

Abordando la vigilancia transnacional de transmisión de tuberculosis

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11 Abril 2019



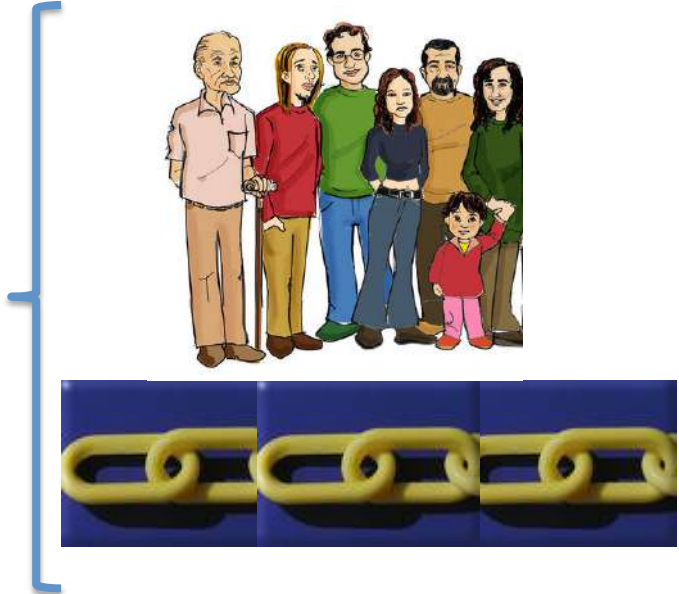
ciberes
Centro de Investigación Biomédica en Red
Enfermedades Respiratorias



Investigación epidemiológica



Estudio de contactos



Epidemiología
Enfermería
Trabajadores sociales
Médicos de familia



Investigación epidemiológica



Alternativa desde el laboratorio

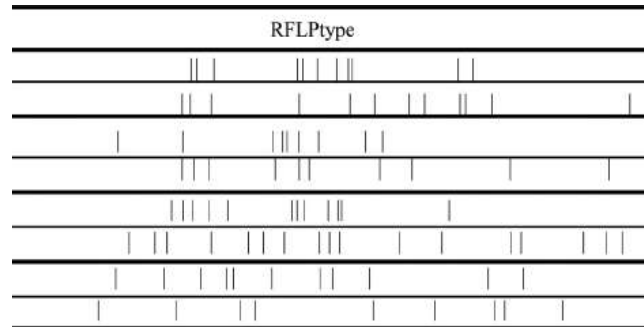


Y tú, malvada....

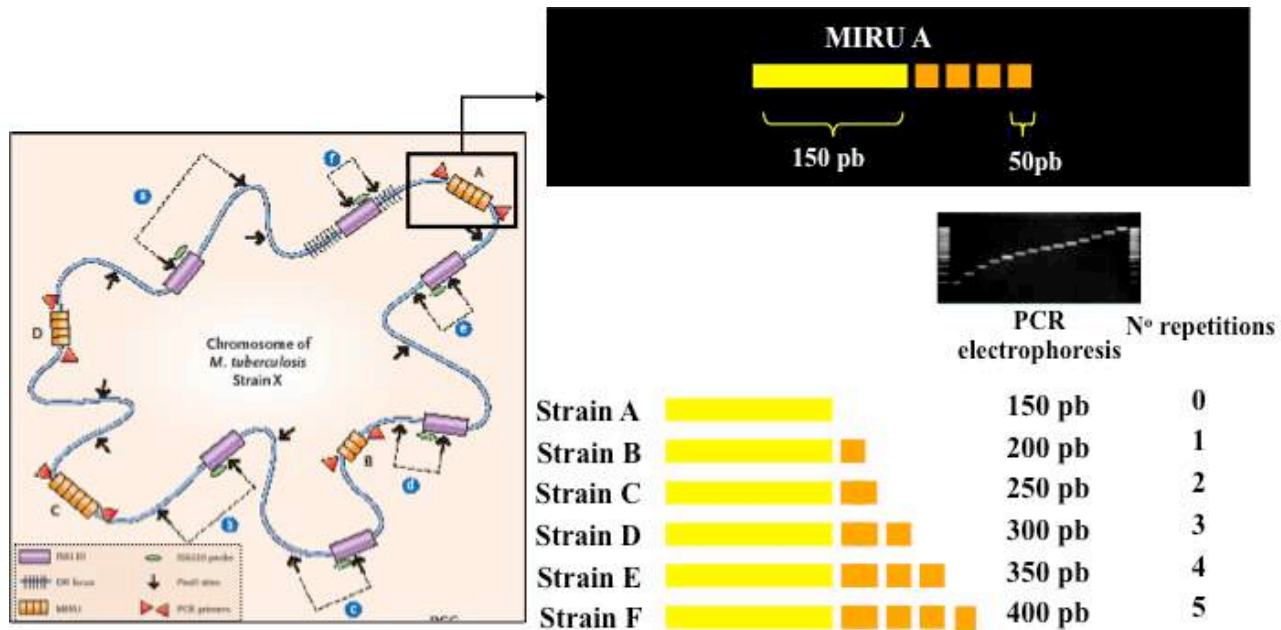
¿A quien has infectado?

Epidemiología molecular

RFLP



MIRU-VNTR (Variable number tandem repeats)



MIRU-type: 246684848883434578741126



Standard Molecular epidemiology

Sistematic universal

Cluster 1



MIRU-VNTR

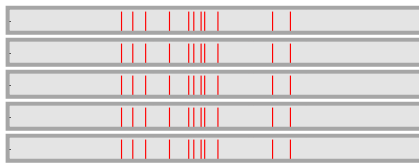
335222759811632
164872295586344
773334992261735
613432392835948
772263739999540
239918883447457
613432392835948

Recent transmission chains

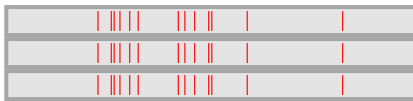


Cluster 2

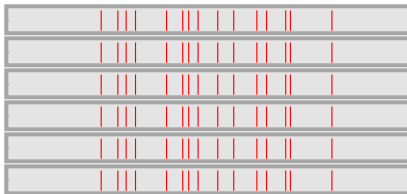
Concordancia entre clusters y vínculos epidemiológicos



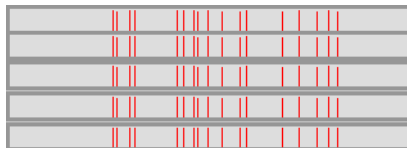
Vinculación



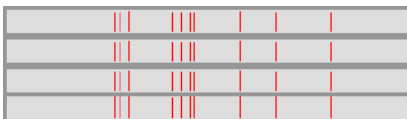
Vinculación



Vinculación



No vinculación



Vinculación

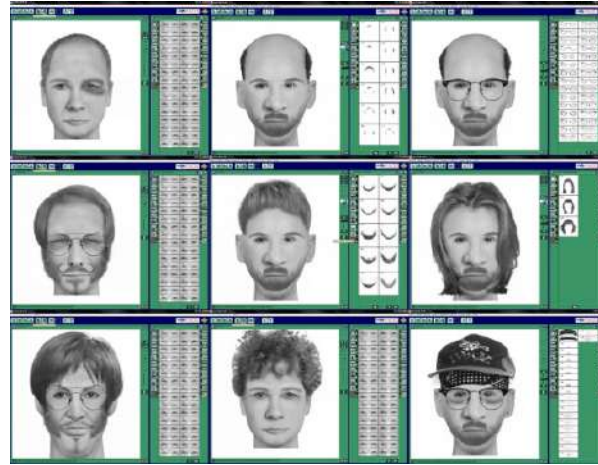


Validación del cluster



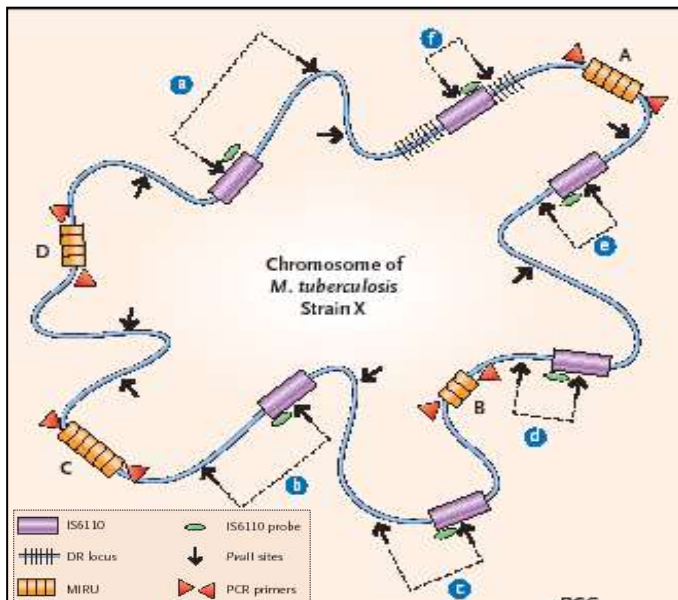
¿Datos epidemiológicos insuficientes?

¿Precisión insuficiente?



