

Bedaquiline-containing regimen in the TRUNCATE-TB Trial

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TRUNCATE-TB Rationale

- Current global standard treatment for DS-TB is 6m regimen (2RHZE/4RH)
- First established in 1980s, associated with 95% cure rate in trials
- Decreases to $\leq 85\%$ under programme conditions (non-adherence, default)



TRUNCATE-TB Rationale

Table 1.11 Short-course chemotherapy studies of smear-negative pulmonary tuberculosis in Hong Kong. Patients with negative cultures or with drug-sensitive cultures initially.

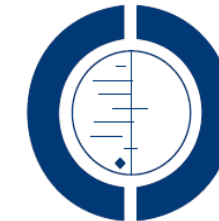
Study no. (date of start)	Initial culture results	Regimen	Duration (months)	Patients assessed for relapse	Relapse rate (%) follow-up for		Reference
					2 years*	5 years*	
1 (1976)	Negative	SC [†]	–	176	53 (40)	57 (41)	212
		SHRZ	2	165	7 (4)	11 (6)	213
		SHRZ	3	162	4 (2)	7 (3)	214
		3SPH/S ₂ H ₂	12	160	1 (0)	2 (1)	
	Positive	SHRZ	2	72	22 (15)	32 (23)	
		SHRZ	3	69	12 (9)	13 (10)	
2 (1978)	Negative	SHRZ	3	364	2	6 (3)	215
		S ₃ H ₃ R ₃ Z ₃	3	345	3	8 (3)	
		S ₃ H ₃ R ₃ Z ₃	4	325	2	4 (1)	
	Positive	SHRZ	4	157	3	3 (3)	
		S ₃ H ₃ R ₃ Z ₃	4	136	1	2 (1)	
		S ₃ H ₃ R ₃ Z ₃	6	166	2	5 (2)	

* Percentage bacteriologically confirmed in parentheses.

[†] Selective chemotherapy group. Treatment started when bacteriological or radiographic evidence of activity occurred during follow-up.

Regimens of less than six months for treating tuberculosis (Review)

Gelband H



THE COCHRANE COLLABORATION®

Fox Int J Tubercul Lung Dis 1999

- With standard 6m Rx we're over-treating the majority to prevent relapse in a minority

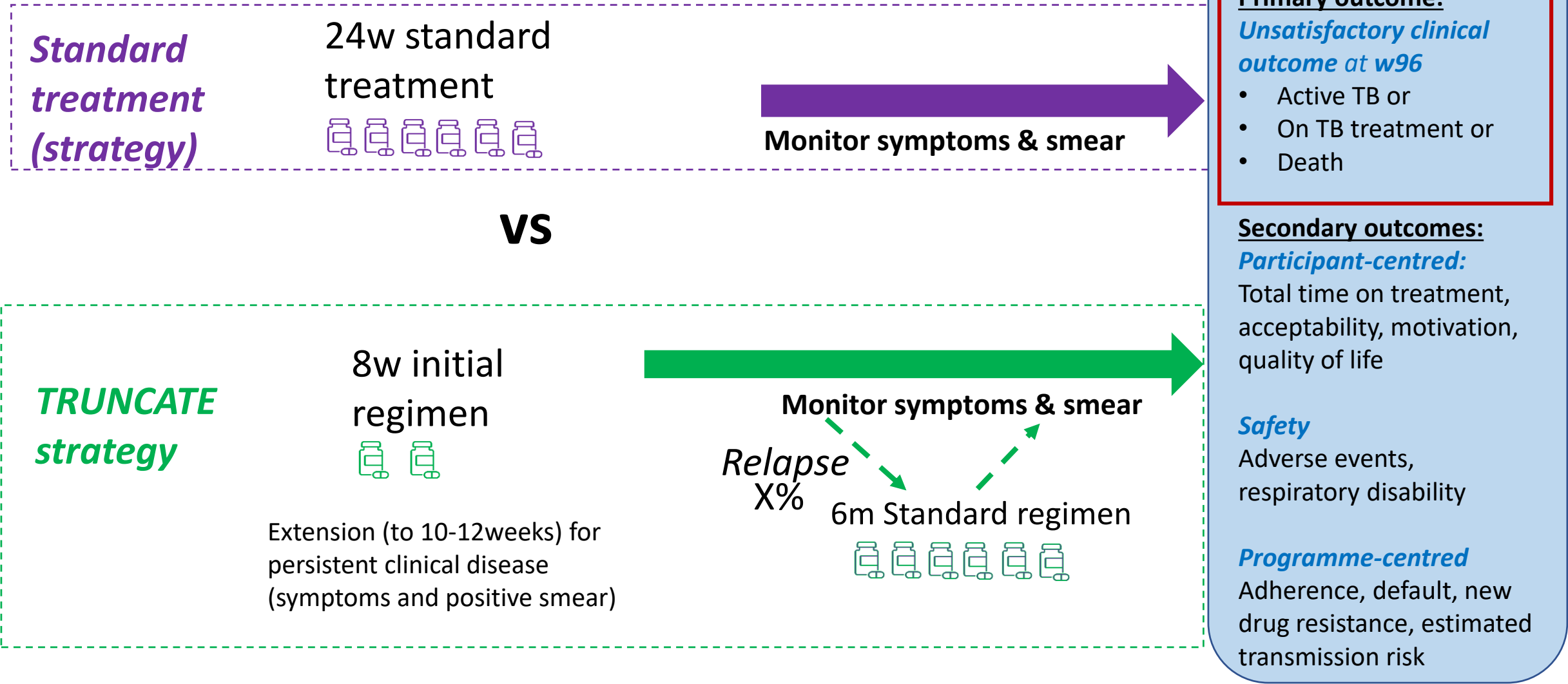
TRUNCATE-TB Rationale

Overall outcomes may be as good (or better) in programme setting if:

