Short Communication

Diagnostic accuracy of paper-based reporting of tuberculosis treatment outcomes in rural eastern Uganda

Jonathan Izudi a,b,*, Imelda K. Tamwesigire a, Francis Bajunirwe b

a Department of Community Health, Mbarara University of Science and Technology, Mbarara, Uganda
b Infectious Diseases Institute, Makerere University, Kampala, Uganda

A R T I C L E   I N F O

Keywords:
Paper-based
Accuracy
Pulmonary tuberculosis
Outcomes
Uganda

A B S T R A C T

Inaccurate reporting of tuberculosis (TB) data to the district and national TB control programmes undermines effective TB control, yet this remains understudied. This study assessed the accuracy of the paper-based approach compared with the World Health Organization (WHO) standard TB treatment outcome as the gold standard for the determination of TB treatment outcome. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the paper-based approach, as well as the percentage agreement between the paper-based approach and the WHO standard TB treatment outcome, are reported. Data from 987 participants were used. Ninety-three participants were misclassified as cured and 195 were misclassified as not cured by the paper-based approach, giving 62.7% sensitivity, 80.0% specificity, 77.9% PPV, 65.5% NPV and percentage agreement of 70.8%. Treatment failure had 64.7% sensitivity, 99.9% specificity, 52.4% PPV, 99.4% NPV, and percentage agreement of 98.4%. Treatment success had 98.8% sensitivity, 96.8% specificity, 99.2% PPV and 94.8% NPV. The paper-based approach was found to report treatment success accurately, but did not report cure and treatment failure accurately. Interventions are thus required to improve the accuracy of the paper-based approach.

Background

The World Health Organization (WHO) recommends a cure rate of 85% and a treatment success rate of ≥95% for optimally performing TB control programmes (World Health Organization, 2017). The success of a national TB control programme for effective control of TB largely depends on its ability to report accurate data on TB treatment outcomes at all levels (World Health Organization, 2018). Inaccurate data have a negative impact on patient treatment and programming. Accurate data are imperative for efficient programme management as this guides the evaluation of programme targets, efforts to allocate staff, and result monitoring.

In Uganda, paper-based TB unit registers are used for routine reporting of TB data to the National TB and Leprosy Control Programme (NTLP) from peripheral health facilities, districts and regions. As the data capture process is not electronic, it is referred to as ‘paper-based’. Usually, TB focal persons (healthcare providers identified and designated to provide stewardship for TB care and management) at peripheral health facilities record, count, compute and submit the health facility TB performance data to the district through the District TB and Leprosy Supervisor (DTLS) who, in turn, submits the data to NTLP. TB treatment outcomes are thus computed through a paper-based system as there are no computerized systems. Although this is cheap and pragmatic for a resource-limited setting, using the paper-based approach for the determination of TB treatment outcome has the potential disadvantage of inaccurate data generation, but the magnitude of these inaccuracies has not been studied rigorously in Uganda. The primary objective of this study was to investigate the accuracy of the paper-based approach in determining TB treatment outcomes compared with the WHO standard TB treatment outcomes. Although data for all TB treatment outcomes were available, cure, treatment failure and treatment success were considered in this study as they are determined based on conditional probabilities, and are therefore prone to error.

Materials and methods

This study used data from a previous study on the completion of sputum smear monitoring among drug-susceptible persons with pulmonary bacteriologically confirmed TB, collected across 10 TB treatment units in rural eastern Uganda between January 2015 and June 2018 (Izudi et al., 2020a). These data have been described elsewhere (Izudi et al., 2020a, 2020b, 2020c).

