Title: COVID-19: Cross-border contact tracing in Germany, February-April 2020

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Abstract

Introduction:

The Robert Koch Institute (RKI) managed the exchange of cross-border contact tracing data between public health authorities (PHA) in Germany and abroad during the COVID-19 pandemic.

Aim:

We aimed to describe the extent of RKI cross-border contact tracing and the challenges experienced.

Methods:

We analysed cross-border COVID-19 contact tracing events from 03 February to 05 April 2020 using information exchanged through the European "Early Warning Response System" (EWRS) as well as communication with International Health Regulation (IHR) national focal points. We described events by PHA involved, number of contact persons and exposure context.

Results:

The RKI processed 467 events, initiating contact to PHA 1,099 times (median 1, IQR [1;2]) and sharing data on 5,099 contact persons. Of 327 (70%) events with known exposure context, most common reported were exposures on aircraft 64 (14%), on cruise ships 24 (5%) and exposures related to non-transport contexts 210 (45%). Cruise ship and aircraft exposures yielded higher median numbers of authorities contacted (10[2;16], 4[2;11]) and contact persons (60 [9;269], 2[1;3]) than non-transport related exposures (1[1;6] and 1[1;2]), respectively. The median time spend on contact tracing activities was the highest for cruise ships: 5 days [IQR 3;9].

Conclusion:

In the current COVID-19 pandemic cross-border contact tracing is considered a critical component of the outbreak response. While the majority of international contact tracing activities did not relate to exposure events in transport, they contributed substantially to the workload. The numerous communications highlight the need for fast and efficient global outbreak communication channels between PHA.

Introduction

Since January 2020, the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) rapidly spread to become a global pandemic [1]. Active case finding, early detection and isolation of cases and their contacts are essential for breaking transmission chains. A modelling study showed that 70% of contacts should be traced in order to control the outbreak, assuming a baseline reproduction rate of 2.5 [2].

Early warning systems for the serious cross-border spread of infectious pathogens include the International Health Regulations (IHR) 2005 and the Early Warning and Response System (EWRS) for the European Union/European Economic Area (EU/EEA) countries [3, 4]. Within Germany, the communication channels have been established in accordance with the German Infection Protection Act (Infektionsschutzgesetz; IfSG). Cross-border contact tracing at the national level is operated by the Robert Koch Institute (RKI), the federal public health institute in Germany.

The first cases of Coronavirus disease 2019 (COVID-19) in Germany occurred in Bavaria at the end of January 2020 [5].

The first SARS-CoV-2 cluster also led to cross-border contacts and exposures on flights since close contacts and suspected cases traveled to Austria and Spain after exposure. This required intensive international communication to identify and share the information of contacts with the responsible health authorities. An international communication and contact tracing team (RKI IC-Team) was rapidly created within the RKI COVID-19 Emergency Operations Centre (EOC) including members of all units of the department for infectious disease epidemiology and other departments at the RKI. The core task of the team was to collect and communicate information on confirmed COVID-19 cases and their contacts to other countries in the event of cross-border relevance. In addition, incoming information on German citizens abroad was communicated through the federal state health authorities to the responsible local health authorities in Germany.

The spread of SARS-CoV-2 in Germany triggered the introduction of various measures: (1) mass gatherings with over 1000 participants were banned after calendar week 10, (2) schools and public places were closed in several federal states, (3) physical distancing measures of at least 1, 5 m to another person were recommended, (4) non-essential travels were recommended to be cancelled, and (5)

quarantine measures for travelers from high risk areas entering Germany were introduced in the calendar week 15. Due to the federal structure fo Germany varied the measures and their implementations throughout the states.
This work aims to describe the extent and course of activities resulting from information on COVID-19 exposure events with a cross-border context. Furthermore, the challenges experienced and possible workflow improvements are discussed.