- Treat everyone with a shorter duration needed for the majority
- Shift resources to ensure early detection and re-treatment of relapses in the minority

→ Potential advantages for people with tuberculosis and for programmes

TRUNCATE-TB Trial design



Main eligibility Criteria

Selected inclusion criteria

- Age 18 to 65 years
- Clinical symptoms consistent with pulmonary TB and/or evidence of pulmonary TB on CXR
- Sputum Xpert MTB/RIF positive

Selected exclusion criteria

- Rifampicin resistance on Xpert MTB/RIF
- Previous active TB disease
- Extra-pulmonary TB
- Severe clinical PTB
- Sputum smear 3+ *
- Cavity size >4cm on screening CXR*
- HIV positive*
- Poorly-controlled diabetes
- Cardiac disease
- Severe chronic lung disease
- Peripheral neuropathy

*Removed/modified in stage 3 of trial

Main eligibility Criteria

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Selected exclusion criteria

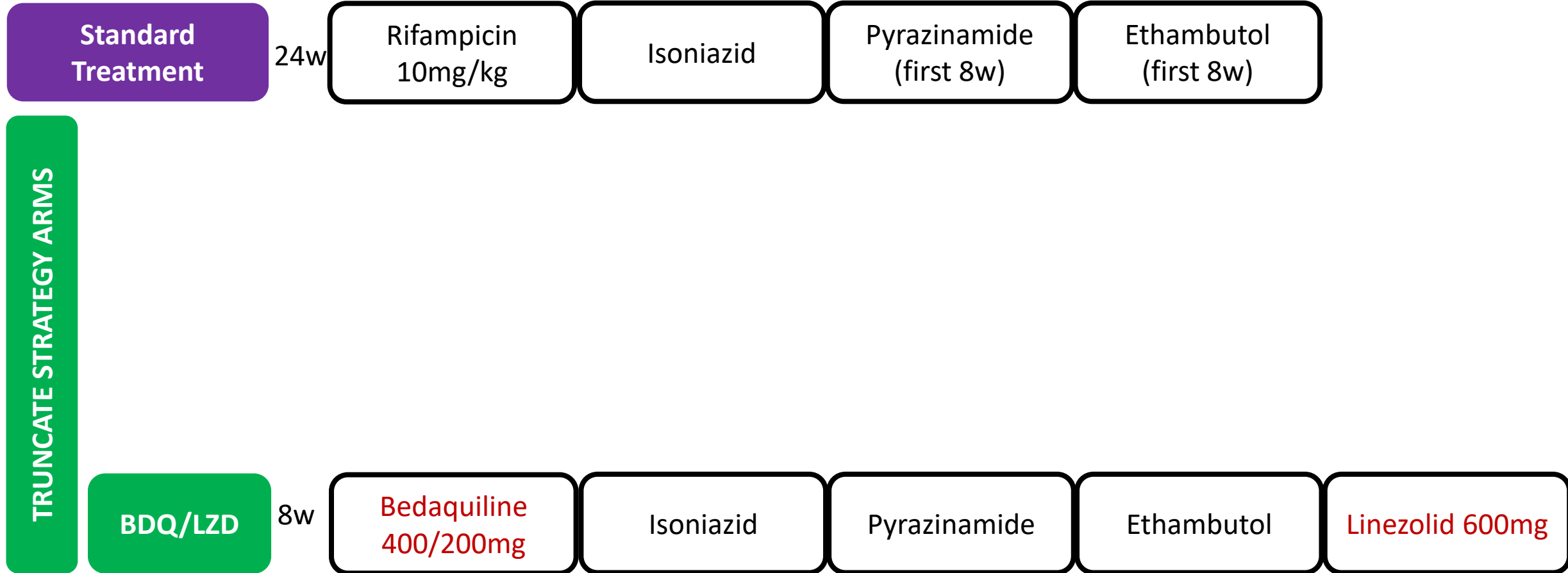
- Rifampicin resistance on Xpert MTB/RIF
- Previous active TB disease
- Extra-pulmonary TB
- Severe clinical PTB
- ~~Sputum smear 3+ *~~
- ~~Cavity size >4cm on screening CXR*~~
- ~~HIV positive*~~
- Poorly-controlled diabetes
- Cardiac disease
- Severe chronic lung disease
- Peripheral neuropathy