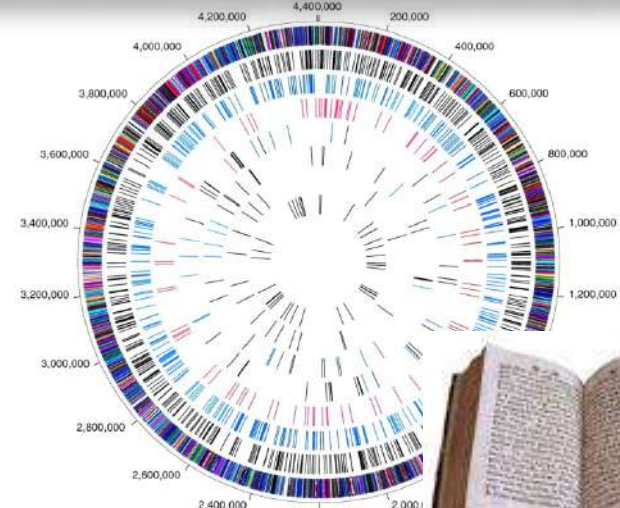
Métodos de genotipado actuales

Secuenciación de Genoma Completo

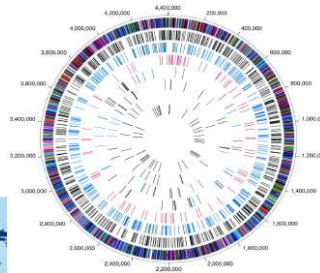


0.03%

4.4Mb



Poder de discriminación máximo

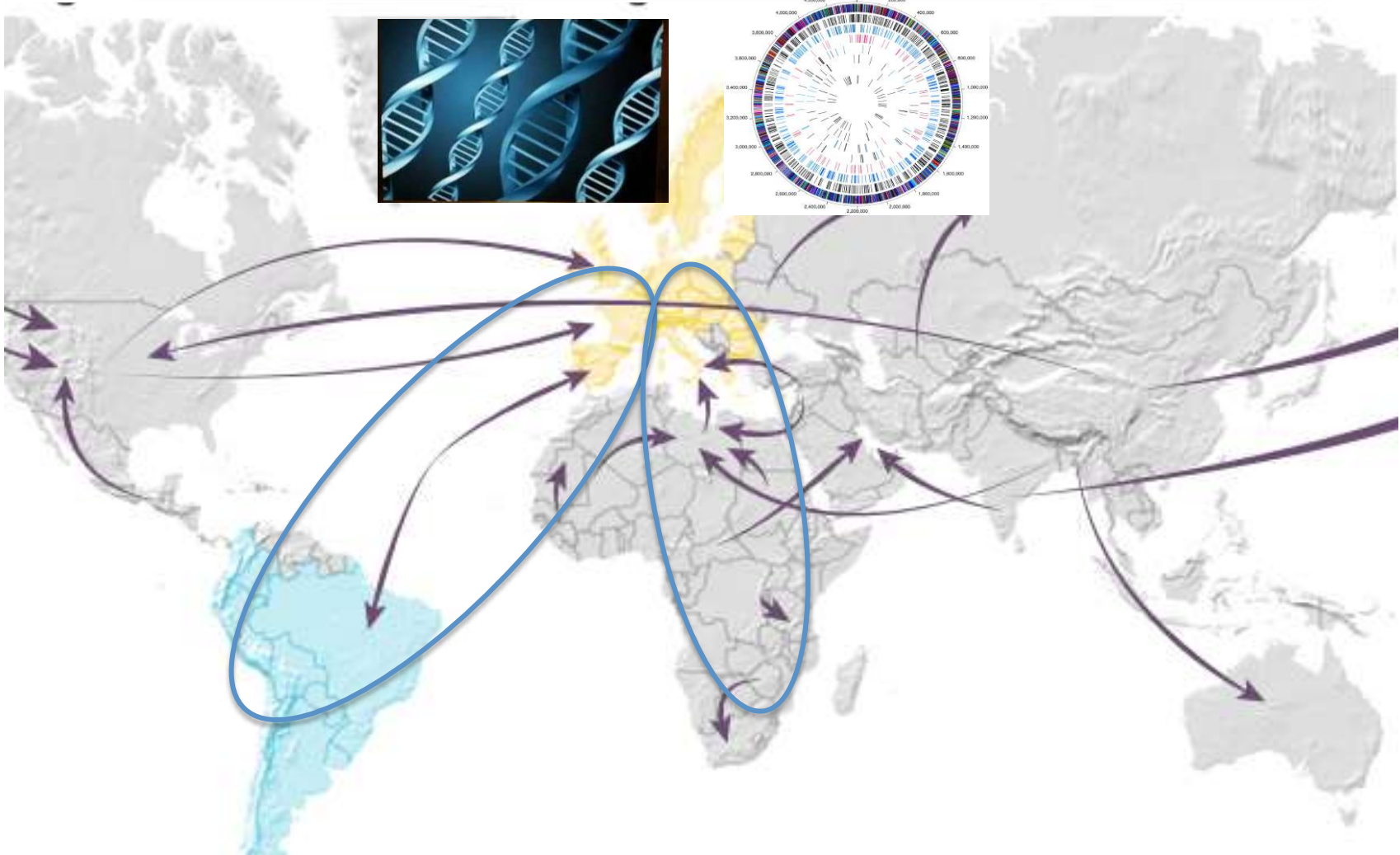


TB is a Global Issue



TB is a Global Issue

Moving on to Surveying complete migratory axis





Project acronym:

TRANS-TB-TRANS

Project full title:

A novel transnational strategy to control high-risk tuberculosis transmission events

Italy



Spain



France



Panama



Peru



Argentina



TB is a Global Issue

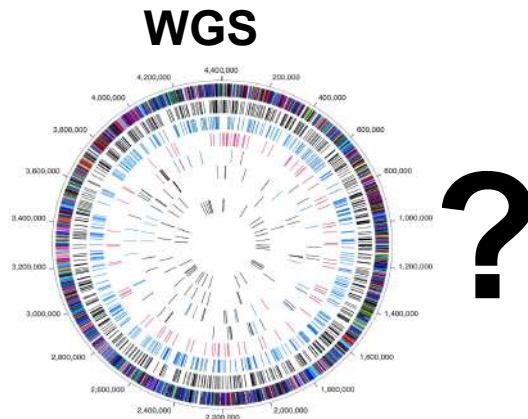
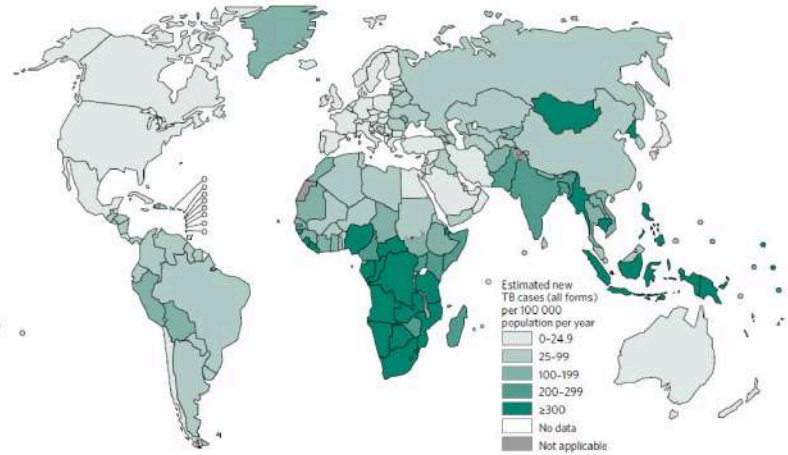


FIG. 3.3
Estimated TB incidence rates, 2015

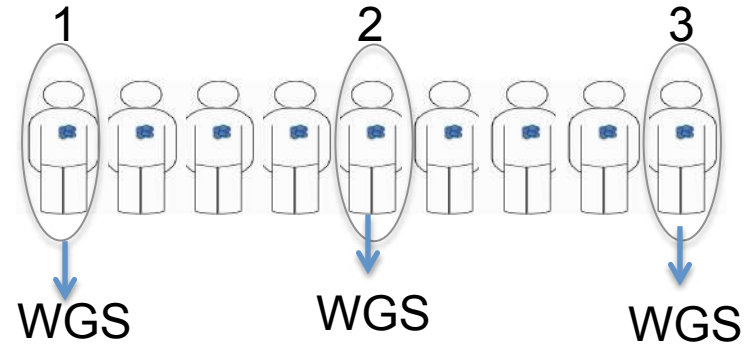
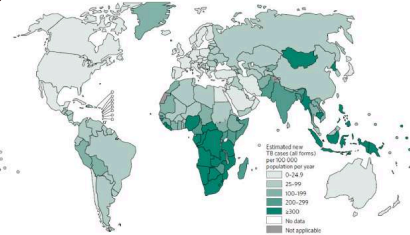
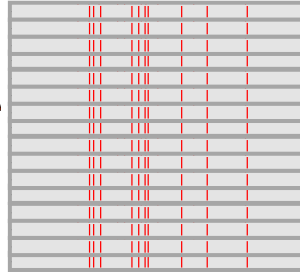


Alternative to survey
TB transmission
based on WGS

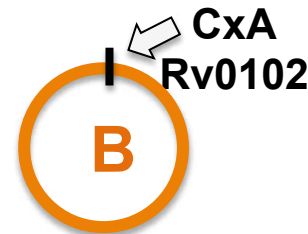
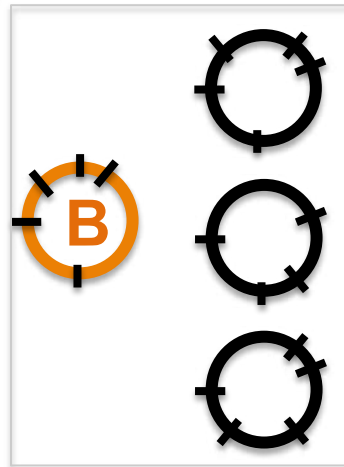
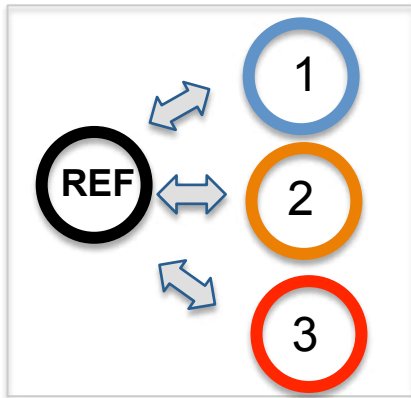


Our proposal

1



2



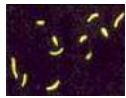
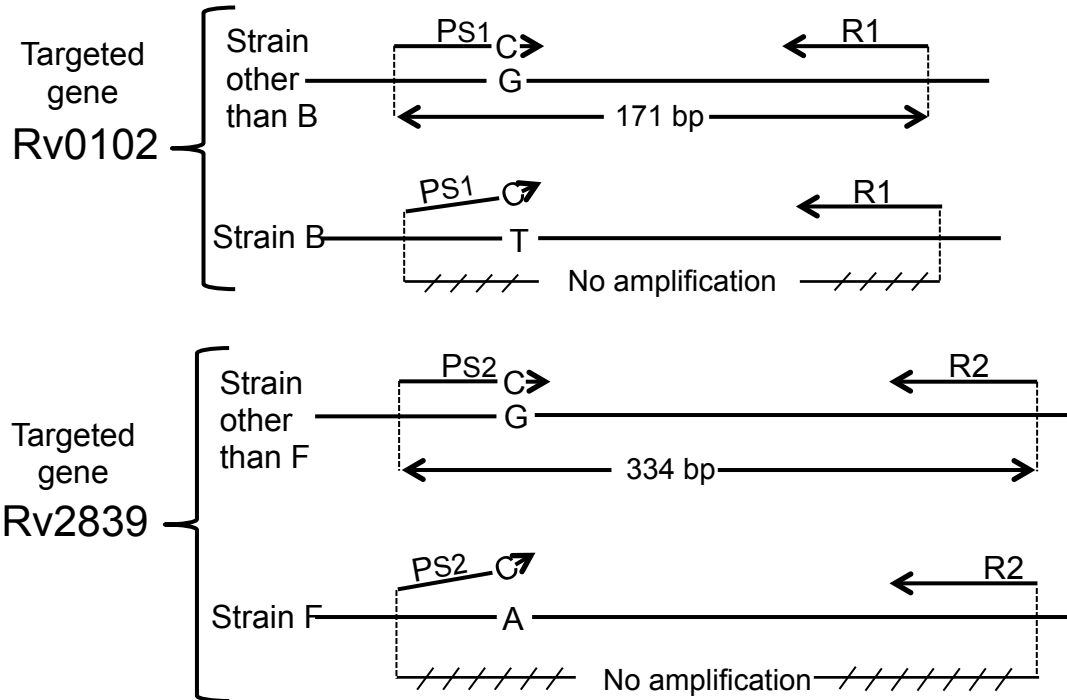
Strain Specific
SNPs