Methods

Information flow in the context of international contact tracing

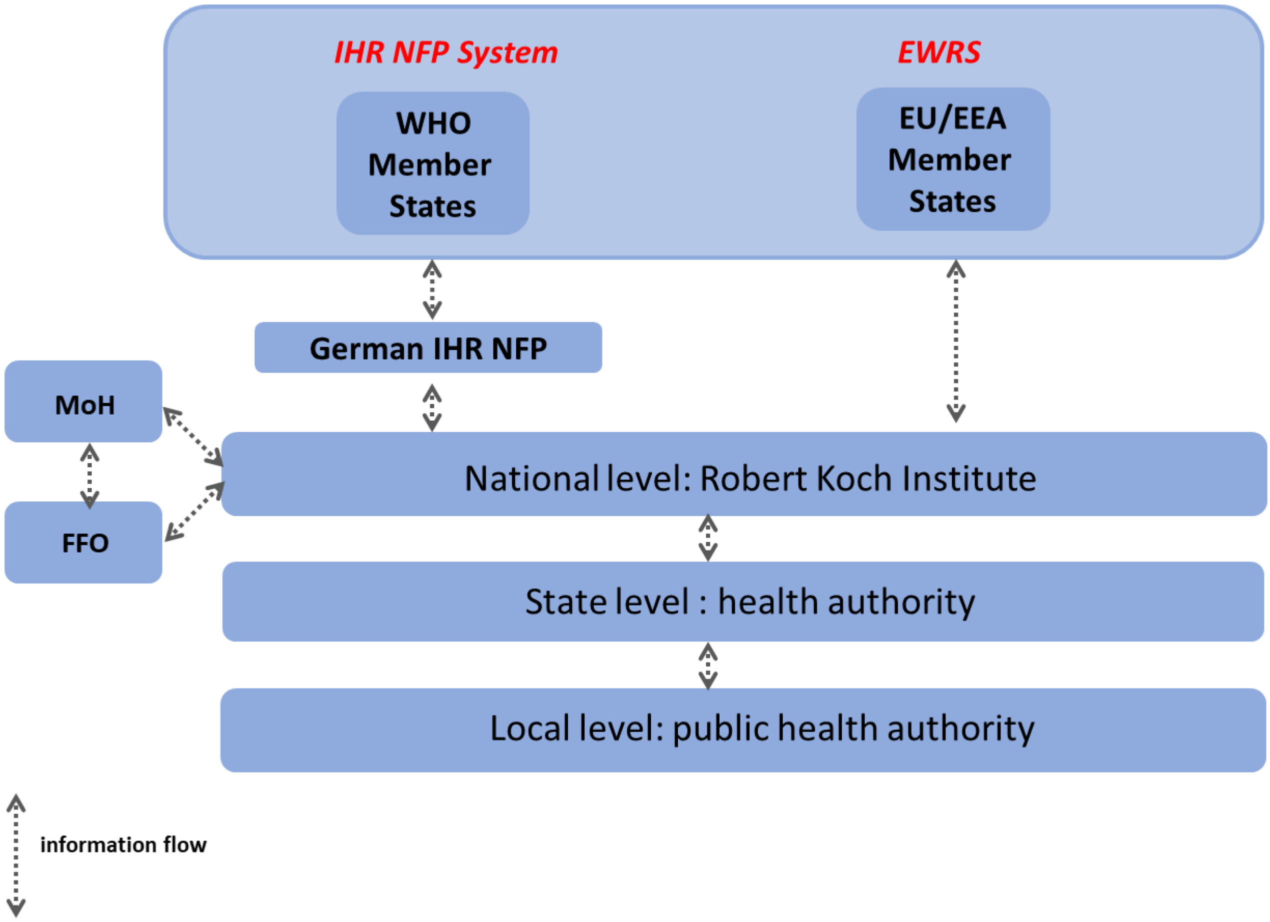
Information on cross-border COVID-19 exposure events and personal data were shared between the RKI and EU/EEA countries via the EWRS communication platform which provides a single-window messaging system (so-called "Selective Exchange") to communicate with EU/EEA member states and transmit personal data securely. The World Health Organization (WHO) member states outside the EU/EEA received information through the IHR National Focal Point (NFP) by email. In Germany, the IHR NFP is located within the Joint Information and Situation Centre of the Federal Government and the Federal States. Within Germany, email or telephone was used to communicate with health authorities. Personal data was transmitted using an encrypted exchange server (Cryptshare®).
Upon receipt of information, the RKI IC-Team assessed the content and determined the required action. The COVID-19 case and contact person definition employed by the country transmitting the data was used accordingly. The information was forwarded through the federal state health authority to the respective local public health authority (PHA) where the contact was living or currently staying. The local PHAs then proceeded with contact tracing activities (i.e. telephone interview, regular monitoring) according to the IfSG. Similarly, information from the local PHA concerning persons staying abroad during the infectious period was forwarded to the responsible foreign health authorities.
In addition to the local German PHAs and PHAs from foreign countries, the RKI was in contact with the German Federal Foreign Office and its embassies abroad.

Logistic considerations

The RKI IC-Team worked in a two-shift operation per day. Outside office hours, an on-call epidemiologist was available. Standard operating procedures (SOPs) were developed to enable the continuity of work, and team members were regularly trained and regular opportunity for feedback was provided.