*Removed/modified in stage 3 of trial

Trial Regimens

Standard Treatment		24w	Rifampicin 10mg/kg	Isoniazid	Pyrazinamide (first 8w)	Ethambutol (first 8w)	
TRUNCATE STRATEGY ARMS	hRIF/LZD	8w	↑ Rifampicin 35 mg/kg	Isoniazid	Pyrazinamide	Ethambutol	Linezolid 600mg
	hRIF/CFZ	8w	↑ Rifampicin 35 mg/kg	Isoniazid	Pyrazinamide	Ethambutol	Clofazimine 200mg
	RPT/LZD	8w	Rifapentine 1200mg	Isoniazid	Pyrazinamide	Levofloxacin 1000mg	Linezolid 600mg
	BDQ/LZD	8w	Bedaquiline 400/200mg	Isoniazid	Pyrazinamide	Ethambutol	Linezolid 600mg

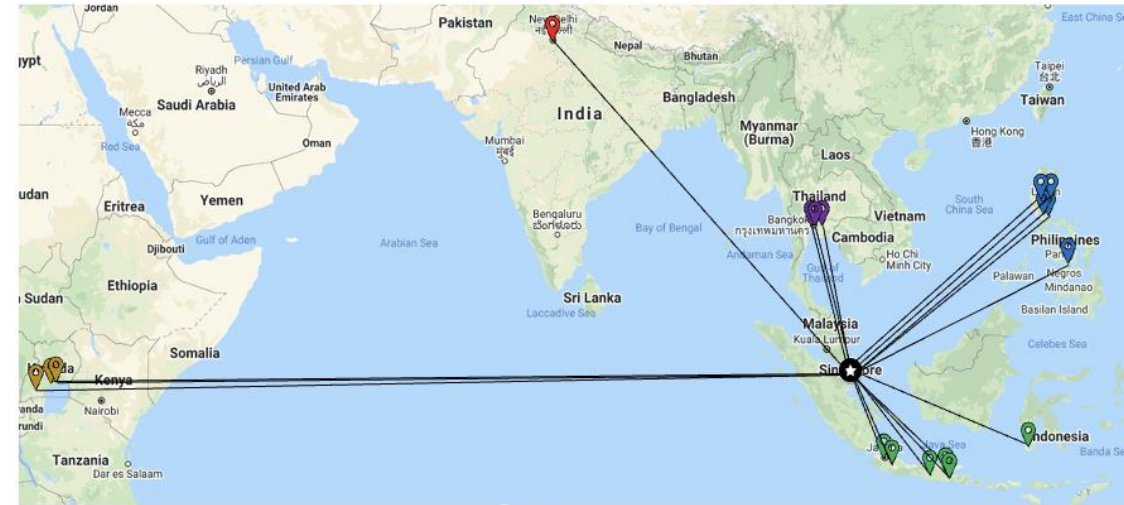
Trial Regimens – focus for today



Enrolment and retention

- Randomised in trial: 675
 - Randomised in error, immediately withdrawn: 1 (0.2%)
 - Lost to follow-up or withdrawal: 4 (0.6%)
 - Died before week 96: 10 (1.5%)

- Alive and under follow-up at W96: 660
 - Evaluated at W96: 660
 - 643 (97%) in person
 - 17 (3%) by telephone



18 sites, 5 countries

Indonesia (6), Philippines (5), Thailand (3), India (1), Uganda (3)

Treatment received

Outcome	Standard Rx (N = 181)	BDQ/LZD (N=189)
Completed randomised Rx only – N (%)		
8-week arms: completed assigned Rx	–	179 (95)
Completed 8w	–	162 (86)
Extended up to 10w	–	13 (7)
Extended up to 12w	–	4 (2)
Standard Rx: completed assigned Rx	178 (98)	–
Switched to standard treatment – N (%)		
Overall switched	–	8 (4)
Did not complete initial treatment – N (%)		
Overall did not complete	3 (2)	2 (1)
Died	2 (1)	0 (0)
Defaulted treatment	1 (1)	2 (1)
Adherence		
Adherence over first 56d – <i>mean ± SD</i>	98.7 ± 4.9	98.9 ± 3.2
Missed ≥ 14 doses in first 56d – N (%)	4 (2.2)	2 (1.1)

