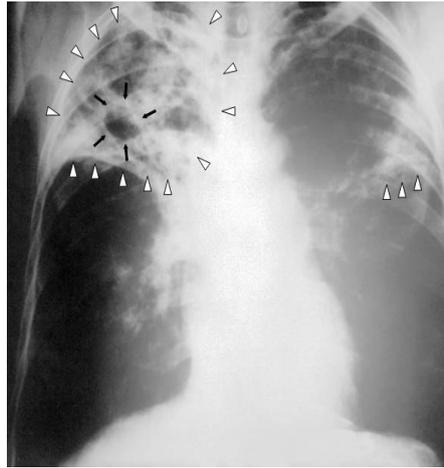


Figure-1 Chest X-Ray.

Chest X-ray of a person with advanced tuberculosis: Infection in both lungs is marked by white arrowheads, and the formation of a cavity is marked by black arrows. Tuberculosis may infect any part of the body, but most commonly occurs in the lungs (known as Pulmonary Tuberculosis). Extrapulmonary TB occurs when tuberculosis develops outside of the lungs, although extrapulmonary TB may coexist with pulmonary TB. General signs and symptoms include fever, chills, night sweats, loss of appetite, weight loss, and fatigue. If a tuberculosis infection does become active, it most commonly involves the lungs (in about 90% of cases). Symptoms may include chest pain and a prolonged cough-producing sputum. About 25% of people may not have any symptoms. Occasionally, people may cough up blood in small amounts, and in very rare cases, the infection may erode into the pulmonary artery or a Rasmussen's aneurysm, resulting in massive bleeding. Tuberculosis may become a chronic illness and cause extensive scarring in the upper lobes of the lungs. The upper lung lobes are more frequently affected by tuberculosis than the lower ones. The reason for this difference is not clear. It may be due to either better air flow, or poor lymph drainage within the upper lungs. In 15-20% of active cases, the infection spreads outside the lungs, causing other kinds of TB. These are collectively denoted as "extrapulmonary tuberculosis". Extrapulmonary TB occurs more commonly in immunosuppressed persons and young children. In those with HIV, this occurs in more than 50% of cases. Notable extrapulmonary infection sites include the pleura, the central nervous system, the lymphatic system, the genitourinary system, and the bones and joints, among others. A potentially more serious, widespread form of TB is called "disseminated tuberculosis", also known as miliary tuberculosis. Miliary TB currently makes up about 10% of extrapulmonary cases.

Interpolation is a technique, in which a tool for finding the estimated values of the dependent variable corresponds to the value of the independent variable. A number of interpolation formulas for equal intervals such as Newton's forward interpolation formula, Newton's Backward interpolation formula, Newton's central differences interpolation, Stirling formula, Bessel's formula, and for unequal intervals such as Newton's divided differences interpolation formula, Lagrange's interpolation formula.

When the values of arguments are given at unequal or unevenly spaced intervals, then the various differences will also be affected by the changes in the value of the argument and in that case, the definition of differences for equal intervals will not hold good.

The National Strategic Plan 2020 – 2025: At the same time, an assessment took place of the progress that had been made with the NSP 2017-2025. This was helped by the Report of the joint Monitoring Mission, carried out by the NTEP and the WHO. Key governance interventions and structures had been identified that needed to be in place to end TB by 2025. But the planned expansion and restructuring of the NTEP had not happened. Because of this and the rapidly changing environment within which the NTEP was operating it was also decided to produce an updated NSP, the NSP 2017-2025.

The NSP 2020-25 is a frame work to guide the activities of all stakeholders. It is a five-year strategy document that aims to direct the attention of all stakeholders to the most important interventions that the Guide believes will bring about significant changes in the incidence, prevalence, and mortality of TB. But despite the development of the National Strategic Plan 2020-2025, it is the National Strategic Plan for 2017-25 that is still referred to in documents such as the annual TB report. These strategies and interventions are in addition to the processes and activities already ongoing in the country.

Developing the NSP 2020 – 2025: The development of this new NSP started when the NTEP, jointly with the World Health Organisation, carried out the Joint Monitoring Mission (JMM) in 2019. The JMM applauded India's commitment to end TB by 2025 and to the NSP 2017 - 2025.