* Corresponding author. Department of Community Health, Mbarara University of Science and Technology, P.O. Box 1410, Mbarara, Uganda. Tel.: +256 782097744.
E-mail address: jonahzd@gmail.com (J. Izudi).

https://doi.org/10.1016/j.ijregi.2022.01.001
Received 28 July 2021; Received in revised form 21 November 2021; Accepted 2 January 2022
2772-7076/© 2022 The Author(s). Published by Elsevier Ltd on behalf of International Society for Infectious Diseases. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/)
Table 1
List of operational definitions.

| Terms                     | Definitions                                                                 |
|---------------------------|-----------------------------------------------------------------------------|
| Sensitivity               | The proportion of participants who have the WHO standard TB treatment outcome, and who have been correctly identified as having the outcome by the paper-based approach. |
| Specificity               | The proportion of subjects who do not have the WHO standard TB treatment outcome, and who have been correctly identified as not having the outcome by the paper-based approach. |
| Positive predictive value | The probability that a participant who has been identified by the paper-based approach as having a TB treatment outcome has the outcome as per the WHO standard TB treatment outcome. |
| Negative predictive value (NPV) | The probability that a participant who has been identified by the paper-based approach as not having a TB treatment outcome does not have the outcome as per the WHO standard TB treatment outcome. |
| Care                      | A patient with pulmonary TB with bacteriologically confirmed TB at the beginning of treatment, who is smear or culture negative in the last month of treatment and on at least one previous occasion (World Health Organization, 2013). |
| Treatment failed          | A patient whose sputum smear or culture is positive after ≥5 months of treatment (World Health Organization, 2013). |
| Treatment success         | The sum of cured and treatment completed (World Health Organization, 2013). |

WHO, World Health Organization; TB, tuberculosis.

Table 2
Cross-tabulation of tuberculosis (TB) treatment outcomes based on the World Health Organization (WHO) definition with the paper-based system tuberculosis treatment outcome registered in the TB unit register (n=987).

| TB treatment outcome recorded in TB unit register | True TB treatment outcome based on WHO definition |
|--------------------------------------------------|--------------------------------------------------|
|                                                  | No | Yes | Total |
| Cure                                             | 371 | 195 | 566   |
| Treatment failure                                | 464 | 523 | 987   |
| Treatment success                                | 960 | 6   | 966   |
| Treatment failure                                | 10  | 11  | 21    |
| Treatment success                                | 181 | 10  | 191   |
| Treatment failure                                | 10  | 10  | 20    |
| Total                                            | 186 | 800 | 987   |

The parent study received approval from Mbarara University of Science and Technology Research Ethics Committee (Ref. No. 03/11-18) and the Uganda National Council for Science and Technology (HS 2531).

A waiver to analyse the secondary data was granted by the ethics committee. A diagnostic test was conducted using the WHO standard TB treatment outcome computed using a statistical software program as the gold standard, and cross-tabulated with TB treatment outcomes reported in the TB unit register. Paper- and case-based computerized data were from the same register and were collected after routine (quarterly) data validation by the DTLS. The outcomes (i.e. cure, treatment failure and treatment success) were assigned in accordance with the WHO definitions (Table 1). In the diagnostic test/analysis, the paper-based and WHO standard TB treatment outcomes were compared, with the former as the screening test and the latter as the true outcome. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were computed (Table 1). All analyses were performed in Stata Version 15 (Stata Corp., College Station, TX, USA) using the "diagt" command.

Results

In total, 987 patients were analysed (Table 2). For cure, the paper-based approach showed sensitivity of 62.7% [95% confidence interval (CI) 58.4–66.9], specificity of 80.0% (95% CI 76.0–83.5), PPV of 77.9% (95% CI 73.6–81.8) and NPV of 65.5% (95% CI 61.5–69.5). The percentage agreement between the two approaches was 70.8% (Kappa=0.421; P<0.0001). For treatment failure, sensitivity was 64.7% (95% CI 38.3–85.8), specificity was 99.9% (95% CI 98.1–99.5), PPV was 52.4% (95% CI 29.8–74.3) and NPV was 99.4% (95% CI 98.7–99.8). The percentage agreement was 98.4% (Kappa=0.571, P<0.0001). For treatment success, sensitivity was 98.8% (95% CI 97.7–99.4), specificity was 96.8% (95% CI 93.1–98.8), PPV was 99.2% (95% CI 98.4–99.7) and NPV was 94.8% (95% CI 90.6–97.5).