User-friendly approach

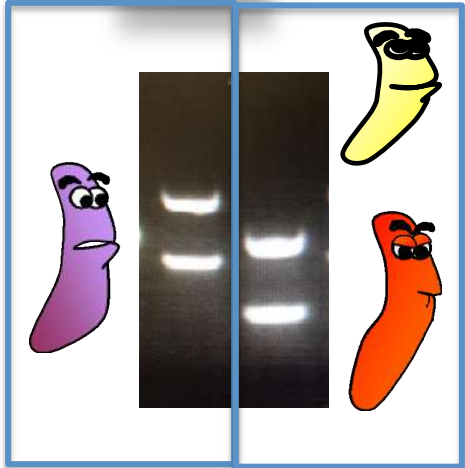
Targeted Regional Allele-specific PCR (TRAP)



Strain-specific PCRs



TRAP



IDENTIFICACIÓN DE CLUSTERS ACTIVOS NO CONTROLADOS

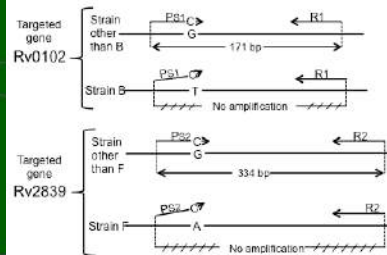
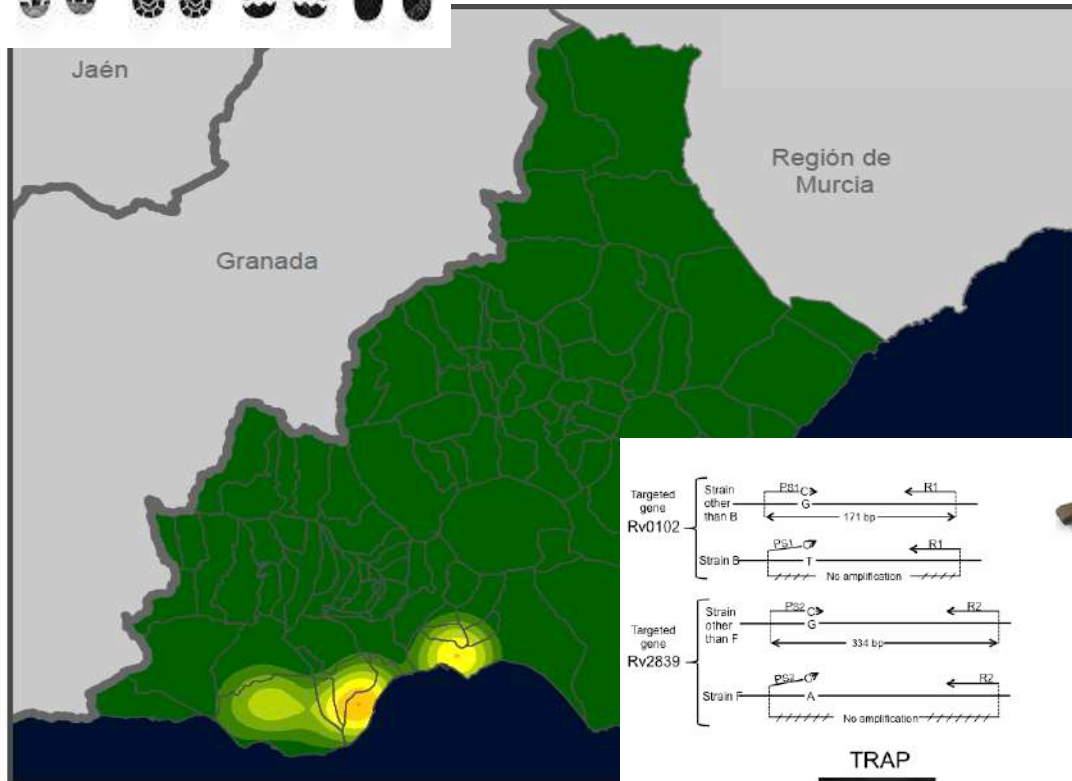


15 años Epidemiología Molecular

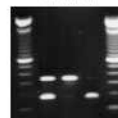


PACIENTE ID	latitud	longit
706	36,846848	-2,43903
166	36,847622	-2,431053
176	36,848117	-2,431711
1027	36,848954	-2,450219
1027	36,849664	-2,452592
291	36,853268	-2,440572
620	36,930058	-2,459445
362	36,998741	-1,891973
601	37,330388	-2,435772
1123	37,331108	-2,304269
1086	37,347682	-2,440023
700	37,354519	-2,297269





TRAP



NoB B F
noF

CLUSTER B

Patient	Year of diagnosis	Origin	Place
1	2003	Spain	Roquetas
2	2005	Spain	Roquetas
3	2005	Spain	Almería
4	2006	Spain	Roquetas
5	2007	Spain	Roquetas
6	2007	Senegal	El Ejido
7	2008	Spain	Roquetas
8	2008	Ghana	Roquetas
9	2008	Nigeria	Roquetas
10	2011	Spain	Roquetas
11	2011	Spain	Roquetas
12	2011	Spain	Roquetas
13	2011	Morocco	Roquetas
14	2011	Spain	Roquetas

CLUSTER F

Patient	Year of diagnosis	Origin	Place
15	2007	Spain	Roquetas
16	2007	Spain	Roquetas
17	2007	Gambia	Vicar
18	2008	Argentina	Huerca-Overa
19	2008	Spain	Roquetas
20	2008	Rumania	Roquetas
21	2012	Spain	Vicar
22	2012	Spain	Roquetas

Moving on to Surveying complete migratory axis



Latin-America/Mediterranean-Europe
Migratory Axis

Project acronym:	TRANS-TB-TRANS
Project full title:	A novel transnational strategy to control high-risk tuberculosis transmission events

Italy



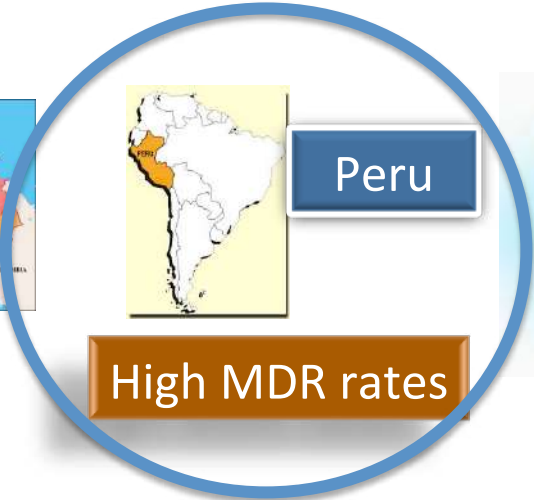
Spain



France



Panama



Argentina

Population selected

Lima

San Juan de Lurigancho



Perú



One of the poorest districts

The highest incidence of TB in the city (193/ 100,000)



<p>MR Piedra Liza</p> <p>C.S Piedra Liza C.S Caja de Agua C.S Chacarilla de Otero P.S Ascarrunz Alto C.S Zárate C.S Mangamarca C.S Campoy P.S Daniel A. Carrión</p>	<p>MR San Fernando</p> <p>C.S San Fernando C.S San Hilarión C.S Santa Rosa C.S La Libertad C.S La Huayrona C.S Santa Fe de Totorita P.S 15 de Enero</p>	<p>MR Ganimedes</p> <p>C.S Ganimedes C.S Huáscar II C.S Huáscar XV P.S Medalla Milagrosa P.S Ayacucho</p>
<p>MR Jaime Zubieta</p> <p>C.S Jaime Zubieta C.S Bayovar C.S Santa María P.S Túpac Amaru II P.S Proyectos Especiales P.S Sagrada Familia</p>	<p>MR Jose Carlos Mariátegui</p> <p>C.S Jose Carlos Mariátegui C.S Cruz de Motupe C.S 10 de Octubre C.S Juan Pablo II P.S Jose Carlos Mariátegui V Etapa P.S Manscal Cáceres P.S César Vallejo</p>	

2014/15

60 MDR isolates

France



Prescreening by TB-SPRINT

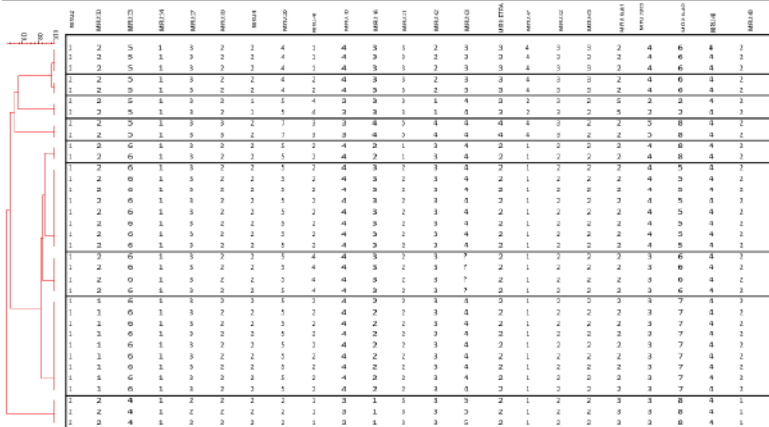
ID	Sex	Age	Country	Genotype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000
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Spain



Confirmation by MIRU-VNTR

Fig. 3. Dendrogram of 24 locus MIRU-VNTR patterns from MDR-TB Isolates (2014-15).