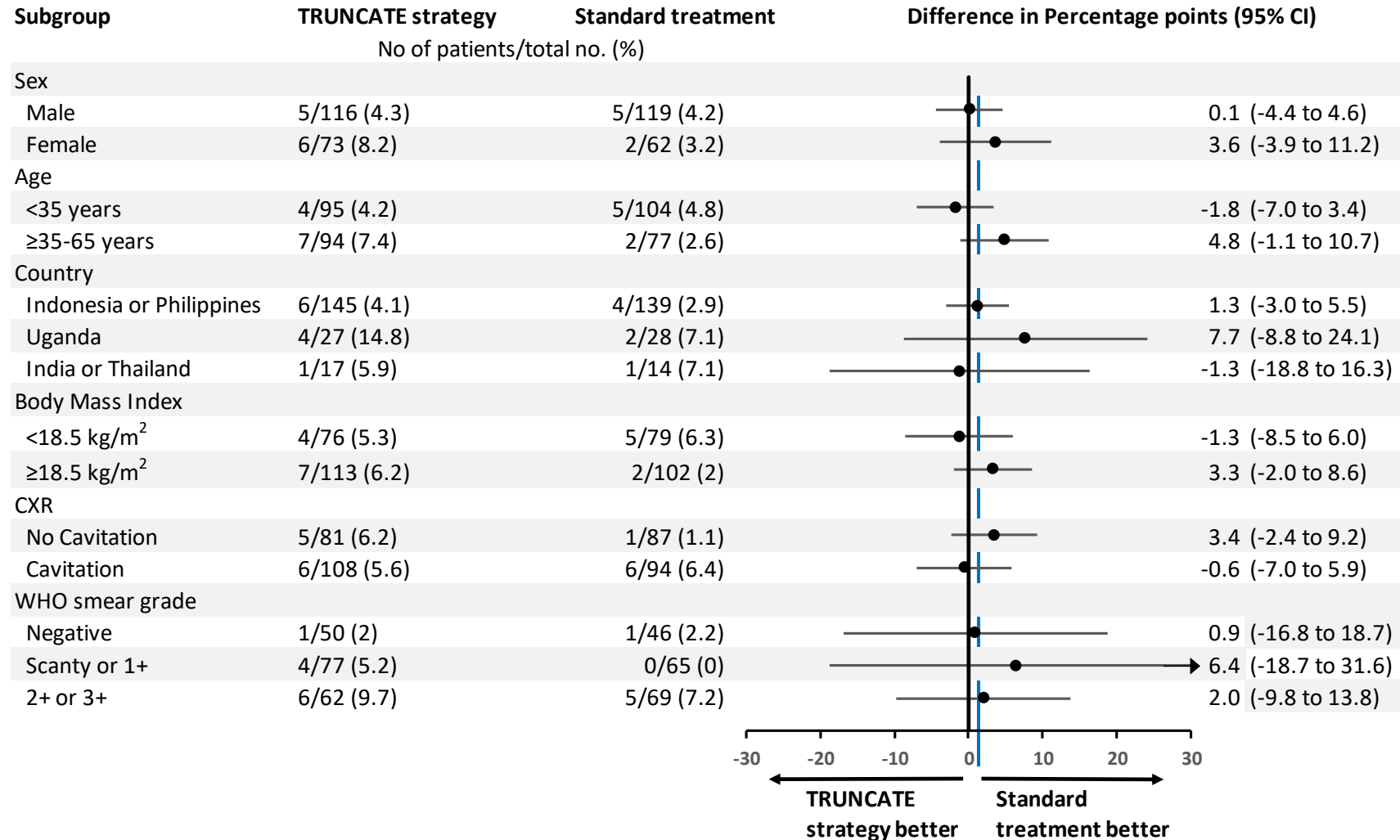
Primary strategy efficacy outcome, BDQ/LZD arm



Outcome	Standard treatment (N= 181)	BDQ/LZD arm (N=189)	Adjusted difference (97.5% CI)
ITT population			
Unsatisfactory outcome – no. (%)	7 (3.9)	11 (5.8)	0.8 (-3.4 to 5.1)
Participants with unassessable outcome – no. (%)	1 (0.6)	2 (1.1)	-
Participants with satisfactory outcome – no. (%)	173 (95.6)	176 (93.1)	-
Sensitivity analysis populations			
Assessable population	7/180 (3.9)	11/187 (5.9)	0.8 (-3.4 to 5.1)
Per-protocol population	6/177 (3.4)	9/176 (5.1)	0.9 (-3.3 to 5.1)

Pre-specified non-inferiority threshold of 12%

Primary strategy efficacy outcome, BDQ/LZD arm



Regimen analysis: unfavourable outcome

	24w Standard Rx (N=181)	8w BDQ/LZD (N=189)
Unfavourable outcome – no (%)	7 (3.9)	26 (13.8)
Treatment failure at switch to standard Rx	0 (0.0)	1 (0.5)
Treatment failure at end of treatment	0 (0.0)	1 (0.5)
Confirmed relapse	4 (2.2)	20 (10.6)
Un-confirmed relapse	0 (0.0)	3 (1.6)
Death by W96, possible TB-related cause	2 (1.1)	0 (0.0)
Did not attend W96, lacks evidence of cure at last attended visit	1 (0.6)	1 (0.5)
Unassessable outcome – no (%)	6 (3.3)	16 (8.5)

Selected secondary outcomes

	Standard treatment (N= 181)	BDQ/LZD arm (N=189)	Adjusted difference (95% CI)
Total time on treatment			
Treatment days to week 96	180.2 ± 37.9	84.8 ± 65.3	-95.3 (-106.2 to -84.5)

Selected secondary outcomes

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Total time on treatment			
Treatment days to week 96	180.2 ± 37.9	84.8 ± 65.3	-95.3 (-106.2 to -84.5)
Safety			
Any grade 3 or 4 adverse event – no. (%)	29 (16.0)	30 (15.9)	-0.2 (-7.9 to 7.4)
Any serious adverse event – no. (%)	11 (6.1)	14 (7.4)	1.3 (-4.2 to 6.9)
Death no. (%)	3 (1.7)	1 (0.5)	-1.1 (-4.3 to 1.5)

