Mhealth in Tuberculosis Treatment: A new approach to improve adherence

[1]Dr. T. Rajavardhana, [2]*Dr. M.G. Rajanandh, [3]Dr. M. Geethavani, [4]Dr. V. Sreedhar

ABSTRACT--Adherence to tuberculosis (TB) treatment is very important in promoting individual and public health. As Poor adherence may result in suffering, disease worsening and death as well as it again leads to increased economic burden to the patients as length of the treatment regimen increases and drug resistance develops.[1] Exploring newer ways in improving adherence is very essential with growing non adherence. Mobile health (mHealth) holds considerable promise to improve quality and efficiency in health care.[2] Yet its potential in Tuberculosis remains largely unexplored [3, 4]. and there is a lack of patient-centered mHealth approaches in response to the complexity of real life.[5] Also lacking are ethical evaluations of mHealth interventions[6,7]. The planning, implementation, and evaluation of mHealth interventions for Tuberculosis treatment adherence must be guided by values as much as by technical innovation.

Keywords-- tuberculosis treatment: a new approach to improve adherence

I. INTRODUCTION

Through this article we want to explore new ideas to improve medication adherence with the help of mHealth approaches to monitor and enhance TB treatment adherence, establish a framework for consideration of the central ethical issues, particularly when mHealth is coordinated with incentives, and outline a model to guide the ethical planning, implementation, and evaluation of future mHealth interventions for adherence in order to make it the best as possible. In doing so, we highlight the areas of ethical concern as well as opportunities for ethical improvement over direct observation of therapy (DOT), the global standard for monitoring TB treatment adherence

II. TUBERCULOSIS AND THE IMPORTANCE OF ADHERENCE

10 million people fell ill with TB in 2017, including 0.9 million among people living with HIV. TB was one of the top 10 causes of death worldwide in 2017, and was responsible for more deaths than HIV. In 2017, 1.6 million people died from TB, including 0.3 million among people with HIV. Globally in 2017, an estimated 558 000 people developed TB that was resistant to rifampicin (RR-TB), the most effective first-line drug, and of these, 82% had multidrug-resistant TB (MDR-TB). [8, 9]

According to the World Health Organization (WHO), the optimal Tuberculosis treatment plan consists of an initial treatment phase requiring daily ingestion of 4 first-line anti-TB drugs for 2 months, followed by a 4-month continuation phase during which 2 daily drugs are necessary. Regimens of ingesting drugs thrice weekly in both

[1] *Asst. Professor, Balaji College of Pharmacy, Ananthapuramu*

[2] *Asst. Professor, Faculty of Pharmacy, Sri Ramachandra Institute of Higher education and Research, Chennai*

[3] *Professor, Balaji College of Pharmacy, Ananthapuramu*

[4] *Principal, Balaji College of Pharmacy, Ananthapuramu*

the initial and continuation phase are also possible.[10] TB susceptible to first-line drugs is called drug-susceptible TB (DS-TB). Two forms of drug resistant TB (DR-TB) are widely recognized: multi drug resistant TB and extensively drug-resistant TB. Treating even the less resistant forms of DR-TB can take up to 2 years and may also require daily medication. Proper treatment of all forms of TB is very important in reducing individual morbidity and mortality in tuberculosis patients. Prventing transmission among family and community members is also very significant. Appropriate treatment also limits the development and spread of DR-TB. Treatment for DR-TB is more expensive, less effective, and has more serious side effects.[11] The impact of poor treatment on morbidity, mortality, and disease transmission is further increased and affected by poverty, weak health systems, and low levels of health literacy which is found in many tuberculosis patients of developing countries. Because proper treatment rests in part on proper adherence, monitoring and enhancing adherence is important to safeguarding both individual and public health.

