Research Article

Triaging for Severe Illness amongst Adults with Tuberculosis Followed by Referral and Inpatient Care: A Statewide Pilot in Tamil Nadu, India

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Abstract

Background: **This research paper reports on the first statewide implementation of differentiated Tuberculosis (TB) care in routine health system settings in India and possibly globally. This pilot aimed to assess the feasibility in routine health system settings and to identify the predictors of triaging and the burden of triage positive.**

Methods/Design: **An observational study involving cross-sectional and longitudinal descriptive design. This differentiated TB care was implemented amongst all public notified adults (≥15 years) with TB (not known to be drug resistant at diagnosis) in routine health system settings involving the existing workforce in Tamil Nadu, India (except Chennai).**

Results: **Of 2,382 adults with TB notified during 14-27 March 2022, 1,636 (69%) were triaged for severe illness and 290 (18%) were triage positive. Of these 298, a total of 160 (55%) were comprehensively assessed after referral. Of 136 confirmed as severely ill, 116 (85%) were admitted and 103 were discharged. The median admission duration was 4 days. From diagnosis, the median time interval to admit a severely ill patient was 1 day. Adults diagnosed by rapid molecular test, with extrapulmonary TB and transferred out of district, were less likely to be triaged.**

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Conclusion: To reduce TB deaths, the losses in the care cascade should be reduced and the admission duration increased. The findings of this pilot exercise guided the eventual implementation starting 01 April 2022.

Keywords: Differentiated Tuberculosis care, hospitalisation, India, operational research, severe Tuberculosis, triaging

Introduction

Globally, the estimated Tuberculosis (TB) case fatality ratio increased from 17:100 in 2019 to 19:100 in 2020.[1] For the first time in a decade, largely due to COVID-19 pandemic-related challenges, TB deaths increased in 2020 (7.3% higher when compared to 2015).[1] The solution to address this ranges from ramping up TB case finding and differentiated TB care (triaging for severe illness at diagnosis followed by appropriate care) to enhancing the rations (including pulses) and direct cash transfers pending restoration of livelihoods amongst the poor.[2]

In January 2021, the National TB Elimination Programme (NTEP) in India recommended an assessment of severity amongst all notified patients at diagnosis and referral of severely ill for inpatient care.[3] However, there are two challenges in implementing the differentiated TB care guidance. First, the criteria to assess severe illness involve 16 indicators which are time-consuming and require clinical capacity, laboratory and radiology infrastructure (not available in all the peripheral health institutions [PHIs] diagnosing TB).[3] As most of the TB deaths are early deaths occurring within 2 months (half of early deaths happen within the first 2 weeks of diagnosis),[4] this mandates quick triaging for severe illness at the time of diagnosis. Second, the exact modality of implementation, including standard operating procedures and the recording, reporting, monitoring and evaluation framework, has not been specified.

A precursor to this, in Karnataka (October–November 2020) and Gujarat (June 2021), triaging for severe illness at diagnosis was piloted in routine settings and found to be feasible.[5,6] Triaging involved easy-to-use and infer indicators (possible to use even in community settings) of very severe undernutrition, respiratory insufficiency and poor performance status [Box 1].[7] The burden of 'high risk of severe illness' [triage-positive-presence of any one indicator from Box 1], 35% in Karnataka and 42% in Gujarat, as well as early TB deaths (7% in Karnataka) was high.[4-6] Early TB deaths were significantly higher amongst triage positive when compared to triage negative.[4] The limitation was that those who were triage positive were not systematically referred for the provision of appropriate care.