**58% in 8 clusters
(2-9 cases)**



Perú

Italy

High prevalence of clustered tuberculosis cases in Peruvian migrants in Florence, Italy

Lorenzo Zammarchi,¹ Enrico Tortoli,²
 Emanuele Borroni,² Filippo Bartalesi,³
 Marianne Strohmeyer,¹
 Simonetta Baretta,⁴
 Maria Tullia Simonetti,³ Carola Liendo,⁰
 Maria Grazia Santini,⁴
 Gian Maria Rossolini,³ Eduardo Gotuzzo,⁰
 Alessandro Bartoloni,^{1,3}
 COHEMI project study group

Italy



MDR cluster involving 11 Peruvian migrants in Florence

Cluster name	City of isolation	Country of origin	Year of isolation
C8-LPMDR	Florence	Latin America	2007
	Milan	Peru	2009
	Florence	Peru	2010
	Milan	Latin America	2011
	Florence	Latin America	2012
	Florence	Italia	2013
	Florence	Albania	2013
	Florence	Peru	2013
	Florence	Latin America	2014
	Florence	Latin America	2014
	Florence	Peru	2016

MIRU-VNTR: 134224242224126153312822

Integrated analysis Peru-Italy

MIRU-VNTR: 134224242224126153312822



Perú



Italy

Integrated analysis Peru-Italy

MIRU-VNTR: 134224242224126153312822



Perú

134224242224126153312822

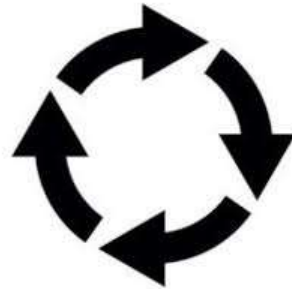
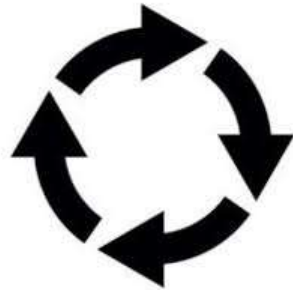
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134224242224126153312822

134224242224126153312822



Italy



134224242224126153312822

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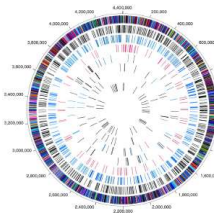
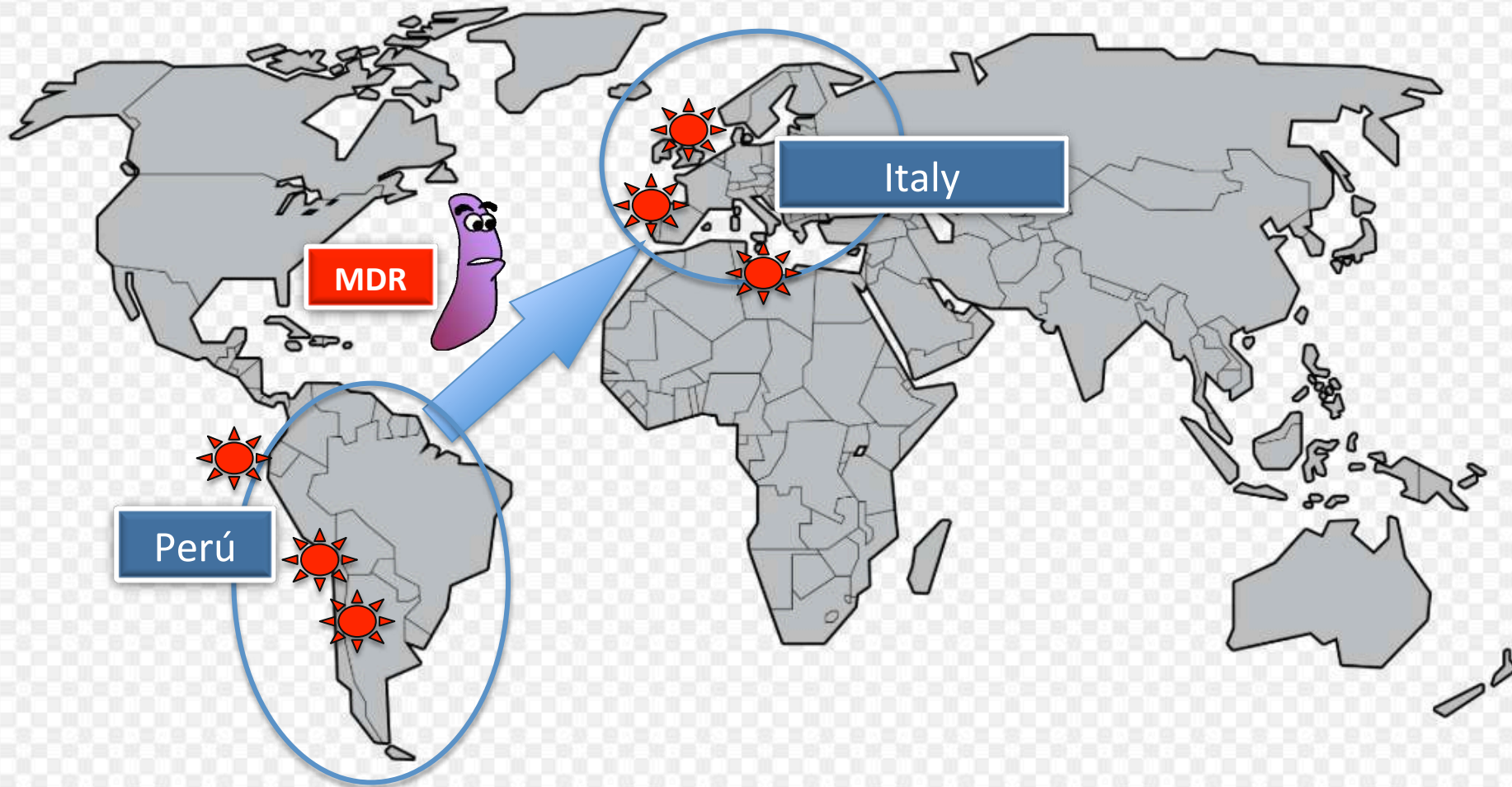
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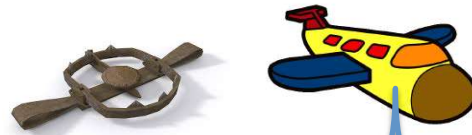
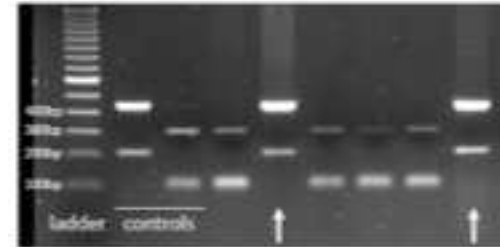
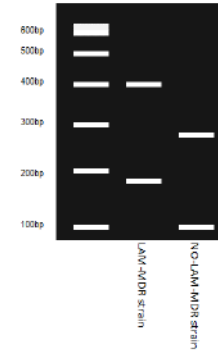
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Short-cut

SHARED strain-specific test

Primer name	Sequence (5'---3')	PCR product size (pb)	PCR product in:
Rv2386Fm	CGACGGAGTGGTGATCACT	400	LAM-MDR strain
Rv2386R	CATCCGCCGAAAGCATCAC		
Rv3631F	ACTGCACCGGGCGTATTC	280	NO-LAM-MDR strain
Rv3631Rw	GCTTCGTTGAAGGCGGGA		
Rv1617Fm	GGGACGACCTGGTCAGC	189	LAM-MDR strain
Rv1617R	AGGCGAAGCGTCCCAAC		
Rv3579Fw	ATACGTCGCCCTTGGTACC	99	NO-LAM-MDR strain
Rv3579R	TCGGCACGTAGCAGCTC		



Italy

Spain

Peru

Argentina

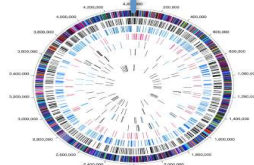


2 CASES

1 CASE

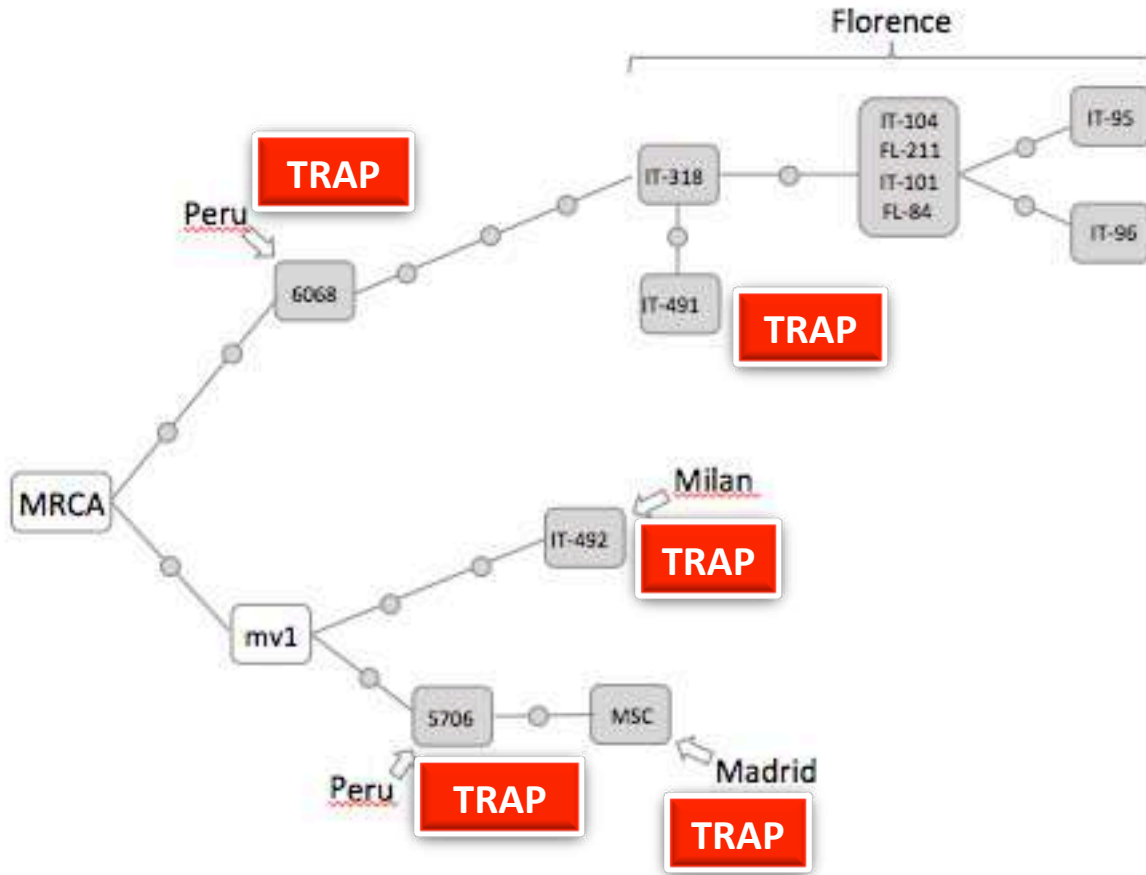
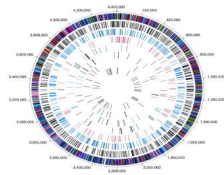
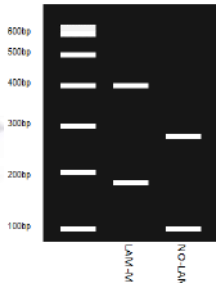
2 CASES