Data management and protection

Each incoming COVID-19 cross-border exposure event received an internal identifier (ID) to which all information was assigned. The ID was documented in a line list including the date of the receipt of the initial communication, the start of RKI activities, the last possible exposure date of the contacts to a confirmed COVID-19 case, a description of the exposure, the affected countries, the number of contacts and an activity log for all communications. All personally identifiable information on cases and contacts were stored in a separate secure drive in accordance with the General Data Protection Regulation (Directive 95/46/EC) [6]. When the outbreak activities are completed, this information will be permanently deleted.



Abbreviations
WHO: World Health Organization
EWRS: Early Warning and Response System
IHR NFP: International Health Regulations (2005) National Focal Point
EU/EEA-States: States of the European Union or the European Economic Area
FFO: German Federal Foreign Office
MoH: German Federal Ministry of Health

Figure 1: Flow of information in the context of contact tracing in Germany and abroad

Inclusion and exclusion criteria

We reviewed all COVID-19 cross-border exposure events involving Germany which triggered a contact-tracing related activity of the RKI IC-team. Included were all activities between the 03 February and 05 April 2020 with at least one confirmed case or contact person of a confirmed COVID-19 case and the start date of RKI event-specific activities.

Data analysis

The number of COVID-19 cross-border exposure events processed by the RKI from 03 February to 05 April 2020 (calendar weeks 6-14) was analysed to assess:

1) Number of German and international authorities in contact with the RKI and communication channels used;
2) Context and country of the exposure events as well as number of contacts followed-up;
3) Time course according to country and context of exposure;
4) Time delay (time between last exposure and start of RKI activities), and time duration (time between start and end of RKI activities).

The following information for each event was analysed: Date of the initial communication, communication channel, start and end date of the RKI activities, country which initiated the communication, number of national and international authorities the RKI was in contact with, country where the exposure occurred, date of the last possible exposure, context of the exposure, and number of contact persons.

The results were summarised graphically and descriptively using frequency counts (n), average (n), median (n), interquartile range [IQR 25th;75th percentile], range [min-max], and proportions (%). To determine differences between continuous variables we used the Wilcoxon-Mann-Whitney-Test. The data analysis was conducted with Stata™ (software version 15, StataCorp).
Case studies of selected COVID-19 cross-border exposure events were used to highlight extent and complexity of cross-border contact tracing activities.

Definitions
A distinction was made between countries where communication was carried out through EWRS in the EU/EEA versus communication which occurred through the IHR NFP. Each authority with whom the RKI was in contact was counted once per event, the initially received information was not considered. The number of transport providers, travel agencies or other companies that provided data on contact persons and exposures, as well as communication with the Federal Ministry of Health (MoH), was not included in the analysis.

If no information on the country of exposure was available, the country which initiated the communication was used as the country of exposure. For events involving only contact persons in an aircraft or on a cruise ship, the country of exposure was indicated as "transnational", since the exposure occurred during the journey. Possible means of transport included plane, ship, bus or taxi. For non-transport related exposures, a distinction was made between private overnight stays (e.g. hotel, guesthouse), professional events (e.g. congress, business meetings) and other social contexts (e.g. carnival, restaurant).

For larger groups or if the last date of contact between the case and the contacts was unknown, the last date on which contact may have occurred (e.g. last day of a holiday, last day of a cruise) was used as the exposure date.

Additional data source

Data available in Germany's national reporting electronic database for communicable diseases (Surv*N*et@RKI) was also reviewed to supplement missing information on location and context of exposure, for events notified within Germany [7].

Ethics

The data was collected within the legal framework of the IfSG, the EU Decision 1082/2013 and the IHR. Only aggregated data is presented. Therefore, ethics committee approval was not sought.

Results

Between 03 February 2020 and 05 April 2020 (calendar weeks 6-14), 467 cross-border contact tracing events were included in the analysis. Germany initiated the communication for 59% (n=276) of these. From 29 countries 213 abroad exposure events were processed. Most frequent countries of exposure included Germany (n=164, 35%), Austria (n=101, 22%), Italy (n=32, 7%) and Spain (n=11, 2%). Outside the EU/EEA, the United States of America, Egypt and Israel were the most frequent countries (each n=5, 1%). The country of exposure was classified as transnational in 19% (n=90). Half of the exposures (n=139, 50%) communicated initially by Germany also occurred there. In 13% (n=25), Germany was informed from abroad about an exposure in Germany.