Box 1: Criteria to triage for severe illness at diagnosis amongst adults (≥15 years) with T.uberculosis (without known drug-resistant disease at diagnosis) notified from public facilities in Tamil Nadu, India, 14–27 March 2022[5,7]*

If at least one of the following is present, then the person with TB is 'high risk of severe illness' (triage positive – requires referral for comprehensive assessment and inpatient care)

- BMI ≤14.0 kg/m^2[#]
- BMI ≤16.0 kg/m^2 with leg swelling[#]
- Respiratory rate >24/min[##]
- Oxygen saturation <94%[##]
- Not able to stand without support (standing with support/ squatting/sitting/bedridden)

*Reprinted from Shewade *et al*.[5] under a CC BY license, with permission from MDPI, copyright MDPI 2021, a tool adapted from Bhargava and Bhargava,[7] [#]Very severe undernutrition indicators, [##]Respirator insufficiency indicators. BMI: Body mass index, TB: Tuberculosis, NTEP: National TB Elimination Programme

Starting in April 2022, with the aim to reduce deaths amongst notified TB patients, Tamil Nadu (a state in Southern India) implemented Tamil Nadu-*Kasanoi Erappila Thittam* (TN-KET), meaning 'TB death-free programme' in the Tamil language. All adults with TB (≥15 years) were triaged for severe illness at diagnosis, followed by referral of triage positive for comprehensive assessment, confirmation of severe illness and inpatient care in routine health system settings. Globally and nationally, there is limited experience of implementing such a strategy in routine settings.

This article presents the findings of the statewide pilot in March 2022, which contributed towards the eventual implementation starting in April 2022. Findings of the pilot fed into the implementation of TN-KET and enabled better programme performance. The specific objectives were to assess the i) feasibility of implementing TN-KET (retention and delay in TN-KET care cascade) in routine health system settings, ii) predictors of triaging and iii) burden of triage positive.

Material and Methods

Study design

A longitudinal descriptive design to track the TN-KET care cascade, and a cross-sectional design to determine the predictors of triaging and the burden of triage positive.

Setting

General setting

Details about study settings have been published elsewhere.[8]

Tamil Nadu-Kasanoi Erappila thittam

TN-KET is a health system initiative and not merely a state TB programme initiative with the involvement of the National Health Mission–Tamil Nadu and three key health Directorates. Tertiary-level care through teaching hospitals (one per district) is provided by the Directorate of Medical Education. Secondary-level care is provided by the Directorate of Medical and Rural Health Services through district headquarters and sub-district hospitals. Primary-level care is provided by the Directorate of Public Health and Preventive Medicine through primary health centres. Between December 2021 and February 2022, the preparation of tools, standard operating procedures, monitoring mechanisms and the corresponding training were completed. On 11 March 2022, districts were prepared to implement TN-KET. Eventual implementation began from 01 April 2022 preceded by a 2-week statewide pilot during 14–27 March.