Discussion

The data show that the paper-based approach determines treatment success accurately, but does not determine cure and treatment failure accurately. Incorrectly categorizing people who have not achieved cure as 'cured' exacerbates TB morbidity and mortality at both individual and population levels. Inconsistencies in TB data recording and reporting are not unique, and have been reported previously (Heunis et al., 2011).

Previous research to assess the accuracy and completeness of data in the TB treatment register in two South African urban communities using record linkage also found inadequacies in the accuracy and completeness of data between the TB treatment and central laboratory registers (Dunbar et al., 2011). The present finding is thus consistent with a previous study recommendation calling for training of TB staff on the correct recording and reporting of TB data and improved access to computers (Podewils et al., 2016). The reasons for incorrect computation of TB treatment outcomes in the study setting need to be identified and tackled to enable accurate reporting of TB performance data at national and international levels. The paper-based approach to computing TB treatment outcomes and reporting to NTLP is accurate for treatment success, but not for cure and treatment failure. Revisions that incorporate conditional probabilities are required in the paper-based approach to improve its accuracy along with correct recording. This will enable good strategic planning, effective programme design and implementation, and correct decision-making at both district and national levels.

Acknowledgements

The authors wish to thank the District Health Officers and the District TB and Leprosy Supervisors of Soroti, Kumi, Serere and Ngora for providing administrative support. The authors also wish to thank the TB focal persons at the respective study sites, including the research assistants.
Conflict of interest statement

None declared.

Funding sources

None.

Ethical approval

Ethical approval was obtained from Mbarara University of Science and Technology Research Ethics Committee (Ref. No. 03/11-18) and the Uganda National Council for Science and Technology (HS 2531). A waiver to analyse the secondary data was granted by the ethics committee.

References

Dunbar R, Lawrence K, Verver S, Enarson D, Lombard C, Hargrove J, et al. Accuracy and completeness of recording of confirmed tuberculosis in two South African communities. Int J Tuberc Lung Dis 2011;15:337–43.
Heunis C, Wouters E, Kigozi G, Engelbrecht M, Tsibolane Y, van der Merwe S, et al. Accuracy of tuberculosis routine data and nurses’ views of the TB-HIV information system in the Free State. South Africa. J Assoc Nurses AIDS Care 2011;22:67–73.
Izudi J, Tamwesigire IK, Bajunirwe F. Association between GeneXpert diagnosis and same-day initiation of tuberculosis treatment in rural eastern Uganda. Am J Trop Med Hyg 2020c;103:1447–54.
Izudi J, Tamwesigire IK, Bajunirwe F. Surveillance for multi-drug and rifampicin resistant tuberculosis and treatment outcomes among previously treated persons with tuberculosis in the era of GeneXpert in rural eastern Uganda. J Clin Tuberc Other Mycobact Dis 2020b;19.
Izudi J, Tamwesigire IK, Bajunirwe F. Treatment success and mortality among adults with tuberculosis in rural eastern Uganda: a retrospective cohort study. BMC Public Health 2020c;20:501.
Izudi J, Tamwesigire IK, Bajunirwe F. Treatment supporters and level of health facility influence completion of sputum smear monitoring among tuberculosis patients in rural Uganda: a mixed-methods study. Int J Infect Dis 2020d;91:149–55.
Podewils LJ, Bronner Murrison L, Bristow C, Bantubani N, Mamejea JD. The other side of surveillance: monitoring, application, and integration of tuberculosis data to guide and evaluate programme activities in South Africa. S Afr Med J 2016;106:55.
World Health Organization. Definitions and reporting framework for tuberculosis –2013 revision; updated December 2014 and January 2020. 9241505346. Geneva: WHO; 2013.
World Health Organization. Guidelines for treatment of drug-susceptible tuberculosis and patient care. Geneva: WHO; 2017.
World Health Organization. Compendium of WHO guidelines and associated standards: ensuring optimum delivery of the cascade of care for patients with tuberculosis. Geneva: WHO; 2018.