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Death no. (%)	3 (1.7)	1 (0.5)	-1.1 (-4.3 to 1.5)
Respiratory disability at W96			
MRC breathlessness scale ≥ 3 – no. (%)	0	2.7 (1.4)	1.4 (-0.5 to 3.3)
FEV1 < 50% of Predicted value	24.3 (13.4)	22.4 (11.8)	0.1 (-7.8 to 7.9)

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FEV1 < 50% of Predicted value	24.3 (13.4)	22.4 (11.8)	0.1 (-7.8 to 7.9)
Acquired drug resistance			
Acquired drug resistance	0	2 (1.1)	-

Acquired drug resistance

Participant 1

- Baseline INH resistance
- Missed 14 days (12 consecutive) of all drugs during the first 4 weeks
- Relapsed at W52 with new phenotypic and genotypic resistance to BDQ (and CFZ)
- Retreatment with standard treatment (with quinolone added) was successful.

Participant 2

- No baseline drug resistance
- Adherent to initial 8-week treatment
- Relapsed at W36 with new phenotypic and genotypic resistance to BDQ (and CFZ)
- Retreatment with standard treatment was successful.

No acquired drug resistance in the other TRUNCATE strategy or standard treatment arms

Conclusions

The TRUNCATE strategy was:

- ✓ **Non-inferior** to standard treatment on clinical outcome at week 96 (with initial BDQ/LZD regimen) - consistent in subgroup analyses
 - ✓ Associated with an excess of relapses but these were manageable within the framework of the strategy
 - ✓ Resulted in **substantial reduction in overall days** on treatment
 - ✓ **Safe** – no excess severe/serious AEs, death, respiratory disability
 - ✓ Had **low rate of drug resistance** (1.1% with BDQ/LZD regimen only) – a caution
- Alternatives to over-treating the large majority of people with TB can be successful

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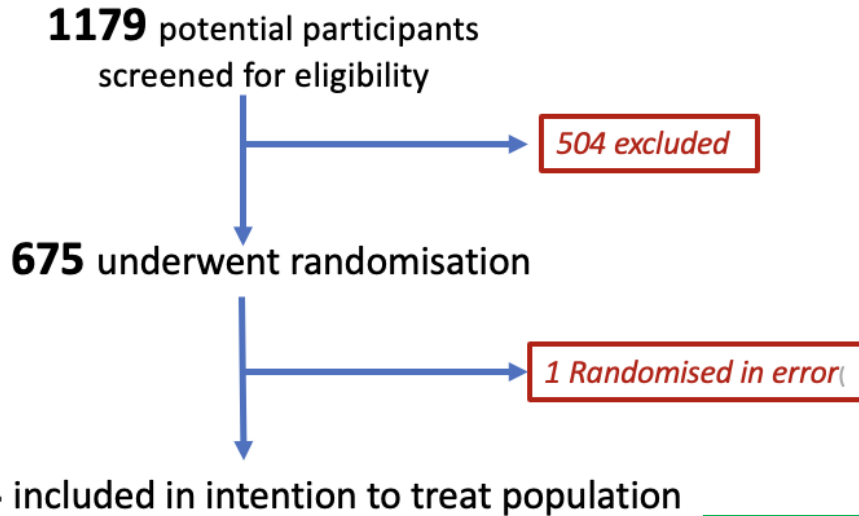
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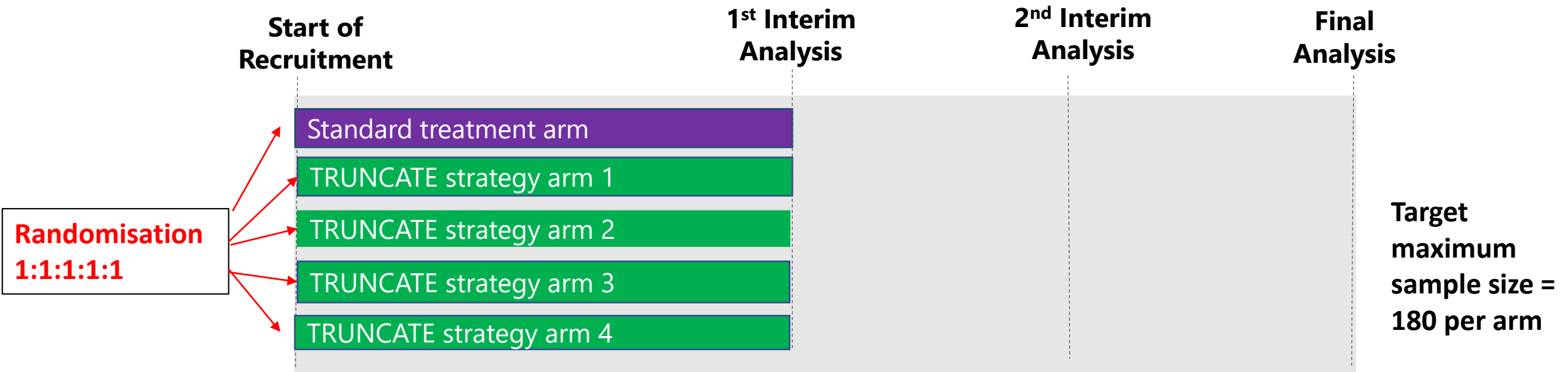
Back-up slides