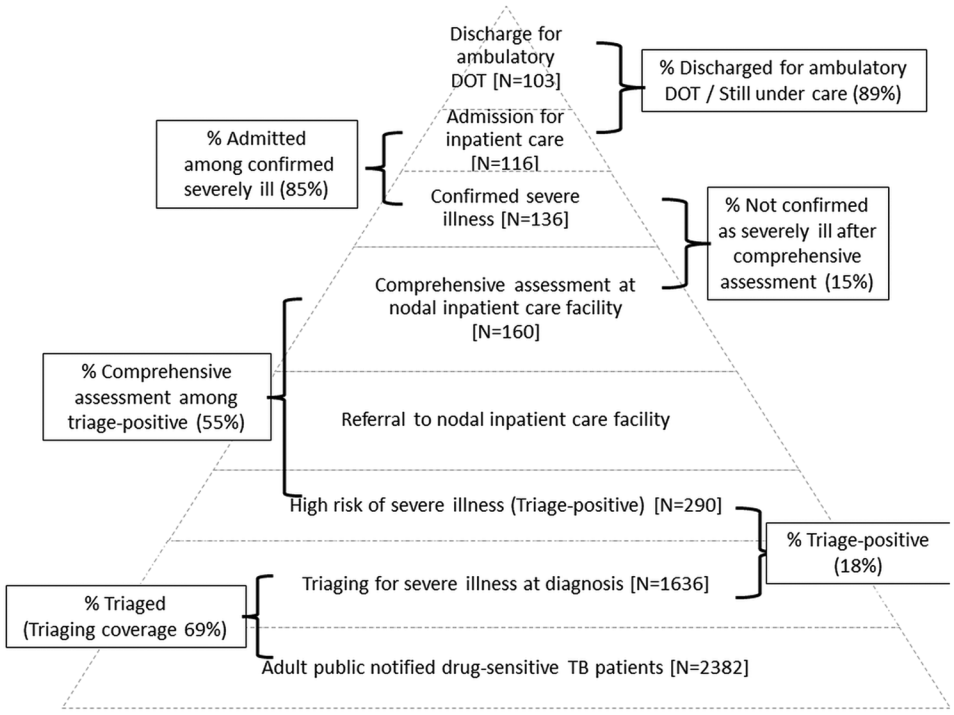

Figure 1: TN-KET care cascade among adults (≥15 years) with TB (without known drug-resistant disease at diagnosis) notified from public facilities of Tamil Nadu, India, 14 to 27 March 2022*. TN-KET – Tamil Nadu *Kasanoi Erappila Thittam* (Tamil Nadu TB death freCe programme, 150 nodal inpatient care facilities and 900 TB beds were identified in the 30 districts of Tamil Nadu), TB—T.uberculosis, DOT – directly observed treatment. *data as on 22 April 2022

Study population

Adults (≥15 years) with TB (not known to be drug resistant at diagnosis) notified during 14–27 March 2022 from all the public PHIs of 30 NTEP districts of Tamil Nadu (except Chennai). Patients were included irrespective of their treatment initiation or transfer out status. We excluded patients transferred-in from other non-study districts.

Patients known to be drug resistant and children (<15 years) were excluded because patients with drug-resistant TB mandatorily undergo pre-treatment evaluation at drug-resistant TB centres, while the children are diagnosed by a paediatrician at a secondary- or tertiary-level facility.

Tamil Nadu-*Kasanoi Erappila Thittam* care cascade

Authors have summarised the TN-KET care cascade and its indicators in Figure 1.

Triaging for severe illness

The indicators used in the paper-based triage tool [Box 1] are a subset of the indicators in the 2021 criteria for inpatient care/confirmation of severe illness [Table 1].[3] Very severe undernutrition, respiratory insufficiency and inability to stand without support (used in triage tool) by themselves are known risk factors for death and have a strong association with TB mortality.[9-17]

With the support of a laboratory technician and TB-health visitor (if present at PHI), a PHI staff collected the triaging-related data in a paper-based triage tool. The PHI medical officer reviewed this. It was emphasised during training that triaging should be done (as early as possible) at the diagnosis PHI (not the PHI where treatment is initiated) to ensure that severe illness is detected, and appropriate care provided as early as possible.

Referral of triage-positive adults

The triage-positive adults were referred to nodal TN-KET inpatient care facilities using public ambulance service. They underwent comprehensive assessment, confirmation of severe illness [Table 1] and inpatient care in the nodal facilities. Tamil Nadu has identified 150 nodal TN-KET inpatient care facilities and 900 TB beds (10% being in high dependency/intensive care units). This includes teaching hospitals; district headquarter hospital and sub-district hospital with a chest or internal medicine physician. Tamil Nadu has prepared an 'important care guide for adults with TB who are severely ill' to assist the nodal physicians in managing triage-positive patients. Details regarding the management of comorbidities, management of TB complications and discharge criteria are covered in the guide.[18]

Data capture

The STS transcribed the triaging details at the time of TB notification in the Severe TB Web Application (TB SeWA).

Co-ordination and monitoring

The contact details of key district NTEP staff (district TB officer, district programme coordinator and STS) and nodal TN-KET inpatient care facilities (nodal physician and nodal paramedical staff) for all 30 districts have been provided and shared in an online monitoring tool. This is to coordinate referral (from PHI to nodal TN-KET facility) and discharge (from nodal TN-KET facility to PHI) for ambulatory directly observed treatment. This facilitates not only intra-district referral but also inter-district referral. Once a week, the district programme coordinator monitored the gaps in the care cascade, provided feedback for corrective actions and indicated this in the online monitoring tool.