0 CASES

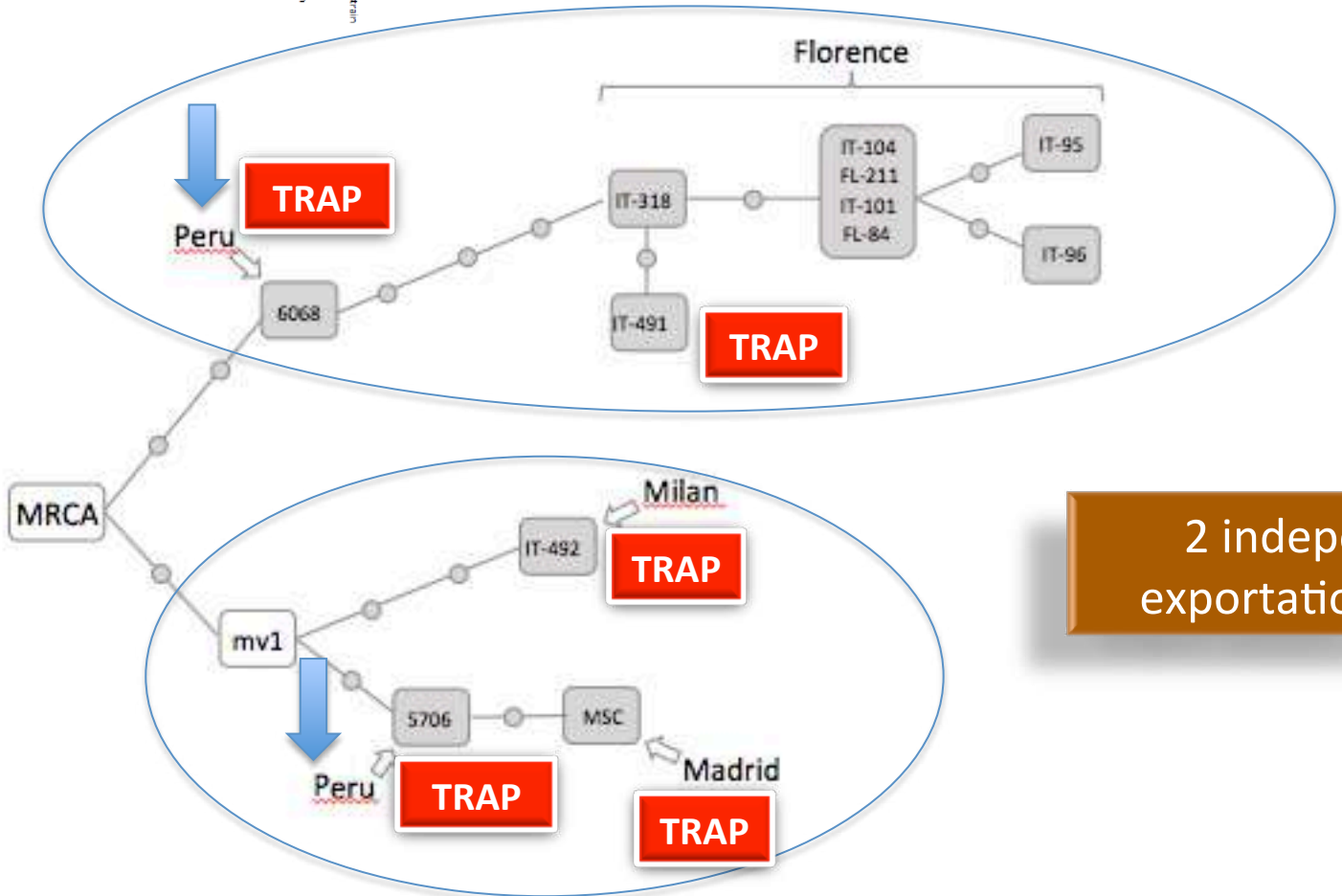
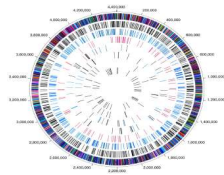
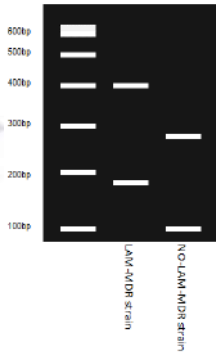


designed by freepik.com

TRAP

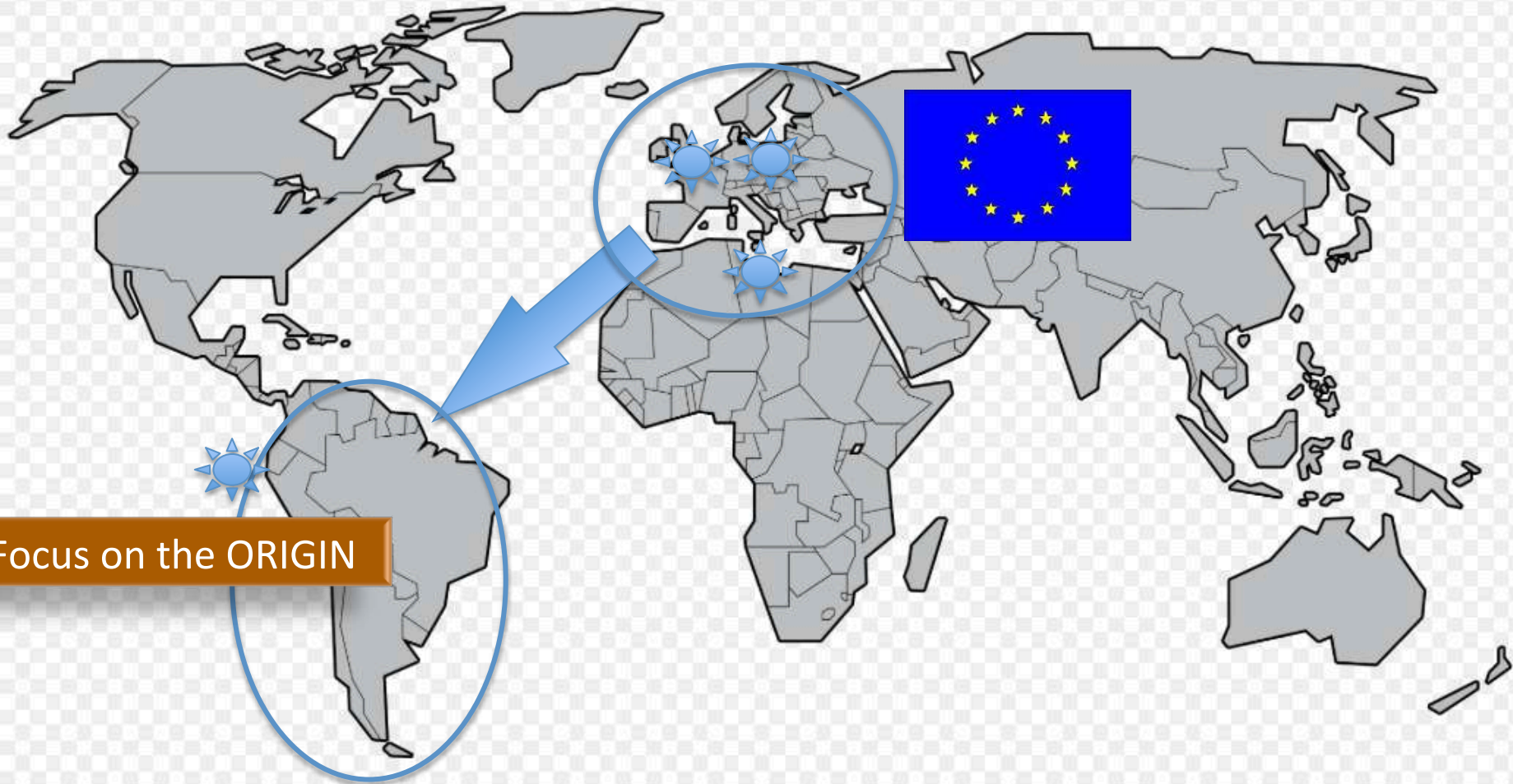


TRAP



2 independent exportation events

Focus on the origin



Focus on the ORIGIN

Peru



San Juan de Lurigancho

Focus on the ORIGIN

Short-cut



El Callao
prison

Penal de Lurigancho, Av. ...
 Sarita Colonia, Callao 070
 Añadir destino

Salir ahora OPCIONES

Enviar indicaciones a tu teléfono

por Auxiliar Panamericana Nte./Panamericana Nte./Carretera 1N 38 min 23,7 km
 La ruta más rápida debido al estado del tráfico
 ⚠ Esta ruta incluye algún peaje.
 DETALLES

por Auxiliar Panamericana Nte./Panamericana Nte./Carretera 1N y Av. Perú 39 min 24,5 km

San Juan de Lurigancho
 Penal de Lurigancho
 Plaza Mayor de Lima
 38 min 23,7 km
 39 min 24,5 km
 41 min 25,3 km

San Juan de Lurigancho prison



San Juan de Lurigancho
prison

Prison agreement Peru-Spain

Spain



Peru



2016

Prevalent strain

Spain



MDR-TB



335222759811632833114625

El Callao
prison

2017

335222759811632833114625

MDR-TB



335222759811632833114625

2018

MDR-TB



2005

El Callao
prison



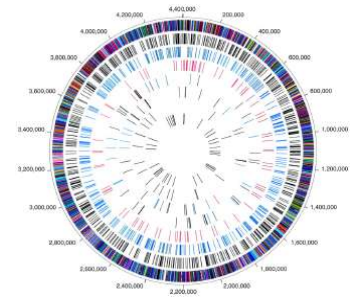
Moving on to Surveying complete migratory axis

Latin-America/Mediterranean-Europe Migratory Axis





shutterstock.com • 1303914586



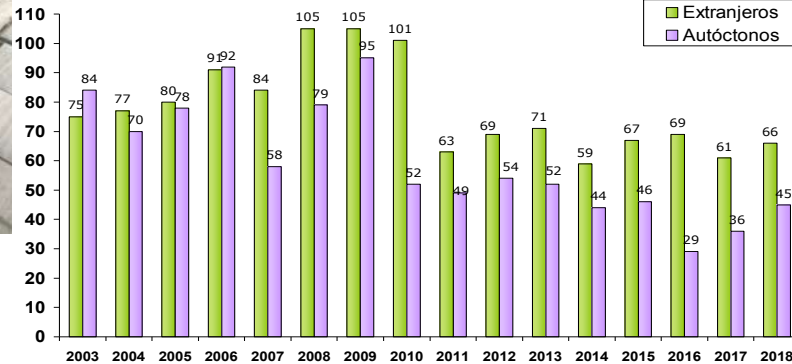
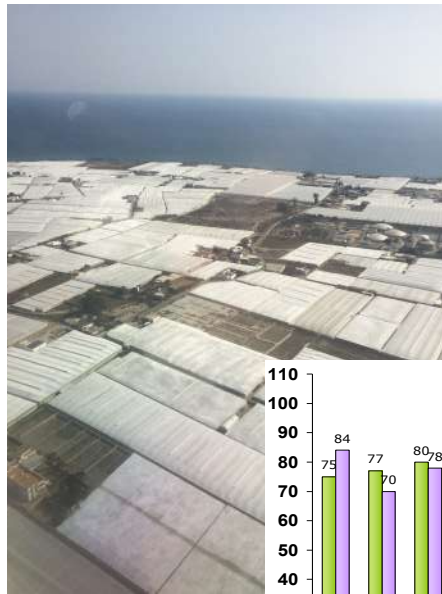
Identifying failures

STANDARD SURVEILLANCE



REFINED SURVEILLANCE PROGRAM

Refined TB surveillance program 2019-21



Migrants
Autochtho
nous

Refined TB surveillance program 2019-21

Identifying failures

Filling gaps

1

Integrating epidemiologist and molecular biologists

Epidemiologist

Notes

1. primer círculo
Contacto de alto riesgo:
día: > 6 horas.
2. segundo círculo
Contacto frecuente:
día: < 6 horas.
3. tercer círculo
Contacto esporádico:
no día.