Ensuring Good medication adherence is therefore a key component of WHO's post-2015 global TB strategy— the ''End TB Strategy.'' Pillar 1 of this strategy calls for ''supportive treatment supervision [to help] patients to take their medication regularly and to complete treatment, thus facilitating their cure and preventing the development of drug resistance.''[12] The strategy indicates supervision should be ''carried out in a context-specific and patient-sensitive manner'' and acknowledges the many barriers to adherence, including ''educational, emotional, and material needs,'' ''stigmatization and discrimination,'' and health-system factors[12] Given these diverse barriers, supportive treatment supervision will be necessarily complex, spanning interventions to train treatment partners, provide greater social protection, disseminate and exchange necessary information and experiences across potentially long distances, and using incentives. Where supportive treatment supervision includes monitoring of adherence, DOT (i.e., when a health worker directly witnesses the swallowing of anti-TB drugs in a clinical, community, work, or personal setting) has long been recommended by WHO and is the global standard of care. New adherence monitoring techniques should therefore be compared with DOT in terms of ethical acceptability.

III. BARRIERS TO ADHERENCE

While DOT has seen great success in specific contexts,[13] its limitations can be understood against the barriers of non-adherence recognized in WHO's End TB Strategy. Munro et al. elaborated on these barriers by identifying and describing 4 categories of adherence barriers related to structural, patient, social, and health care service factors.[14] The influence of these 4 factors may vary. Addressing non-adherence to TB treatment therefore requires awareness of context and targeting all relevant factors.

IV. STRUCTURAL FACTORS

Structural factors are obstacles, which includes poverty and gender, over which patients have very little control and which can complicate adherence even when patients are strongly motivated. Poverty, especially when linked to the factors discussed below, can impact medication adherence. For example, where treatment costs are not covered, poor patients or those supporting others, may feel they must choose between work and health. In

developing countries the mean total cost of TB is 39% of annual reported household income, and maximum is 148%.[15]

Gender-related factors may also impact medication adherence. TB-related stigma can lead to greater suppression and rejection of disease among women when compared with men, as gender roles within traditional or poor families that translate to women having less leisure time and status may result in greater difficulties for women to undergo treatment.[16]

V. PATIENT FACTORS

Variations in patient motivation and willingness can also impact medication adherence and may be affected by forgetfulness, lack of understanding regarding the importance of tuberculosis treatment, general interpretations of illness such as the belief that one is sick only if symptomatic, alcohol or drug use. Furthermore, side effects of TB drugs, which include fever, fatigue, weakness, nausea, vomiting, hepatitis, or death, [17] can affect patient motivation due to unpleasantness or substantial interference with a patient's ability to work. This is especially true as the side effects grow more diverse and severe during DR-TB treatment to include psychiatric disorders, hearing loss, and epileptic seizures.[18]

VI. SOCIAL CONTEXT

Strong social support within a patient's family, community, or health care context can help counteract structural and personal barriers to adherence by influencing motivation or knowledge and beliefs about TB. However, lack of support or knowledge about TB and its treatment in a patient's family, community, or health care context, as well as real or supposed stigmatization of the sick, can hinder adherence.[19]

VII. HEALTH CARE SERVICE FACTORS

Inadequate drug stocks, long waiting time, inconvenient service hours, and difficulties accessing health facilities reveal the opportunity costs associated with attending health facilities, such as neglecting household responsibilities (e.g., caring for one's children) and losing work and income. All these factors can therefore reduce medication adherence to TB treatment.

VIII. MHEALTH FOR ADHERENCE TO TB TREATMENT

Due to the barriers of medication adherence to TB treatment needs to be considered, mHealth interventions can potentially deal with several central adherence challenges. First, the number of mobile cellular subscriptions per 100 people in developing countries is 87 and growing. [20] mHealth can potentially prevent DOT-related travel and improve adherence in remote areas. Second, mHealth may improve health system efficiency in regions where resources and trained medical professionals are inadequate. Additionally, mHealth can address important patient factors in non-adherence by facilitating novel and sophisticated ways of providing financial and non-financial incentives. For example, a study of warfarin adherence used pill compartments that wirelessly entered patients into a daily lottery when opened according to the prescribed treatment plan, [21] therefore eliminating the need for human

observation and recordkeeping. Mobile platforms can also help overcome some logistical challenges of incentive delivery. Examples from Kenya, [22] Malawi, [23] and Zambia [23] demonstrate the feasibility of efficient electronic transfer schemes that eliminate the need for travel to a bank or remote patient areas, potentially expanding the reach of incentive programs, lowering the costs of incentive delivery, and rendering the process more sustainable. Finally, empirical research supports mHealth's promise for improving adherence. A recent study, the first to conduct a large and rigorous trial in this area, found that electronic reminders from medication monitors improved TB treatment adherence.[24] Various smaller, proof-of-concept studies have established the potential benefit of using other forms of mHealth for TB adherence.[4]

IX. TYPES OF MHEALTH TECHNIQUES

Video observation of therapy (VOT): patients use smart phones to record videos of themselves taking each medication dose, allowing health care workers to view the videos either synchronously or asynchronously; facial recognition and motion-detecting software can even replace the need for human observation

Indirect monitoring technology, patient **facilitated (IP):** after ingesting their medication, patients place a free call or send an SMS to a central server.