Enrolment and retention



	Standard Rx	hRIF/LZD	hiRIF/CFZ	RPT/LZD	BDQ/LZD	Overall (n [%])
Number in ITT:	181	184	78	42	189	674
• <i>Died</i>	3	5	0	1	1	10 (1.5)
• <i>Lost to follow up</i>	0	0	0	0	2	2 (0.3)
• <i>Withdrew consent</i>	0	1	0	0	1	2 (0.3)
• <i>Alive w96 - clinic</i>	176	170	77	39	181	643 (95)
• <i>Alive w96 - Telephone</i>	2	8	1	2	4	17 (2.5)

Multi-arm multi-stage design



Stopping guidelines at interim analysis:

High rate of early relapse (>20%)

Time to culture conversion worse than control (HR < 0.9)

Poor tolerability/toxicity

Trial schedule



Telephone visits



VISIT TIMING ¹	SCREENING	D0	W1	W2	W4	W6	W8	W10	W12	W16	W20	W24	W36	W48	W60	W72	W84	W96
Informed Consent	X																	
Eligibility criteria	X	X																
Randomisation		X																
CLINICAL EVALUATION																		
Medical history & demographics	X	X																
Symptoms	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Physical examination	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Medication review and adherence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
HEALTHCARE UTILISATION & QOL																		
Healthcare utilisation		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
EQ-5D		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MOS-HIV		X																X
Patient acceptability questionnaire														X				X
Socioeconomic evaluation		X																X
INVESTIGATIONS																		
ECG ²	X	X	X		X		X											
CXR ³	X	X					X											X
Spirometry							X							X				X
URINE																		
Pregnancy test	X				X		X											
Urine for storage ⁴		X			X		X					X						
SPUTUM																		
Smear ⁵	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Liquid culture ⁶		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
GeneXpert test ⁷	X						X											
Drug susceptibility tests ⁸		X					X											
BLOOD																		
Standard safety monitoring ⁹	X	X	X	X ¹⁰	X	X ¹⁰	X	X ¹⁰										
HIV test ¹¹ (and CD4 count) ¹²	X																	
Drug levels (PK) ¹³		X			X		X					X						
Plasma and RNA storage ¹⁴		X			X		X					X						

Clinic visits 2 weekly

Clinic visits 4 weekly

Clinic visits 12 weekly +
telephone visits monthly

Baseline characteristics

Demographics

Characteristic – %	Standard Rx (N = 181)	hRIF/LZD (N = 184)	BDQ/LZD (N = 189)	Overall (N = 674)
Male sex	66	61	61	62
Age group				
< 35 years	57	59	50	57
35 – 50 years	33	31	37	32
51 – 65 years	10	10	13	11
Country				
Indonesia	43	40	43	44
Philippines	34	26	33	35
Thailand	6	8	6	7
Uganda	15	14	14	12
India	2	3	3	2
Weight (kg) – median (range)	50 (32–81)	50 (30–97)	50 (32–86)	50 (30–97)
BMI (kg/m ²) – median (range)	19 (14–29)	19 (14–33)	19 (13–30)	19 (12–33)
HIV positive	0	0	0	0
Diabetes	7	10	13	9

Baseline TB disease severity

Characteristic – N (%)	Standard Rx (N = 181)	hRIF/LZD (N = 184)	BDQ/LZD (N = 189)	Overall (N = 674)
Proportion of lung affected on CXR				
<25%	25	34	28	30
25–50%	52	47	52	50
>50%	23	19	20	20
Cavitation on CXR				
Absent	48	45	43	46
Present	52	55	57	53
WHO smear grade				
Negative	26	31	26	28
Scanty	15	15	13	15
1+	21	26	28	26
2+	24	20	20	20
3+	14	8	13	11
Bacillary burden on GeneXpert				
Very low	14	13	9	12
Low	23	28	28	27
Medium	42	46	40	42
High	21	13	23	19

Breakdown of primary outcome, BDQ/LZD arm

Outcome	Standard treatment (N= 181)	TRUNCATE strategy (BDQ/LZD) (N=189)	Adjusted difference (97.5% CI)
Unsatisfactory outcome – no. (%)	7 (3.9)	11 (5.8)	0.8 (-3.4 to 5.1)
On tuberculosis treatment at W96	2 (1.1)	5 (2.6)	-
Tuberculosis disease activity at W96	1 (0.6)	3 (1.6)	-
Death before W96	2 (1.1)	1 (0.5)	-
Telephone evaluation W96 – insufficient evidence of disease clearance when last seen	2 (1.1)	1 (0.5)	-
No evaluation W96 - insufficient evidence of disease clearance when last seen	0	1 (0.5)	-
Participants with unassessable outcome – no. (%)	1 (0.6)	2 (1.1)	-
Single positive culture at W96	0	0	-
Death (not related to tuberculosis)	1 (0.6)	0	-
No evaluation W96 – evidence of disease clearance when last seen	0	2 (1.1)	-
Participants with satisfactory outcome – no. (%)	173 (95.6)	176 (93.1)	-