But despite the achievements and a new commitment to patient-centred services, the JMM also suggested many actions that would be needed if the Prime Minister's targets for 2025 were to be reached. The recommended actions included:

- Mounting a TB elimination campaign inspired by lessons gained from the eradication of Polio;
- Providing urgent reinforcements to the existing workforce;
- Scaling up private provider engagement;
- Move from passive community engagement to full community participation and ownership;
- Invest in TB surveillance staff and systems for accurate, complete, and timely information;
- Deployment of new precision diagnostic tools;
- Supporting patients comprehensively throughout treatment;
- Redesigning and pursuing targeted active case finding;

: : :
: : :

Similarly, $A_1 = \frac{f(x_n)}{(x_n - x_0)(x_n - x_1) \dots (x_n - x_{n-1})}$

Substituting the value of $A_0, A_1, A_2, \dots, A_n$ in equation (1), We get

$$f(x) = \frac{(x-x_1)(x-x_2)(x-x_3)(x-x_4)}{(x_0-x_1)(x_0-x_2)(x_0-x_3)(x_0-x_4)} f(x_0) + \frac{(x-x_0)(x-x_2)(x-x_3)(x-x_4)}{(x_1-x_0)(x_1-x_2)(x_1-x_3)(x_1-x_4)} f(x_1) + \frac{(x-x_0)(x-x_1)(x-x_3)(x-x_4)}{(x_2-x_0)(x_2-x_1)(x_2-x_3)(x_2-x_4)} f(x_2) + \frac{(x-x_0)(x-x_1)(x-x_2)(x-x_4)}{(x_3-x_0)(x_3-x_1)(x_3-x_2)(x_3-x_4)} f(x_3) + \frac{(x-x_0)(x-x_1)(x-x_2)(x-x_3)}{(x_4-x_0)(x_4-x_1)(x_4-x_2)(x_4-x_4)} f(x_4)$$

This is called Lagrange's Interpolation Formula.

CALCULATION: The data collected through 5 patients sample as given below in terms of SPO₂ levels (x_i) corresponding to Pulse Rate $f(x_i)$ as dependent variable.

SPO ₂ (x_i)	78	80	85	90	92
Pulse rate $f(x_i)$	125	119	102	92	87

$$f(x) = \frac{(x-x_1)(x-x_2)(x-x_3)(x-x_4)}{(x_0-x_1)(x_0-x_2)(x_0-x_3)(x_0-x_4)} f(x_0) + \frac{(x-x_0)(x-x_2)(x-x_3)(x-x_4)}{(x_1-x_0)(x_1-x_2)(x_1-x_3)(x_1-x_4)} f(x_1) + \frac{(x-x_0)(x-x_1)(x-x_3)(x-x_4)}{(x_2-x_0)(x_2-x_1)(x_2-x_3)(x_2-x_4)} f(x_2) + \frac{(x-x_0)(x-x_1)(x-x_2)(x-x_4)}{(x_3-x_0)(x_3-x_1)(x_3-x_2)(x_3-x_4)} f(x_3) + \frac{(x-x_0)(x-x_1)(x-x_2)(x-x_3)}{(x_4-x_0)(x_4-x_1)(x_4-x_2)(x_4-x_4)} f(x_4)$$

Here, $x_0 = 78, x_1 = 80, x_2 = 85, x_3 = 90, x_4 = 92$

Substituting the values of x_0, x_1, x_2, x_3, x_4 in this, we get.

$$f(x) = \frac{(x-80)(x-85)(x-90)(x-92)}{(78-80)(78-85)(78-90)(78-92)} (125) + \frac{(x-78)(x-85)(x-90)(x-92)}{(80-78)(80-85)(80-90)(80-92)} (119) + \frac{(x-78)(x-80)(x-90)(x-92)}{(85-78)(85-80)(85-90)(85-92)} (102) + \frac{(x-78)(x-80)(x-85)(x-92)}{(90-78)(90-80)(90-85)(90-92)} (92) + \frac{(x-78)(x-80)(x-85)(x-90)}{(92-78)(92-80)(92-85)(92-90)} (87)$$

$$f(x) = 0.07677 x^4 - 26.49955 x^3 + 3425.72 x^2 - 51473.209 x + 4223768.388$$

CONCLUSION: This shows a polynomial equation of numerical data on a dependent variable with unequal interval. The degree of the required polynomial equation is one, less than the number of pairs of observation. And the Lagrange's Method of interpolation is used for finding the estimated values in Numerical Analysis.