The RKI IC-Team was in contact with different authorities 1,099 times. Of these, 55% (n=600) were communications with German PHAs, 31% (n=345) were with EU/EEA countries via EWRS, 11% (n=126) were with other countries via IHR NFPs and 3%

(n=28) were with the Federal Foreign Office or its embassies abroad. In 16 events, there was no contact to any authority since the contact person's place of residence was indeterminable. These persons were contacted directly by the RKI. The median number of authorities the RKI was in contact with was 1[IQR 1;2] per activity (Table 2).

Table 1: Number and median of authorities the RKI was in contact with, contact persons and days of time delay by country of initial communication and country of exposure, 03 February to 05 April 2020, n=467

		Number of events		Authorities the RKI was in contact with	Contact persons	Days of time delay#
		n	**%**	**n (median [IQR])**	**n (median [IQR])**	**n (median [IQR])**
	Total	467	100	1,099 (1[1;2])	5,099 (2[1;6])	8[5;11]
Country of initial communication*	**Germany**	276	59.1	643 (1[1;2])	3,135 (2[1;5])	8[5;12]
	Abroad	191	40.9	456 (1[1;2])	1,964 (2[1;8])	8[5;11]
Country of exposure**	**Germany**	164	35.1	249 (1[1;2])	326 (1[1;3])	10[7;14]
	Abroad	213	45.6	452 (1[1;2])	1,894 (2[1;7])	7[4;10]
	Transnational	90	19.3	398 (2[1;5])	2,879 (8[2;16])	7[5;10]

#days of time delay were defined as time between last exposure of a contact person to a confirmed COVID-19 case and start of RKI activities

/To compare medians the Wilcoxon-Mann-Whitney-Test was used.*

**Comparison of median number of authorities involved between communication initiated from Germany or abroad yielded a p-value of < 0.001*

Comparison of median number of contact persons between communication initiated from Germany or abroad yielded a p-value of 0.095

Comparison of median time delay between communication initiated from Germany or abroad yielded a p-value of 0.929

***Comparison of median number of authorities involved between exposure in Germany or abroad and Germany or transnational, respectively, yielded a p-value of < 0.001*

Comparison of median number of contact persons between exposure in Germany or abroad and Germany or transnational, respectively, yielded a p-value of < 0.001

Comparison of median time delay between exposure in Germany or abroad and Germany or transnational, respectively, yielded a p-value of 0.095

Table 2: Cross-border contact tracing events, contact with health authorities and contact persons by exposure context (n, (median [range]), 03 February to 05 April 2020, n=467

Exposure context	**Total no. of cross-border contact tracing events**		**Number of authorities the RKI was in contact with**					**Number of contact persons**
			Total	**German health authorities**	**EWRS**	**IHR NFPs**	**German Federal Foreign Office**	
	n	**%**	**n (median [IQR]) ***					**n (median [IQR]) ****
Total	467	100	1,099 (1[1;2])	600 (1[0;1])	345 (1[0;15])	126 (0[0;0])	28 (0[0;0])	5,099 (2[1;6])
Aircraft	64	14	150 (2[1;3])	76 (1[0;6])	43 (0[0;1])	26 (0[0;0])	5 (0[0;0])	391 (4[2;11])
Cruise ship	24	5	247 (10[2;16])	190 (9[2.;12])	29 (0[0;1])	14 (0[0;1])	14 (0[0;1])	2,467 (60[9;269])
Other means of transportation	5	1	9 (1[1;2])	5 (1[1;1])	4 (1[0;1])	0 (0[0;0])	0 (0[0;0])	2 (1[1;1])
Non-transport related event**	210	45	398 (1[1;2])	220 (0[0;1])	136 (1[0;1])	38 (0[0;0])	4 (1[0;0])	1,510 (2[1;6])
Both transport and non-transport related event	24	5	91 (1[1;4])	53 (1[0;2])	21 (0[0;1])	14 (0[0;1])	3 (0[0;0])	464 (15[2;33])
Unknown	140	30	204 (1[1;2])	56 (0[0;1])	112 (1[0;1])	34 (0[0;0])	2 (0[0;0])	265 (1[1;2])

/To compare medians the Wilcoxon-Mann-Whitney-Test was used.*

**Comparison of median number of authorities involved between exposure on cruise ship or aircraft and cruise ship or non-transport related event, respectively, yielded a p-value of < 0.001. Comparison of median number of authorities involved between exposure on cruise ship or other means of transportation yielded a p-value of 0.019.*