Treatment received - inc hRIF/LZD

Outcome	Standard Rx (N = 181)	hRIF/LZD (N = 184)	BDQ/LZD (N=189)
Completed randomised Rx only – N (%)			
8-week arms: completed assigned Rx	–	169 (92)	179 (95)
Completed 8w	–	143 (78)	162 (86)
Extended up to 10w	–	21 (11)	13 (7)
Extended up to 12w	–	5 (3)	4 (2)
Standard Rx: completed assigned Rx	178 (98)	–	–
Switched to standard treatment – N (%)			
Overall switched	–	10 (5)	8 (4)
Did not complete initial treatment – N (%)			
Overall did not complete	3 (2)	5 (3)	2 (1)
Died	2 (1)	1 (1)	0
Withdrew	0	1 (1)	0
Defaulted treatment	1 (1)	3 (2)	2 (1)
Adherence			
Adherence over first 56d – <i>mean ± SD</i>	98.7 ± 4.9	96.9 ± 7.7	98.9 ± 3.2
Missed ≥ 14 doses in first 56d – N (%)	4 (2.2)	7 (3.8)	2 (1.1)

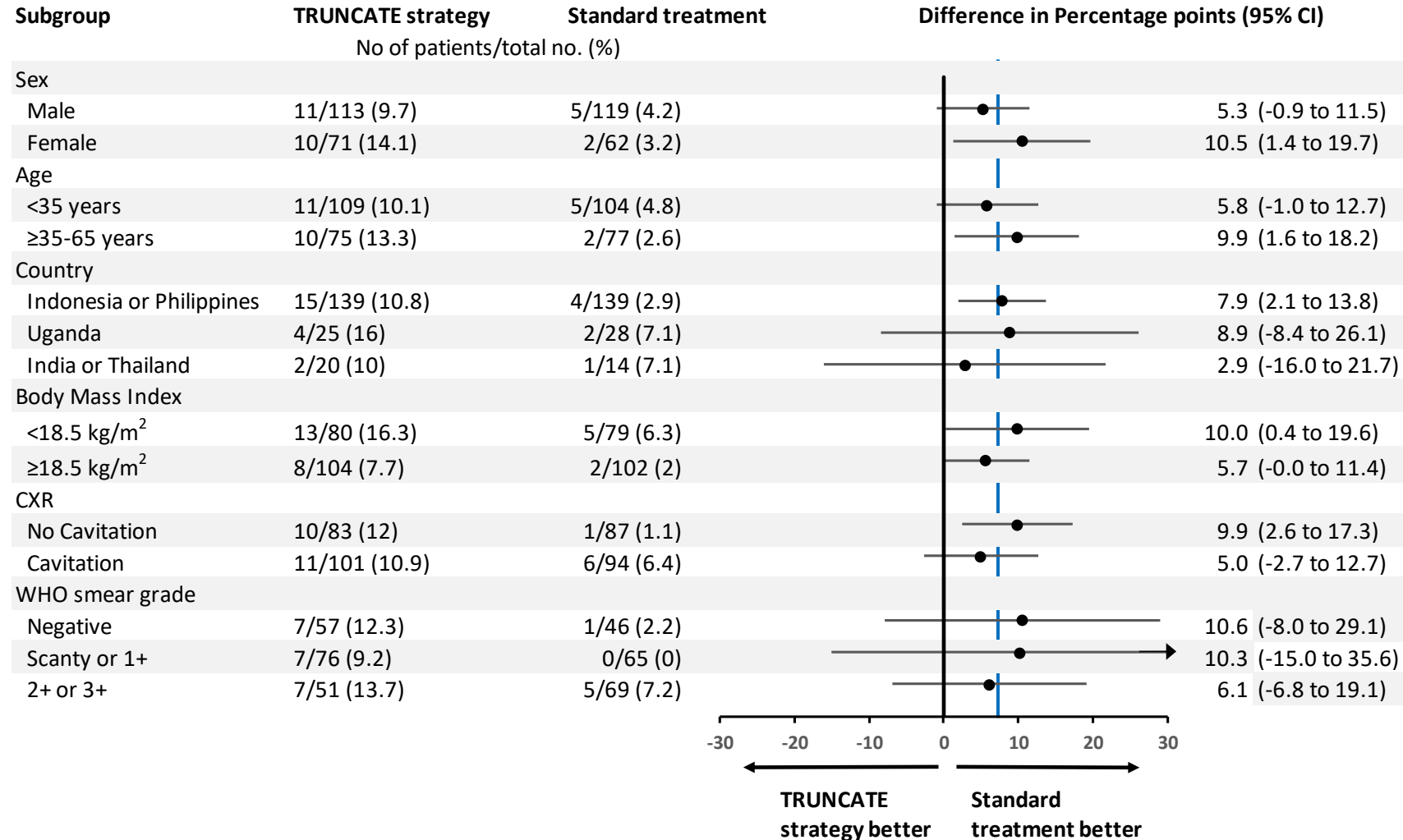
Primary strategy efficacy outcome, hRIF/LZD arm