Controles médicos
Vivienda
Trabajo/escuela

El primer círculo incluye a:
- Contactos convivientes
- Contactos frecuentes en convivencias (escuelas, laboratorios, clubes, compañeros del municipio, etc.), círculo íntimo de amigos.
- Contactos esporádicos en actividades como: residencia de ancianos, peticiones, congresos, cuarentas, etc.



Refined TB surveillance program 2019-21



Servicio Andaluz de Salud
CONSEJERÍA DE SALUD

Hospital de Poniente
UGC LABORATORIOS CLÍNICOS
Área Lab. Clínicos Provinciales - Almería

Paciente: _____

Centro: 2 HOSP. EL EJIDO	NUHSA: AN1340491914	
Servicio: PON - Urgencias	Sexo: M	Nacido el: 27/01/1993
Doctor: JIMENEZ PORTILLO, GUILLERMO	Hab/Cama:	
Diagnóstico: DIAGNÓSTICO	Fecha solicitud: 9/11/18	20:48:59
	Fecha recepción: 9/11/18	21:36:56
	Fecha entrega: 11/11/18	14:54:23

Comentarios: _____

Copia de Laboratorio

LABORATORIO MICROBIOLOGÍA

MICROBIOLOGÍA (Cultivo y microscopía)

Cultivo esputo

Tinción de Gram	>25 leucocitos/campo x 100 y >10 células epiteliales/campo x 100	ICB
Cultivo general Informe Final	Desarrollo de microbiota regional	

Espeto 1 : Micobacterias

Baciloscopia muestra no concentrada (T. de auramina)	<1 BAAR/campo (100x)	MPG
Baciloscopia concentrada (T. de auramina)	>100 BAAR/campo (100x) muestra concentrada	MML
Genotipo (MIRU-24)	genotipo en cluster (N:8)	MML

Caso 2463
Red Alerta 939612
Cluster 493-1 (N:8)
MIRU15: 2 5 3 4 2 3 2 3 2 4 3 3 3 3 7
MIRU24: 2 1 3 1 3 2 2 5 3 4 2 3 2 3 2 4 3 3 3 3 7 2 2 3
M15: 19067 M 36 Marruecos 2006 El Ejido-Las Norias
M15: 25183 M 44 Marruecos 2006 El Ejido-Las Norias
M15: 22082 M 25 Marruecos 2006 El Ejido-Las Norias
M24: 910261 M 57 Guinea Ec. 2017 La Mojonera
M24: 915745 M 23 Marruecos 2017 El Ejido-S M del Águila
M24: 928993 M 49 España 2018 Roquetas De Mar
M24: 937373 M 26 Mauritania 2018 Roquetas De Mar
M24: 939612 M 25 Marruecos 2018 Vicar-Ganpo

Cultivo de Micobacterias
Informe Parcial

PEND



Refined TB surveillance program 2019-21

2

Filling gaps



Speed in cluster identification
to allow intervention

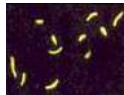
Refined TB surveillance program 2019-21

2

Filling gaps



Speed in cluster identification to allow intervention




Servicio Andaluz de Salud
CONSEJERÍA DE SALUD

UGC LABORATORIOS CLÍNICOS
Área Lab. Clínicos Provinciales - Almería

Paciente: _____
 Centro: _____
 Servicio: PDN - Urgencias
 Doctor: JIMENEZ PORTILLO, GUILLERMO
 Diagnóstico: DIAGNÓSTICO

Sexo: M Nació el: 27/01/1993
 Hab/Carnia: _____
 Fecha solicitud: 9/11/18 20:48:59
 Fecha recepción: 9/11/18 21:36:56
 Fecha entrega: 11/11/18 14:54:23

Comentarios: _____

Copia de Laboratorio

LABORATORIO MICROBIOLOGÍA

MICROBIOLOGÍA (Cultivo y microscopía)

Cultivo esputo

Tinción de Gram >25 leucocitos/campo x 100 y >10 células epiteliales/campo x 100 ICB

Cultivo general Informe Final Desarrollo de microbiota regional

Esputo 1 : Micobacterias

Baciloscopia muestra no concentrada (T. de auramina) <1 BAAR/campo (100x) MPG

Baciloscopia concentrada (T. de auramina) >100 BAAR/c (200x) muestra concentrada MML

Genotipo (MIRU-24) Genotipo en cluster (N:8) MML

Caso 2463
 Red Alerta 939612
 Cluster 493-1 (N:8)
 MIRU15: 2 5 3 4 2 3 2 3 2 4 3 3 3 3 7
 MIRU24: 2 1 3 1 3 2 2 5 3 4 2 3 2 4 3 3 3 3 7 2 2 3
 M15 19067 M 38 Marruecos 2006 El Ejido-Las Norias
 M15 25183 M 44 Marruecos 2006 El Ejido-Las Norias
 M15 22082 M 25 Marruecos 2006 El Ejido-Las Norias
 M24 910261 M 57 Guinea Ec. 2017 La Mojonera
 M24 915745 M 23 Marruecos 2017 El Ejido-S M del Águila
 M24 928993 M 49 España 2018 Roquetas De Mar
 M24 937373 M 26 Mauritania 2018 Roquetas De Mar
 M24 939612 M 25 Marruecos 2018 Vícar, Almería

Cultivo de Micobacterias Informe Parcial PEND



Real-Time Molecular Epidemiology of Tuberculosis by Direct Genotyping of Smear-Positive Clinical Specimens

María Alonso,^{a,b,c} Marta Herranz,^{a,b,c} Miguel Martínez Lirola^d on behalf of the INDAL-TB Group, Milagros González-Rivera,^{b,e} Emilio Bouza,^{a,b,c} and Darío García de Viedma^{a,b,c}

Real-time epidemiology

Refined TB surveillance program 2019-21

3

Filling gaps

Precision in cluster determination



Refined TB surveillance program 2019-21

3

Filling gaps

Precision in cluster determination

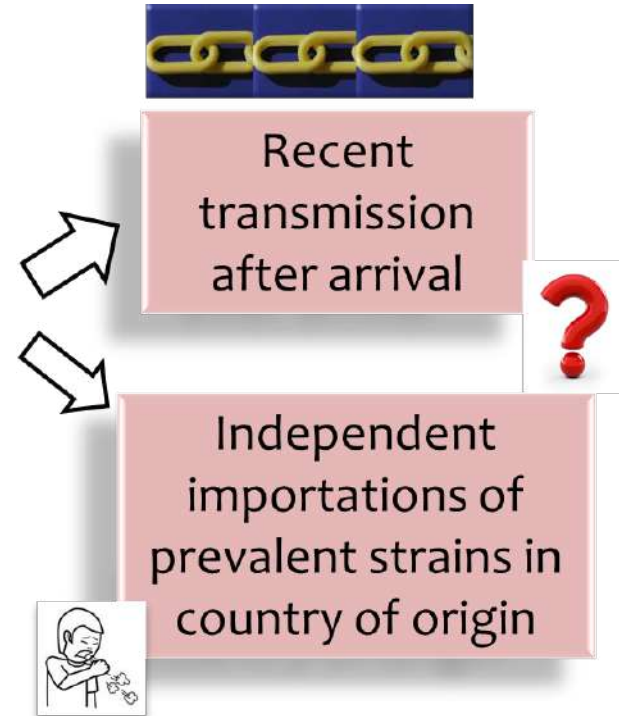


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Lack of precision

Identical VNTRs

Year	Country
2007	Morocco
2010	Morocco
2011	Morocco
2011	Morocco
2014	Morocco
2015	Morocco



Clusters enriched in migrants of a specific country

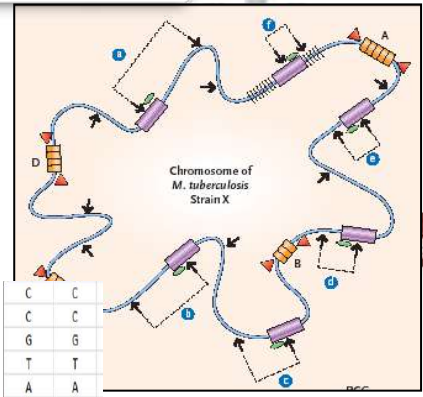
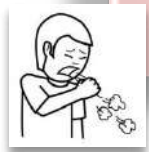
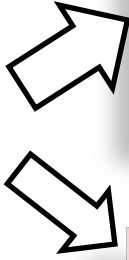
Identical VNTRs

Year	Country
2007	Morocco
2010	Morocco
2011	Morocco
2011	Morocco
2014	Morocco
2015	Morocco



Recent transmission after arrival

Independent importations of prevalent strains in country of origin



C	C
C	C
G	G
T	T
A	A
C	C
C	C
C	C
C	C
C	C
C	C
A	C
T	T
A	A
G	G
T	T
A	A
T	T
C	C
A	A
C	C
T	T
C	C
C	C
G	G
T	T
C	C
A	A
C	C
T	T
A	A
G	G
T	T
C	C
A	A
C	C
T	T
C	C
C	C
T	T
C	C
C	C