Table 1: Criteria for patients requiring inpatient care* among adults (≥15 years) with TB based on CTD 2021 technical guidance on differentiated care of TB patients in India (3)

Criteria	Considered to be emergency**	Scoring criteria	Score assigned
Pulse rate (per minute)		<60	2
		>100 (persistent after 30 minutes)	2
BMI (kg/m^2)	Yes (<14)	<14	1
		<16 with pedal oedema	1
		>40	1
MUAC (cm)		<16	1
Temperature (Celsius)	Yes (<35, >41)	<35	2
		>41	2
Blood pressure (mm Hg)	Yes	Hypertension (≥140/90)	2
		Hypotension (diastolic below 60)	2
Respiratory rate (per minute)	Yes (>24)	18-24	1
		25-30	2
		>30	3
Oxygen saturation (%)	Yes (<94)	90-93	1
		85-90	2
		<85	3
Haemoglobin (g%)	Yes (<7)	<7	2
Icterus		Present	1
Pedal Oedema		Present	1
General condition	Yes (if unable to walk, drowsy, unconscious)	Inability to walk but conscious and oriented	1
		Conscious, not oriented	2
		Drowsy	3
HIV		Positive and on ART	1
		Positive and not on ART	2
Random blood sugar		<70	2
		>200	2
Total white blood cell count		TC >11000	1
		TC <4000	1
Chest radiograph	Yes (massive pneumothorax, hydropneumothorax)	Hydropneumothorax	3
		Bilateral consolidation	2
Haemoptysis	Yes	Present	3

TB - Tuberculosis, CTD – central TB division, BMI – body mass index, MUAC – mid upper arm circumference, HIV – human immunodeficiency virus, ART – antiretroviral treatment

Data management and statistics

On 22 April 2022, we extracted the secondary NIKSHAY data (along with baseline characteristics) and merged it with secondary data from TB SeWA using the NIKSHAY identifier (NIKSHAY was the parent database). We analysed the data using STATA (v16.1, copyright 1985–2019, Stata Corp. LP College Station, TX, USA) software.

To assess feasibility, we calculated the proportion undergoing triaging, delay in triaging, completeness of information during triaging and losses in the TN-KET care cascade [Figure 1]. We also calculated the proportion of triage positive.

We used modified Poisson regression with robust variance estimates to identify the predictors for not undergoing triaging. We summarized the association using adjusted prevalence ratios (aPR). In the multivariable regression model, we included age, gender and factors with $p < 0.05$ for crude PR after ruling out multi-collinearity and considering the variation in triaging coverage across the districts.

Results

Out of 2382, the number notified varied across the districts from as high as 234 to as low as 13. Forty percent (n = 954) were diagnosed in teaching hospitals (tertiary level), 52% in district or sub-district hospitals (secondary level) and the remaining 8% from primary level facilities. Twenty-two percent (n = 525) were diagnosed through rapid molecular tests, and 69% were pulmonary TB. Ten percent were transferred out of the district for treatment [Table 2].

Of 2382 adults, 69% (n = 1636) were triaged; this varied across districts (30%–90%). Triaging coverage significantly improved as the number notified from the district reduced (Pearson correlation coefficient, r = minus 0.49, P = 0.007). Of 1636 triaged, data were collected for all the five indicators in 98%. On adjusted analysis, people diagnosed by rapid molecular test, people with extrapulmonary TB and those transferred out of district were less likely to be triaged [Table 2].