Indirect monitoring technology, device facilitated (ID): after the patient removes the cap of the medication bottle, a message is wirelessly transmitted to a central server.

Direct monitoring technology**, embedded sensors (DE):** when the patient ingests the medication, which is equipped with an ingestible sensor, a wearable hub attached to the patient's body wirelessly transmits the data to a central server.

Direct monitoring technology**, metabolite testing (DM):** patients use low-cost, encrypted chromatography urine test strips, which detect drug metabolites in the patients' urine revealing a code; the patients then send an SMS with the code to a central sever.

X. CONCLUSION

Controlling TB is very important while proper treatment adherence is critical to TB control barriers to adherence are significant and diverse. mHealth constitutes an emerging field with particular promises to address such barriers, thus improving individual and population health and health systems efficiency. With the newer techniques like mhealth we can overcome the barriers of medication adherence to tuberculosis and to achieve the India's regulatory targets to eradicate tuberculosis by the year 2025 and WHO targets to aradicate tuberculosis by the year 2030.

REFERENCES

1. Schmidt H, Gostin LO, Emanuel EJ. Public health, universal health coverage, and Sustainable Development Goals: can they coexist? Lancet. 2015;386(9996):928-930.
2. Lewis T, Synowiec C, Lagomarsino G, Schweitzer J. E-health in low- and middle-income countries: findings from the Center for Health Market Innovations. Bull World Health Organ. 2012; 90(5):332-340.

3. World Health Organization (WHO). Digital health in the TB response: scaling up the TB response through information and communication technologies. Geneva: WHO; 2014. Available from: http://www.who.int/tb/publications/ehealth_TB.pdf

4. Denkinger CM, Grenier J, Stratis AK, Akkihal A, Pant-Pai N, Pai M. Mobile health to improve tuberculosis care and control: a call worth making. Int J Tuberc Lung Dis. 2013;17(6):719-727. CrossRef. Medline

5. van Gemert-Pinjen JEWC, Wynchank S, Covvey HD, Ossebaard HC. Improving the credibility of electronic health technologies. Bull World Health Organ. 2012;90(5):323-323A.

6. World Health Organization (WHO); International Telecommunication Union. National eHealth strategy toolkit. Geneva: WHO; 2012. Co-published by International Telecommunication Union. Available from: https://www.itu.int/ dms_pub/itu-d/opb/str/D-STR-E_HEALTH.05-2012-PDF-E.pdf

7. Kay M, Santos J, Takane M. mHealth: new horizons for health through mobile technologies. Geneva: World Health Organization; 2011. Available from: http://www.who.int/goe/ publications/goe_mhealth_web.pdf

8. World Health Organization (WHO). Global tuberculosis report 2015. Geneva: WHO; 2015. Available from: http://apps.who. int/iris/bitstream/10665/191102/1/9789241565059_eng.pdf

9. World Health Organization (WHO) [Internet]. Geneva: WHO; c2016. Tuberculosis: fact sheet no. 104; reviewed 2016 Mar [cited 2015 Dec 18]. Available from: http://www.who.int/ mediacentre/factsheets/fs104/en/

10. World Health Organization (WHO). Treatment of tuberculosis: guidelines, 4th ed. Geneva: WHO; 2010. Available from: http://apps.who.int/iris/bitstream/10665/44165/1/ 9789241547833_eng.pdf

11. Centers for Disease Control and Prevention (CDC) [Internet]. Atlanta (GA): CDC. Drug-resistant TB; last updated 2016 Apr 13 [cited 2015 Dec 18]. Available from: http://www.cdc.gov/tb/ topic/drtb/default.htm

12. World Health Organization (WHO). Global strategy and targets for tuberculosis prevention, care and control after 2015: report by the Secretariat. Geneva: WHO; 2013. Available from: http:// apps.who.int/gb/ebwha/pdf_files/EB134/B134_12-en.pdf

13. Islam MA, May MA, Ahmed F, Cash RA. Making tuberculosis history: community-based solutions for millions. Dhaka (Bangladesh): University Press; 2011.