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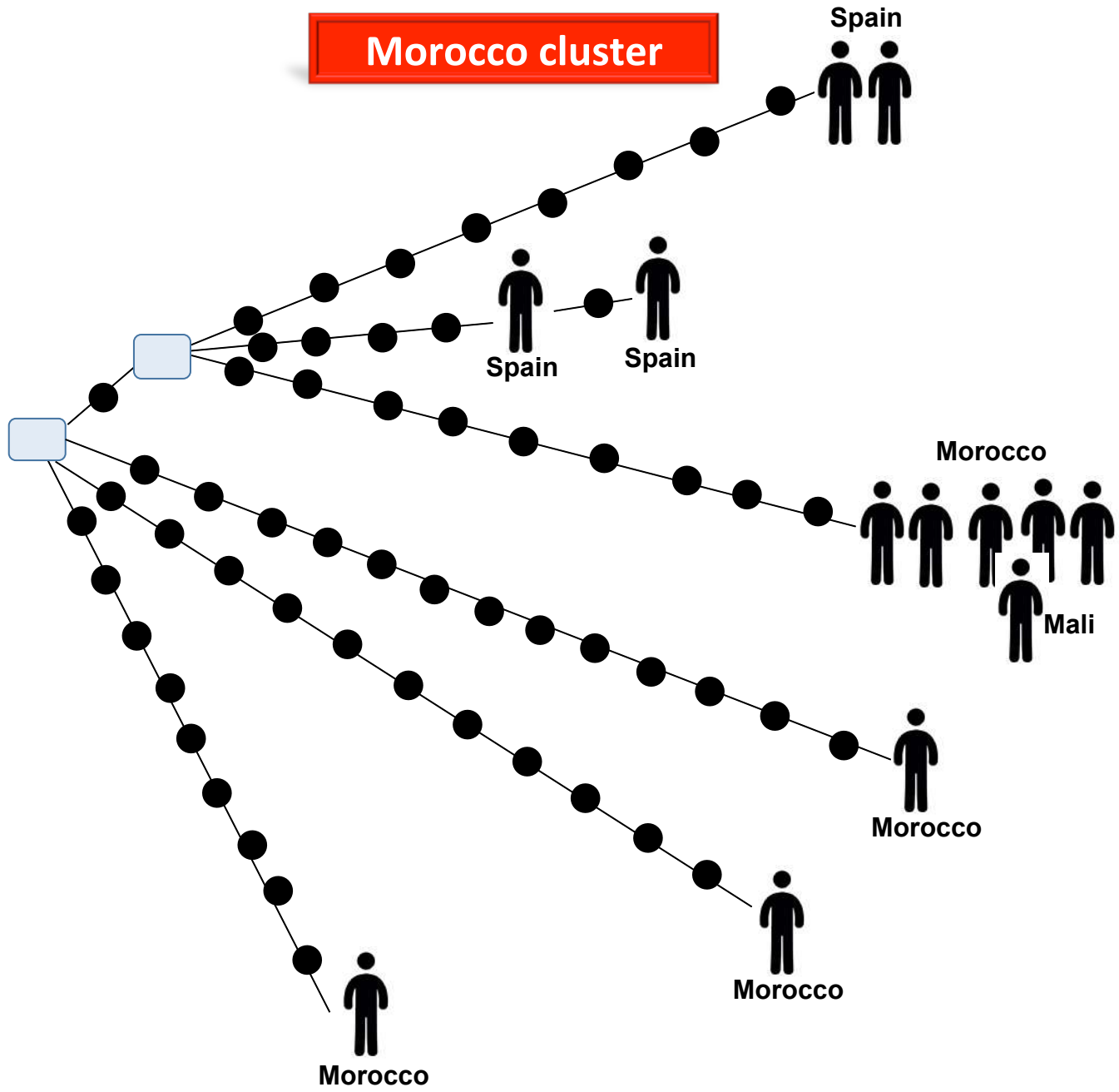
C	A		
C	T		
G	G		
T	T		
C	G		
A	G		
G	C		
C	C		
C	G		
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2244533932	C	G	32228229
2244533932	T	A	32228229
2244533932	A	A	32228229
G	G		
T	C		
C	A		
T	A		
C	T		
A	C		
C	C		
T	G		
T	C		
C	G		
C	T		



Year	Country
2003	Morocco
2004	Morocco
2007	Spain
2007	Spain
2010	Morocco
2011	Morocco
2014	Morocco
2014	Mali
2015	Spain
2015	Spain
2015	Morocco
2015	Morocco
2015	Morocco
2016	Morocco
2016	Morocco

Cluster 113

Identical VNTRs

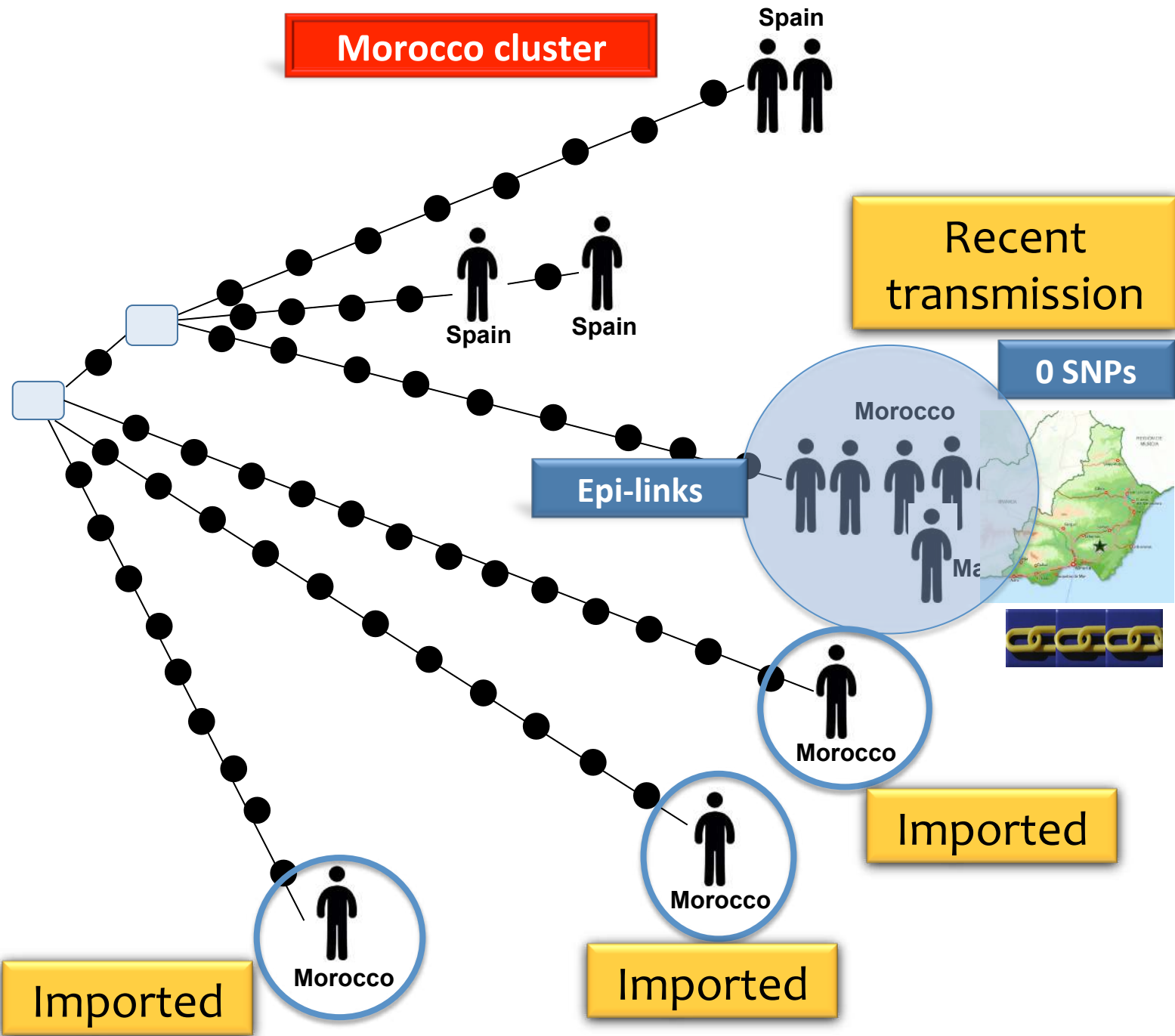


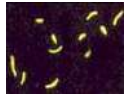


Year	Country
2003	Morocco
2004	Morocco
2007	Spain
2007	Spain
2010	Morocco
2011	Morocco
2014	Morocco
2014	Mali
2015	Spain
2015	Spain
2015	Morocco
2015	Morocco
2015	Morocco
2016	Morocco
2016	Morocco

Cluster 113

Identical VNTRs





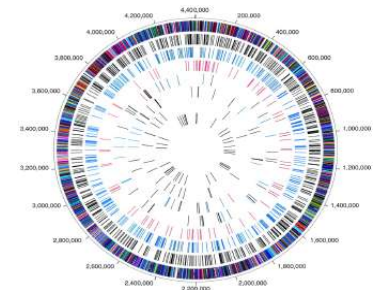
VNTR

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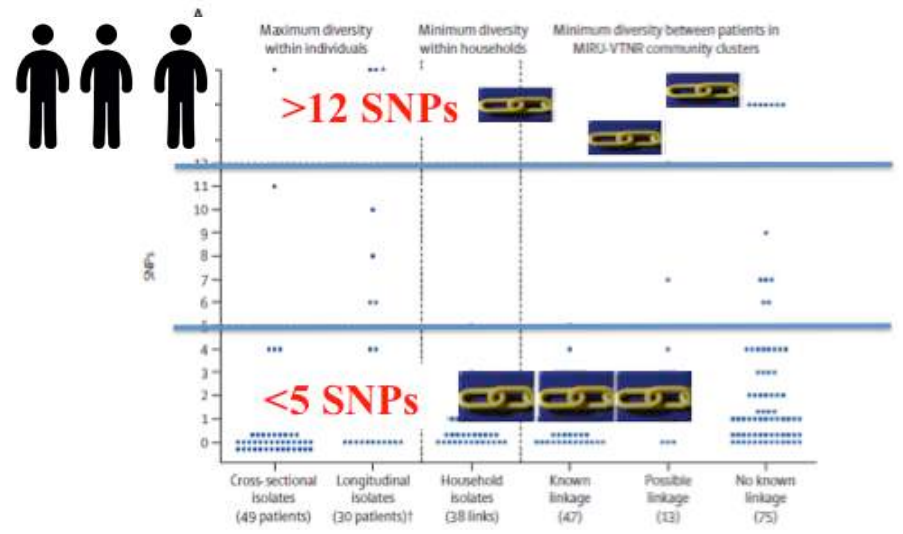


Year	Country
2018	Morocco
2018	Morocco
2019	Morocco

**NO
Epi-link**



Whole Genome Sequencing



**NO link
ACCEPTED
(No recent
transmission)**

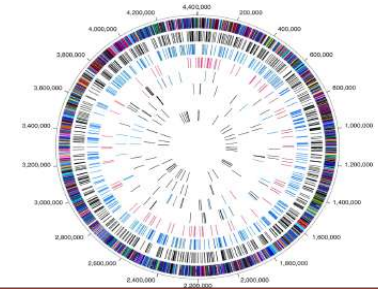
VNTR

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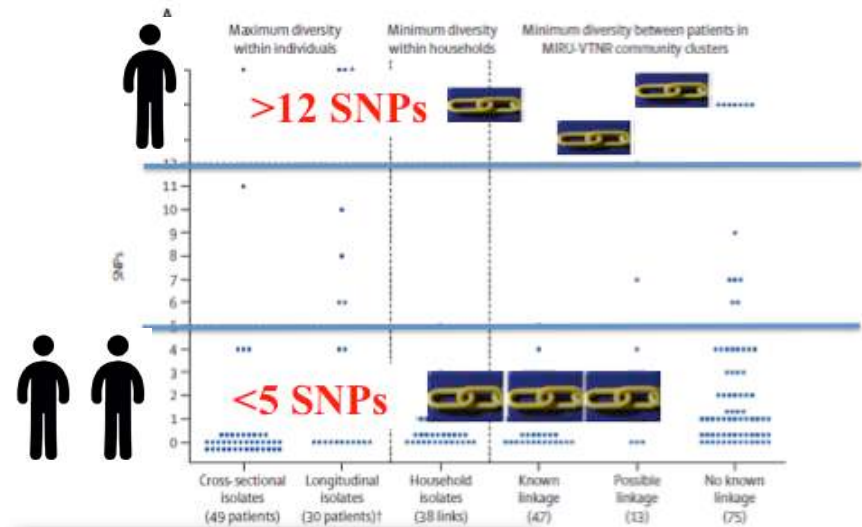