Table 2: Predictors for not getting triaged for severe illness[@] at diagnosis among adults (≥15 years) with TB (without known drug-resistant disease at diagnosis) notified during 14-27 March 2022 from public facilities of Tamil Nadu, India (*n*=2382)

Factors *	Total (%)[$]	Not triaged* *n* (%)[$$]	PR (95%CI)	aPR** (95%CI)
Total	2382 (100)	746 (31.3)		
Age in years				
15–24	260 (10.1)	89 (34.2)	1.09 (0.87, 1.35)	1.05 (0.84, 1.30)
25–34	268 (11.3)	95 (35.5)	1.12 (0.91, 1.39)	1.04 (0.84, 1.28)
35–44	441 (18.5)	139 (31.5)	Ref	Ref
45–54	603 (25.3)	177 (29.4)	0.93 (0.77, 1.12)	0.92 (0.77, 1.10)
55–64	514 (21.6)	150 (29.2)	0.93 (0.76, 1.12)	0.97 (0.80, 1.16)
≥65	296 (12.4)	96 (32.4)	1.03 (0.83. 1.28)	1.06 (0.86, 1.31)
Gender				
Men	1682 (70.6)	509 (30.3)	Ref	Ref
Women	699 (29.4)	237 (33.9)	1.12 (0.99, 1.27)	1.03 (0.91, 1.17)
Transgender	1 (0.04)	0 (0.0)	-	-
Test used for diagnosis				
Rapid molecular tests	525 (22.0)	201 (38.3)	1.58 (1.36, 1.83)^	1.31 (1.13, 1.52)^
Microscopy/culture	1,229 (51.6)	298 (24.3)	Ref	Ref
Chest radiograph	246 (10.3)	94 (38.2)	1.58 (1.31, 1.90)^	1.35 (0.96, 1.91)
Others	382 (16.0)	153 (40.1)	1.65 (1.41, 1.93)^	1.14 (0.79, 1.66)
Microbiological confirmation				
Yes	1,825 (76.6)	522 (28.6)	Ref	Ref
No	557 (23.4)	224 (40.2)	1.41 (1.24, 1.59)^	1.06 (0.75, 1.51)
Site of TB				
Pulmonary	1,648 (69.2)	390 (23.7)	Ref	Ref
Extra pulmonary	293 (12.3)	125 (42.7)	1.80 (1.54, 2.11)^	1.49 (1.21, 1.83)^
Missing	441 (18.5)	231 (52.4)	2.21 (1.95, 2.51)^	1.87 (1.57, 2.22)^
Previous treatment				
Yes	202 (8.5)	60 (29.7)	0.94 (0.76, 1.18)	[#]
No	2,180 (91.5)	686 (31.5)	Ref	
HIV				
Positive	101 (4.2)	42 (41.6)	1.43 (1.13, 1.82)^	1.20 (0.95, 1.53)
Negative	2,114 (88.8)	614 (29.0)	Ref	Ref
Unknown	167 (7.0)	90 (53.9)	1.86 (1.59, 2.17)^	1.24 (1.02, 1.50)^
DM				
Positive	500 (21.0)	124 (24.8)	0.87 (0.71, 1.03)	1.01 (0.85, 1.21)
Negative	1,366 (57.4)	393 (28.8)	Ref	Ref
Unknown	34 (1.4)	12 (35.3)	1.23 (0.77, 1.95)	0.95 (0.57, 1.59)
Missing	482 (20.2)	217 (45.0)	1.56 (1.38, 1.78)^	1.09 (0.90, 1.31)
Peripheral Health Institute - diagnosis facility level				
Primary	188 (7.9)	44 (23.4)	Ref	Ref
Secondary	1,240 (52.1)	329 (26.5)	1.13 (0.86, 1.49)	1.01 (0.77, 1.32)
Tertiary	954 (40.1)	373 (39.1)	1.67 (1.27, 2.19)^	1.17 (0.89, 1.53)
Treatment started				
Yes	1,941 (81.5)	515 (26.5)	Ref	[&]
No	441 (18.5)	231 (52.4)	1.97 (1.76, 2.22)^	
Transferred out of district				
Yes	229 (9.6)	98 (42.8)	1.42 (1.21, 1.67)^	1.35 (1.15, 1.59)^
No	2,153 (90.4)	648 (30.1)	Ref	Ref

TB—Tuberculosis, PTB—pulmonary TB, EPTB—extra pulmonary TB, LPA—line probe assay, HIV—human immunodeficiency virus, DM—Diabetes mellitus; PR—crude prevalence ratio, aPR—adjusted PR; [@]defined as filling and syncing of triaging details in a mobile application (TB SeWA) irrespective of the extent of missing data; *source is the routinely collected baseline data in NIKSHAY and data updated in TB SeWA as on 22 April 2022; [$] column percentage; [$$] row percentage; **modified Poisson regression with robust variance estimation, results have been adjusted for district; [#]Variables with crude $P \geq 0.05$ (Chi square test) were not included in the adjusted analysis; [&]excluded because of variance inflation factor>10; ^$P<0.05$.