14. Munro SA, Lewin SA, Smith HJ, Engel ME, Fretheim A, Volmink J. Patient adherence to tuberculosis treatment: a systematic review of qualitative research. PLoS Med. 2007;4(7):e238.

15. Tanimura T, Jaramillo E, Weil D, Raviglione M, Lo¨nnroth K. Financial burden for tuberculosis patients in low- and middleincome countries: a systematic review. Eur Respir J. 2014; 43(6):1763-1775.

16. Johansson E, Long NH, Diwan VK, Winkvist A. Gender and tuberculosis control: perspectives on health seeking behaviour among men and women in Vietnam. Health Policy. 2000; 52(1):33-51. CrossRef. Medline

17. Centers for Disease Control and Prevention (CDC) [Internet]. Atlanta (GA): CDC. Latent tuberculosis infection: a guide for primary health care providers; last updated 2013 Apr 3 [cited 2015 Dec 18]. Available from: http://www.cdc.gov/tb/ publications/ltbi/treatment.htm

18. To¨ru¨n T, Gu¨ngo¨r G, Ozmen I, Bo¨lu¨kbas¸i Y, Maden E, Bic¸akc¸i B, et al. Side effects associated with the treatment of multidrugresistant tuberculosis. Int J Tuberc Lung Dis. 2005; 9(12):1373-1377. Medline

19. Datiko DG, Lindtjørn B. Cost and cost-effectiveness of treating smear-positive tuberculosis by health extension workers in Ethiopia: an ancillary cost-effectiveness analysis of community randomized trial. PLoS One. 2010;5(2):e9158.

20. World Bank Open Data [Internet]. Washington (DC): The World Bank; c2016. Mobile cellular subscriptions (per 100 people); [cited 2015 Jun 10]. Available from: http://data.worldbank.org/indicator/IT.CEL.SETS.P2

21. Volpp KG, Loewenstein G, Troxel AB, Doshi J, Price M, Laskin M, et al. A test of financial incentives to improve warfarin adherence. BMC Health Serv Res. 2008;8(1):272

22. Center for Health Market Innovations (CHMI) [Internet]. Washington (DC): CHMI; c2016. TIBU: Year launched: 2012; [cited 2015 Dec 18]. Available from: http:// healthmarketinnovations.org/program/tibu

23. Boccia D, Hargreaves J, Lo¨nnroth K, Jaramillo E, Weiss J, Uplekar M, et al. Cash transfer and microfinance interventions for tuberculosis control: review of the impact evidence and policy implications. Int J Tuberc Lung Dis. 2011;15 Suppl 2:S34-S49.

24. Liu X, Lewis JJ, Zhang H, Lu W, Zhang S, Zheng G, et al. Effectiveness of electronic reminders to improve medication adherence in tuberculosis patients: a cluster-randomised trial. PLoS Med. 2015;12(9):e1001876.

25. Alwi, M. N. R. B., Ibrahim, M. I. B. M., Baharuddin, S. S. B., & Salahuddin, S. N. B. (2019). Exploring the perspective of health and well-being among orang asli: An evaluation of jakun. Test Engineering and Management, 81(11-12), 3477-3485. Retrieved from www.scopus.com

26. Agarkhed, J., & Ranjita, R. (2019). Smart health care system using wireless body area network. International Journal of Advanced Science and Technology, 27(1), 358-365. Retrieved from www.scopus.com

27. Agathiyar, M. P., & Sugumar, S. N. (2019). Concept of siddhars aimed at healthy longevity. International Journal of Advanced Science and Technology, 28(16), 2029-2033. Retrieved from www.scopus.com

28. Arifwidodo, S., & Chandrasiri, O. (2019). Urban heat island and health effects in bangkok, thailand. International Journal of Advanced Science and Technology, 28(1), 374-382. Retrieved from www.scopus.com