Year	Country
2018	Morocco
2018	Morocco
2019	Morocco

NO
Epi-link



Whole Genome Sequencing



Epi-link MUST exist

Refined epidemiological survey



Standardized interviews of the clustered cases without epidemiological links



Ospina et al. *BMC Public Health* 2012, **12**:158
<http://www.biomedcentral.com/1471-2458/12/158>



RESEARCH ARTICLE

Open Access

Community health workers improve contact tracing among immigrants with tuberculosis in Barcelona

Jesús Edison Ospina^{1,2*}, Àngels Orcau^{1,3}, Juan-Pablo Millet^{1,2,3}, Francesca Sánchez⁴, Martí Casals^{1,3,5,6} and Joan A Caylà^{1,3}



Optimizando la investigación epidemiológica

<i>RFLP Cluster</i>	<i>RFLP Type</i>	<i>Type of cluster</i>	<i>Countries of origin (No. of cases)</i>	<i>SEI</i>	<i>GenContactTB interview</i>	<i>Epidemiologic links</i>
029		Immigrant	Morocco (3), Romania (1)	No	Yes	Alcohol abuse, Sporadic sharing of housing
005		Immigrant	Morocco (6)	No	Yes	Drug abuse: hashish
280		Immigrant	Morocco (6)	No	Yes	Sporadic sharing of housing
028		Mixed	Morocco (2), Spain (4) Ecuador (1)	No	No	Unknown
074		Mixed	Romania (3), Spain (2) Mali (1)	No	Yes	Bar, Gymnasium
217		Mixed	Romania (3), Spain (2), Bolivia (1)	No	Yes	Sporadic sharing of housing
099		Mixed	Spain (4), Ghana (1)	No	Yes	Home, Health-care centre
015		Mixed	Spain (3), Ukraine (1)	No	Yes	Friends, Drug abuse: hashish
069		Mixed	Morocco (3), Spain (1)	No	Yes	Neighbour, Sporadic sharing of housing
006		Autochthonous	Spain (5)	Yes	Yes	Family
044		Autochthonous	Spain (4)	Yes	Yes	Family
281		Autochthonous	Spain (4)	No	No	Unknown

Advanced Survey of Tuberculosis Transmission in a Complex Socioepidemiologic Scenario with a High Proportion of Cases in Immigrants

Miguel Martínez-Lirola,³ Noelia Alonso-Rodríguez,^{1,2} M. Luisa Sánchez,⁵ Marta Herranz,^{1,2} Sandra Andrés,^{1,2} Teresa Peñafiel,⁵ M. Cruz Rogado,⁴ Teresa Cabezas,⁴ Juan Martínez,⁵ M. Ángeles Lucerna,⁴ Manuel Rodríguez,⁷ Magdalena del Carmen Bonillo,⁵ Emilio Bouza,^{1,2} and Darío García de Viedma^{1,2}

Advanced global surveillance of TB transmission 2019-21

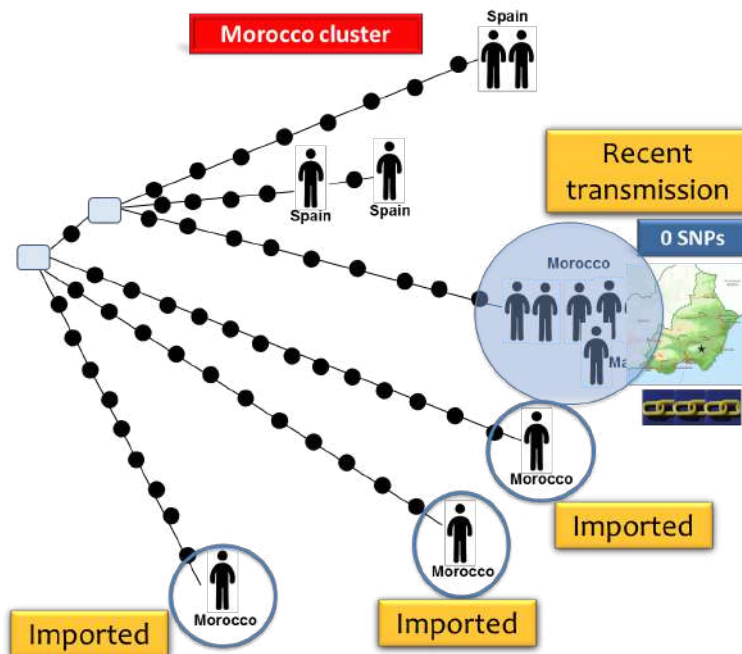
4

Filling gaps

Transborder analysis



Almería

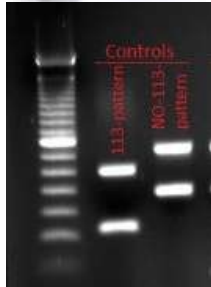


Strain 113 Circulating in Morocco

TRAP



Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN)



designed by freepik.com

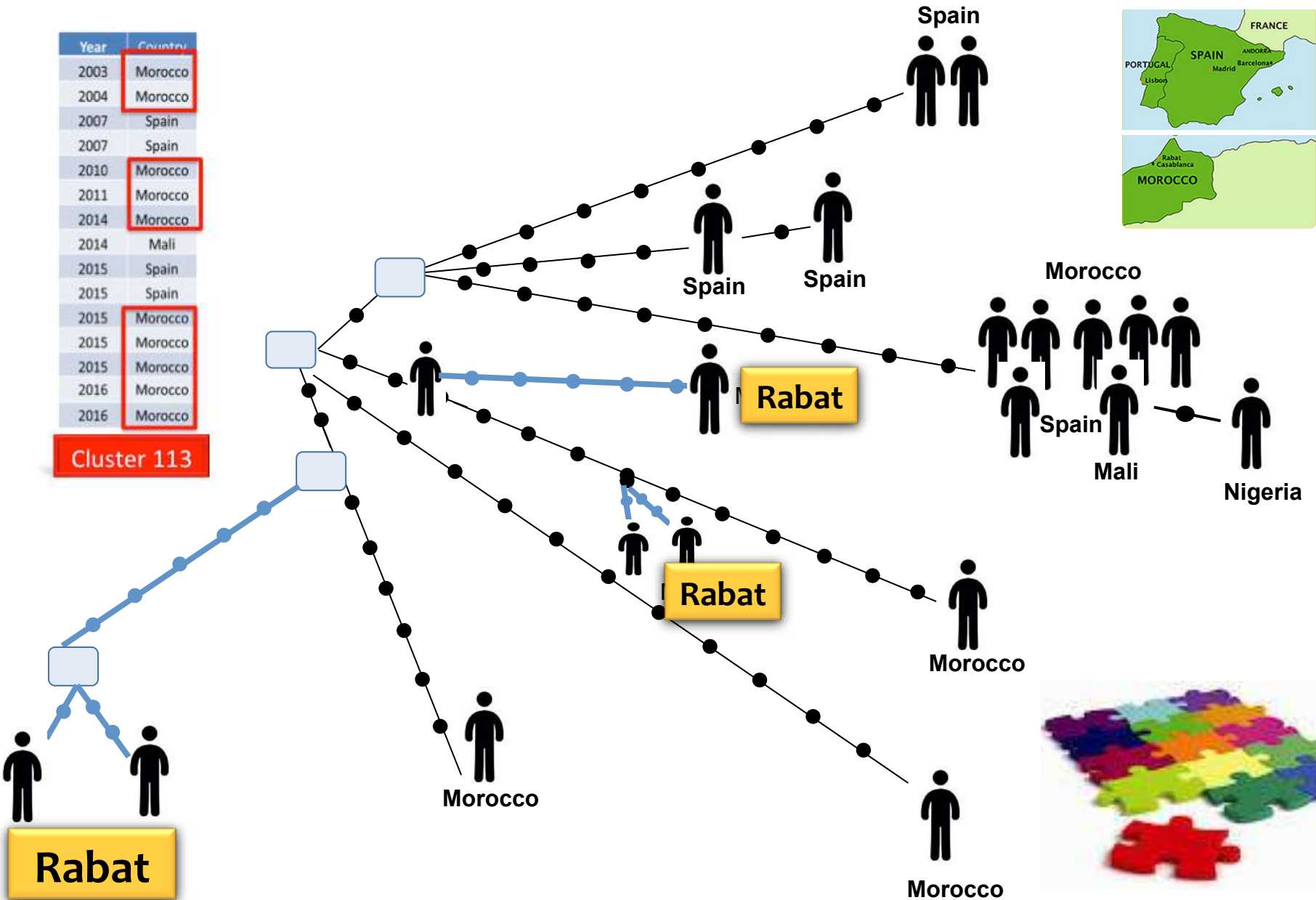
110 isolates analyzed

11 positive cases

Advanced global surveillance of TB transmission 2019-21

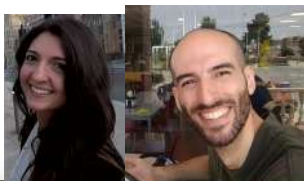
Year	Country
2003	Morocco
2004	Morocco
2007	Spain
2007	Spain
2010	Morocco
2011	Morocco
2014	Morocco
2014	Mali
2015	Spain
2015	Spain
2015	Morocco
2015	Morocco
2015	Morocco
2016	Morocco
2016	Morocco

Cluster 113





Laura Pérez-Lago
 Estefanía Abascal
 Marta Herranz
 Fermín Acosta
 Sandra Rodríguez
 Ana Valera
 Pedro Sola



Almería INDAL-TB team



TRANS-TB-TRANS

Juan Agapito
 Viviana Ritacco; Beatriz López
 Andrea Cabibbe; Daniella Cirillo
 Christophe Sola
 Amador Goodridge; Dilcia Sambrano
 Eduardo Gotuzzo; Juan Agapito



Iñaki Comas
 Alvaro Chimer Om



Pilar Gómez Pintado
 Enrique Acín



Mydriss
 ElMessaoudi



Imane Chaoui

Centre National de l'Energie, des
 Sciences et des
 Techniques Nucléaires (CNESTEN)