Table 3: Distribution of body mass index, respiratory rate and oxygen saturation at diagnosis among adults (≥15 years) with TB (without known drug-resistant disease at diagnosis) triaged for severe illness from public facilities of Tamil Nadu, India, 14 to 27 March 2022 (*n*=1636)[@]

Characteristics	Total		Men		Women		Transgender	
	n	(%)*	*n*	(%)*	*n*	(%)*	*n*	(%)*
Total	1636	(100.0)	1173	(100.0)	462	(100.0)	1	(100.0)
Weight (kg)								
<30	31	(1.9)	10	(0.9)	21	(4.6)	0	(0.0)
30–44.9	696	(42.5)	457	(39.0)	239	(51.7)	0	(0.0)
45–59.9	697	(42.6)	543	(46.3)	154	(33.3)	0	(0.0)
≥60	212	(13.0)	163	(13.9)	48	(10.4)	1	(100.0)
Mean (SD)	*47.2*	*(10.8)*	*48.2*	*(10.2)*	*44.6*	*(11.6)*	-	-
Body mass index (kg/m^2)								
≤14.0	120	(7.3)	74	(6.3)	46	(10.0)	0	(0.0)
14.1–16.0	290	(17.7)	208	(17.7)	82	(17.8)	0	(0.0)
16.1–18.4	451	(27.6)	340	(29.0)	111	(24.0)	0	(0.0)
≥18.5[$]	775	(47.4)	551	(47.0)	223	(48.3)	1	(100.0)
Mean (SD)	*18.8*	*(4.0)*	*18.7*	*(3.6)*	*19.1*	*(4.9)*	-	-
Respiratory rate per minute								
<18	183	(11.2)	118	(10.1)	65	(14.1)	0	(0.0)
18-24	1,289	(78.8)	937	(79.9)	351	(76.0)	1	(100.0)
25-30	108	(6.6)	81	(6.9)	27	(5.8)	0	(0.0)
>30	30	(1.8)	21	(1.8)	9	(2.0)	0	(0.0)
Missing	26	(1.6)	16	(1.4)	10	(2.2)	0	(0.0)
Oxygen saturation (%)								
≥94	1,557	(95.2)	1,112	(94.8)	444	(96.1)	1	(100.0)
90–93	52	(3.2)	41	(3.5)	11	(2.4)	0	(0.0)
85-89	15	(0.9)	13	(1.1)	2	(0.4)	0	(0.0)
<85	11	(0.7)	7	(0.6)	4	(0.9)	0	(0.0)
Missing	1	(0.1)	0	(0.0)	1	(0.2)	0	(0.0)

*Column percentage; TB—tuberculosis, [@]of 2382 patients, a total of 1636 (68.7%) were triaged; [$]157 were overweight (BMI 23.0–27.4) and 56 obese (BMI ≥27.5)

Amongst 1636 triaged, 290 were triage positive, of whom, 160 (55%) were comprehensively assessed at nodal in-patient care facilities, and of these, 24 (15%) were not confirmed as severely ill. Of 136 with confirmed severe illness, 116 (85%) were admitted for in-patient care [Figure 1].

Of 116 admitted for inpatient care, 74% (n = 85) were discharged for ambulatory directly observed treatment, and 16% (n = 18) were still admitted [Figure 1]. Of the 13 with unfavourable admission outcomes, four had died, six left against medical advice and three were referred elsewhere with the outcome unknown. The median admission duration amongst those discharged for ambulatory directly observed treatment was 4 (interquartile range [IQR]: 2, 6) days.