Outcome	Standard treatment (N= 181)	hRIF/LZD arm (N=184)	Adjusted difference (97.5% CI)
ITT population			
Unsatisfactory outcome – no. (%)	7 (3.9)	21 (11.4)	7.2 (1.7 to 13.2)
Participants with unassessable outcome – no. (%)	1 (0.6)	1 (0.5)	-
Participants with satisfactory outcome – no. (%)	173 (95.6)	162 (88.0)	-
Sensitivity analysis populations			
Assessable population	7/180 (3.9)	21 (11.5)	7.5 (1.7 to 13.2)
Per-protocol population	6/177 (3.4)	17 (10.6)	6.9 (0.9 to 12.8)

NI margin of 12%

Primary strategy efficacy outcome, hRIF/LZD arm



Regimen analysis: unfavourable outcome in hRIF/LZD



	24w Standard Rx (N=181)	8w hRIF/LZD (N=184)	8w BDQ/LZD (N=189)
Unfavourable outcome – no (%)	7 (3.9)	46 (25.0)	26 (13.8)
Treatment failure at switch to standard Rx	0 (0.0)	0 (0.0)	1 (0.5)
Treatment failure at end of treatment	0 (0.0)	0 (0.0)	1 (0.5)
Confirmed relapse	4 (2.2)	39 (21.2)	20 (10.6)
Un-confirmed relapse	0 (0.0)	0 (0.0)	3 (1.6)
Death by W96, possible TB-related cause	2 (1.1)	5 (2.7)	0 (0.0)
Did not attend W96, lacks evidence of cure at last attended visit	1 (0.6)	2 (1.1)	1 (0.5)
Unassessable outcome – no (%)	6 (3.3)	29 (15.8)	16 (8.5)
Adjusted proportion - % (95% BCI)	3.4 (1.3 to 6.3)	23.7 (17.2 to 30.9)	12.5 (7.9 to 18.1)
Probability that proportion difference <12%*	-	0.01	0.85

Selected secondary outcomes – hRIF/LZD



	Standard treatment (N= 181)	hRIF/LZD arm (N=184)	Adjusted difference (95% CI)
Total time on treatment			
Treatment days to week 96	180.2 ± 37.9	105.7 ± 80.1	-74.5 (-87.4 to -61.6)
Safety			
Any grade 3 or 4 adverse event – no. (%)	29 (16.0)	32 (17.4)	1.4 (-6.4 to 9.2)
Any serious adverse event – no. (%)	11 (6.1)	18 (9.8)	3.7 (-2.1 to 9.7)
Death no. (%)	3 (1.7)	5 (2.7)	1.1 (-2.4 to 4.8)
Respiratory disability at W96			
MRC breathlessness scale ≥ 3 – no. (%)	0	2.7 (1.5)	1.5 (-0.5 to 3.5)
FEV1 < 50% of Predicted value	24.3 (13.4)	20.5 (11.1)	-1.1 (-8.7 to 6.4)
Acquired drug resistance			
Acquired drug resistance	0	0	-

Other secondary outcomes

	Standard treatment (N= 181)	hRIF/LZD arm (N=184)	BDQ/LZD arm (N=189)
Quality of life (MOS-HIV)			
Mental health summary score	57.5 ± 0.5	57.5 ± 0.5	57.8 ± 0.5
Physical health summary score	56.7 ± 0.5	56.8 ± 0.5	56.7 ± 5.6
Illness-related missed work or study – days	2.6 ± 9.1	3.3 ± 9.4	3.1 ± 12.9
Body weight			
Change from baseline – kg	5.8 ± 4.8	5.6 ± 4.7	6.1 ± 4.8
Change from baseline - %	11.9 ± 10.0	11.4 ± 9.8	12.1 ± 9.8
Acceptability			
Motivation score	6.2 ± 3.9	8.0 ± 3.0	8.1 ± 2.9
Recommend 2-month regimen (%)	-	72	78
Recommend 6-month regimen (%)	-	20	14
No preference re recommendation (%)	-	9	8
Relapse-associated transmission risk			
Transmission risk period – days	0.5 ± 4.3	2.4 ± 8.3	3.2 ± 14.1
New exposed household contacts – no.	0.01 ± 0.15	0.01 ± 0.10	0.06 ± 0.4

Further work

- Ongoing analyses from the TRUNCATE-TB trial will further enhance our understanding:
 - Safety, efficacy and PK-PD of the regimens tested
 - Strategy implementation and health economics
 - Analysis of biomarkers (standard and new)
- TRUNCATE strategy may be refined in future to improve outcomes using:
 - Alternative drug regimens (short duration, well tolerated)
 - Alternative monitoring approaches (biomarkers to decide Rx cessation; or improve relapse detection)
- Need implementation studies of TRUNCATE strategy in broader populations (especially including HIV+)