ACKNOWLEDGEMENT: The authors would like to thanks to Dr. Subnesh Rastogi, Dr. S.P. Singh and also to Prof. V.K. Sharma, Head, Statistics, Hindu College, Moradabad for

providing numerical analysis and their valuable support and help in completing my research project.

REFERENCES

1. **A. Quaterarani, R. Sacco, F. Saleri. 2000.** Numerical Mathematics, Springe-Varlage, New York.
2. **Cooper, G.F. & Herskovits, E.H. (1991)** A Bayesian method for induction of probabilistic networks from data (report SMI-91-I). Pittsburgh PA: University of Pittsburgh, Section of Medical Informatics. (Also available as Report KSL-91-02, from the section on Medical Informatics, Stanford University, Stanford, CA.)
3. **Dinas Kesehatan Daerah Istimewa Yogyakarta (2015)** Petunjuk Teknis Manajemen TB Anak. Jenderal: Kementrian RI.
4. **D. G. Mead, S. K. Stein,** Rocky Mountain. 1998. J. Math. Sci. Net., 28(1): 303.
5. **E. J. Mc Shane. 1946.** The American Mathematical Monthly, 53(5):259.
6. **F. V. Jensen.** Bayesian Networks and Decision Graphs. Springer Verlag. (2001)
7. **G. F. Cooper,** An Overview of the Representations using Bayesian Networks. Computation, Causation & Discovery. C. Glymour and G. F. Cooper, AAAI Press: 3-62. (1999).
8. **Herbert E. Salzer. 1962.** Proceedings of the American Mathematical Society, 13(2): 210.
9. **Han, Jiawie, Kamber, M. (2006)** Data Mining: Concepts and Technique Second Edition. Morgan Kaufman, Amsterdam.
10. **Helen Yeni-Komshian, MD,** relationship between Several Surrogate estimates of insulin Resistance and Quantification of insulin – mediated dlucose Disposal in 490 Healthy Non-diabetic Volunteers, Diabetes care, Volume 23, Number 22, Feburary 2000
11. **J. Kamerbeek and L. Schouls and M. Van Agterveld and D. Van Soolingen and A. Kolk and S. Kuijper and A. Bunschoten and R. Shaw and M. Goyal and J. Van Embden,** Simultaneous detection and strain differentiation of mycobacterium tuberculosis for diagnosis and epidemiology, J. Clin. Microbiol., 1997.
12. **J. Kamerbeek and L. Schouls and M. Van Agterveld and D. Van Soolingen and A. Kolk and S. Kuijper and A. Bunschoten and R. Shaw and M. Goyal and J. Van Embden, R. B. Srivastav, Purushottam Kumar Srivastav, 2011.** J. Chem. Bio. Phy. Sci., 1(2):378.
13. **Kementrian RI Direktorat Jenderal Pengendalian Penyakit dan Penyehatan Lingkungan (2014)** Pedoman Nasional Pengendalian Tuberculosis. Jakarta: kementrian Kesehatan RI.
14. **M. Sebban and I. Mokrousov and N. Rastogi and C. Sola,** A data-mining approach to spacer oligonucleotide typing of Mycobacterium tuberculosis, Bioinformatics, No. 18, pp. 235-243, 2002.
15. **M. Martinez-Morales,** an Algorithm for the Induction of Probabilistic Network from data. XII Reunion Nacional de Inteligencia Artificial, ITESM, Cuernavaca, Morelos, Mexico, Limusa. (1995)
16. **N. Freidman, D. Geiger, S. Goldszmidt,** Bayesian Networks classifiers. Machine Learning, 29(pp 131-161), (1997).

17. **Prasetyo, E. (2014).** Data Mining: Mengolah Data Menjadi Onformasi Menggunakan Matlab, Yogyakarta: Andi Offset.
18. **R. G. Cowell, A. P. Dawid, S.L. Lauritzen.** Probabilistic Networks and Expert Systems. Springer Verlag. (1999)
19. **R. B. Srivastav, Purushottam Kumar Srivastav, 2011.** J. Chem. Bio. Phy. Sci., 1(2):378.
20. **Tan, P.N., Steinbach, M. Kumar, V. (2006)** Data Mining: Introduction to Data Mining Bostan: Pearson Addison Wesley.
21. **W. Gender, J. Hrebicek. 1997.** “Solving Problems in scientific computing using maple and matlab”, 3rd ed., Springer.