Of 1636 triaged, the median time interval from diagnosis to triaging (capturing details in paper-based triage tool) was 1 day (IQR: 0, 4) and from diagnosis to capturing details in TB SeWA was 6 days (IQR: 3, 11). The latter varied from 2 to 13 days across districts. Amongst those triage positive and admitted under TN-KET, the median time interval from diagnosis to admission was 1 day (IQR: 0, 2). Of these, 59% were already admitted at the time of triaging.

Amongst triaged, the mean weight was 47.2 kg (standard deviation 10.8), severe undernutrition (BMI < 16 kg/m^2) was found in 25% and respiratory rate was between 18 and 24 per minute in 79% [Table 3 for data stratified by men and women]. The burden of triage-positive was 17.7% (95% CI: 15.9, 19.7) [Table 4 for indicator-wise burden]. The contribution of various indicators (there was an overlap of indicators) towards triage positive was as follows: very severe undernutrition (43%), respiratory insufficiency (62%) and inability to stand without support (26%) [Figure 2].

Discussion

The pilot study suggests that TN-KET was feasible to implement. Seven in ten adults were triaged; six in ten triage-positive adults were referred and comprehensively assessed and almost nine in ten confirmed that severely ill adults were getting inpatient care. In addition, there were short delays in triaging (more than half the patients triaged within 1 day of diagnosis). Most of the triaged adults had all five triaging indicators collected. Before this, anecdotal experience suggested that admitted patients were discharged as soon as TB was diagnosed. Sixty percent of confirmed severely ill adults were already admitted at the time of triaging, and amongst them, we observed limited attrition after confirmation of severe illness. These findings are encouraging considering it was a pilot.

There are two quality-related issues that need to be addressed. First, one in six triage-positive adults was not confirmed as

Table 4: Burden of triage-positive at diagnosis using our triage tool among adults (≥15 years) with TB (without known drug-resistant disease at diagnosis) notified during 14-27 March 2022 from public facilities of Tamil Nadu, India (*n*=1636)[@]

Criteria	*n*	% (95% CI)
Using the triaging criteria	290	17.7 (15.9, 19.7)
Using BMI ≤14	120	7.3 (6.2, 8.7)
Using BMI 14–16 with leg swelling	5	0.3 (0.1, 0.7)
Using RR >24/min	138	8.4 (7.2, 9.9)
Using oxygen saturation <94%	78	4.8 (3.8, 5.9)
Inability to stand without support	74	4.5 (3.6, 5.7)
Very severe undernutrition related indicator (any one)	125	7.6 (6.4, 9.0)
Respiratory insufficiency related indicator (any one)	181	11.1 (9.6, 12.7)

TB—Tuberculosis, BMI—body mass index (kg/m^2), RR—respiratory rate; [@]Of 2382 people with TB, a total of 1636 (68.7%) were triaged as on 22 April 2022.

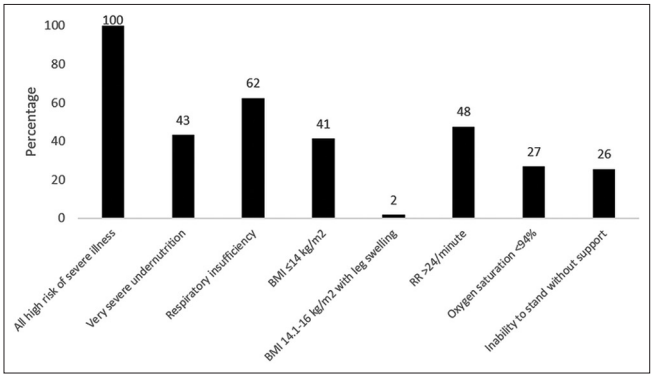

Figure 2: Contribution of individual indicators to 'high risk of severe illness' at diagnosis among adults (≥15 years) with TB (without known drug-resistant disease at diagnosis) from public facilities of Tamil Nadu, India, 14 to 27 March 2022 (N = 290)[@]
TB—T.uberculosis; [@] Of 2382 people with TB, a total of 1636 were triaged and of them 290 were at high risk of severe illness (triage-positive)

severely ill after comprehensive assessment (our target is less than one in 20). As the indicators in the triage tool are a subset of the criteria for confirmation of severe illness, this can be explained by possible measurement errors during triaging. Another reason could be BMI having a '<' sign in criteria for severe illness, while our triage tool uses '≤' sign. We were unable to objectively assess this, as TB SeWA does not capture details of the comprehensive assessment. Second, the median admission duration amongst severely ill adults was only 4 days (our target is 7 days). This should be addressed through quality inpatient care at nodal inpatient care facilities by following the 'inpatient care guide for adults with TB who are severely ill'[18] and infrastructure strengthening (high protein diet, F-75/100 for the management of very severe undernutrition and infection prevention and control amongst many others).

The burden of triage positive was lower than 35% in the neighbouring state of Karnataka and 42% in Gujarat, West India.[5,8] The proportion of severe undernutrition amongst adults with TB (25%) was lower than in Karnataka (30%) and Gujarat (38%).[5,8] This is possibly a reflection of lower undernutrition levels amongst adults in the general population in Tamil Nadu (12%–13%) when compared to Karnataka (14%–17%), Gujarat (21%–25%) and national figures (16%–19%).[19]

With an 18% burden of triage positive and around 4500 adults notified from public PHI per month, we expect around 810 adults who are eligible for referral and comprehensive assessment. Assuming 95% will be confirmed as severely ill with no losses in the TN-KET care cascade and an average of 7 days of admission, Tamil Nadu will have to be prepared for 5390 bed-days (810 × 0.95 × 7) of admission per month. With 900 beds earmarked for TN-KET, it appears that the state is well prepared.

Tamil Nadu intends to achieve the '80-80-80 and 7' targets at the state and district levels: i) 80% triaging coverage, ii) 80% comprehensive assessment amongst triage-positive adults, iii) 80% admission amongst adults with confirmed severe illness and iv) median 7 days of admission. To improve triaging coverage, the focus is now on improving triaging in districts reporting a high number of patients, adults diagnosed by rapid molecular tests, adults with extrapulmonary TB and those transferred out of the district. We did not have a sufficient sample size to assess the factors associated with not undergoing comprehensive assessment and poor admission outcomes. This should be explored in future research.

There is potential for the use of primary healthcare system in differentiated TB care. Once triaging at diagnosis and appropriate care matures, follow-up triaging at frequent intervals during treatment may be considered. The health and wellness centres can play an important role in this.[20] In addition, beyond TN-KET, if we are to reduce TB deaths, a large proportion of patients should be diagnosed in primary-level facilities (only 8% during our pilot). This along with the monthly trend of the burden of triage positive should be tracked to assess the effectiveness of ongoing case-finding strategies.

Conclusion

The finding of this pilot study can guide Tamil Nadu as TN-KET continues to be implemented in routine health system settings. The state should address the predictors of triaging and the losses in the TN-KET cascade. Steps should be taken to increase the duration of inpatient care. This strategy has the potential for replication in other states of India and other low- and middle-income countries with high TB burden. Initiatives to reduce TB incidence and ensure early diagnosis and treatment contribute towards the prevention of TB deaths.

Relevance to the public health:
Most of the TB deaths happen within the first 2 months of diagnosis. By triaging patients at diagnosis and identifying those at high risk early during TB treatment, the chances of preventing deaths through appropriate care are increased. To improve triaging coverage, the TB programme should address the predictors of not getting triaged.

Implications for the clinical practice:
The pilot identified that the duration of inpatient care for triage-positive TB patients was 4 days. This needs to be improved. Quality of inpatient care at nodal inpatient care facilities should be ensured along with infrastructure strengthening (high protein diet, F-75/100 for management of very severe undernutrition and infection prevention and control amongst many others).

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TN-KET (and the operational research around it) is being implemented as a Tamil Nadu health system initiative in the routine programme setting using existing resources and workforce.

Conflicts of interest
There are no conflicts of interest.

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