***Comparison of median number contact persons between exposure on cruise ship or aircraft, cruise ship or non-transport related event and cruise ship or other means of transportation, respectively, yielded a p-value of < 0.001.*

For 327 (70%) events, the exposure context was known. This included 93 (28%) events where the exposure occurred during transport (64 air travel, 24 cruise ships, five busses/taxis/others). The remaining events included exposures in hotels or guesthouses (n=83, 25%), at congresses, trade fairs and other business meetings (n=64, 20%), or in other context such as private stays or gatherings (n=63, 19%). In 24 (5%) events, several exposure contexts were mentioned. The median number of authorities contacted was highest among events with exposures related to cruises (see Table 2).

For 344 (74%) events, information on the number of contact persons was available. In total, data on 5,099 contacts was shared, with a median of two contacts [IQR 1;6] per event. Fewer contact persons per event were involved when the communication was initiated in Germany or when the country of exposure was Germany compared to abroad or transnational (see Table 1). Most contacts per event occurred on cruises (see Table 2).

For 332 (71%) events, the date of exposure was known. The median time delay between date of exposure and receipt of the information by RKI was 8 [IQR 5;11] days. The median time duration of RKI activities in days was 1 [IQR 1;3] and higher among cruise related exposures than for aircraft, other means of transport and non-transport related exposures (5 [IQR 3;9] vs 1[IQR 1;4], $p<0.001$; 3[IQR 1;5], $p=0.255$; and 1[IQR 1;3] $p<0.001$). For aircraft related exposures, it was higher when arrival of flights was in Germany than of flights with arrival abroad (median 3[IQR 1;6] vs. 1[IQR 1;3], $p=0.012$).

The total number of events increased starting in the calendar week 9, peaked with 126 events in calendar week 12, and decreased to 75 events in calendar week 14. Detailed information regarding country and context of exposure is shown in Figure 2 and 3.

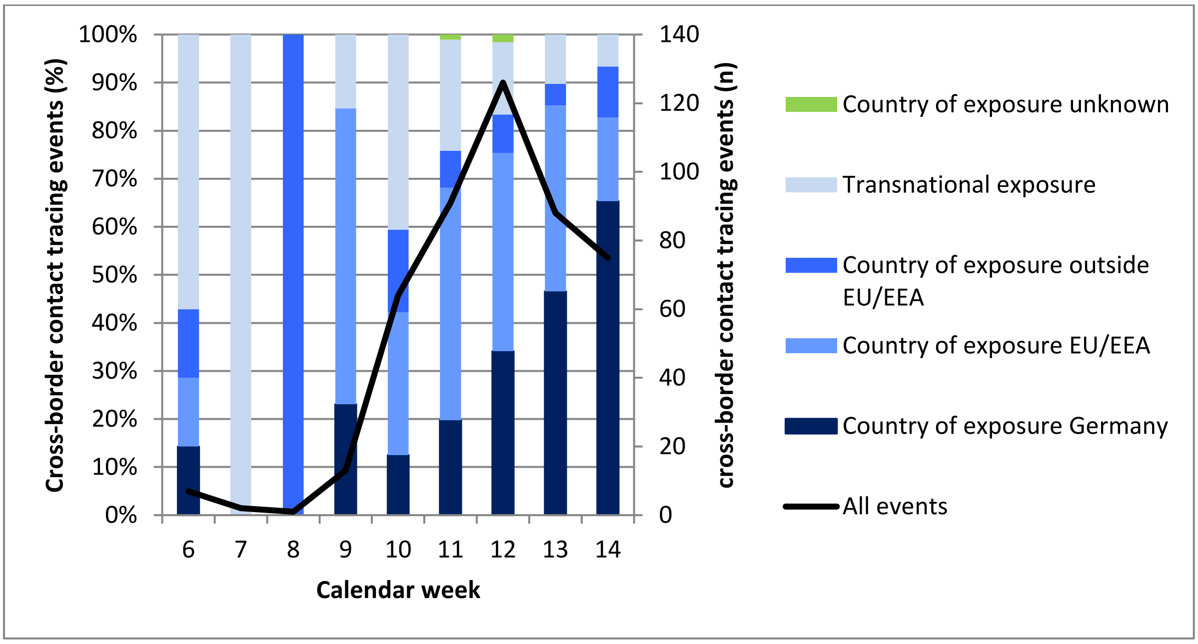


Figure 2: Number of cross-border contact tracing events total and proportion of country of exposure by calendar week of activity start, 03 February to 05 April 2020, n=467

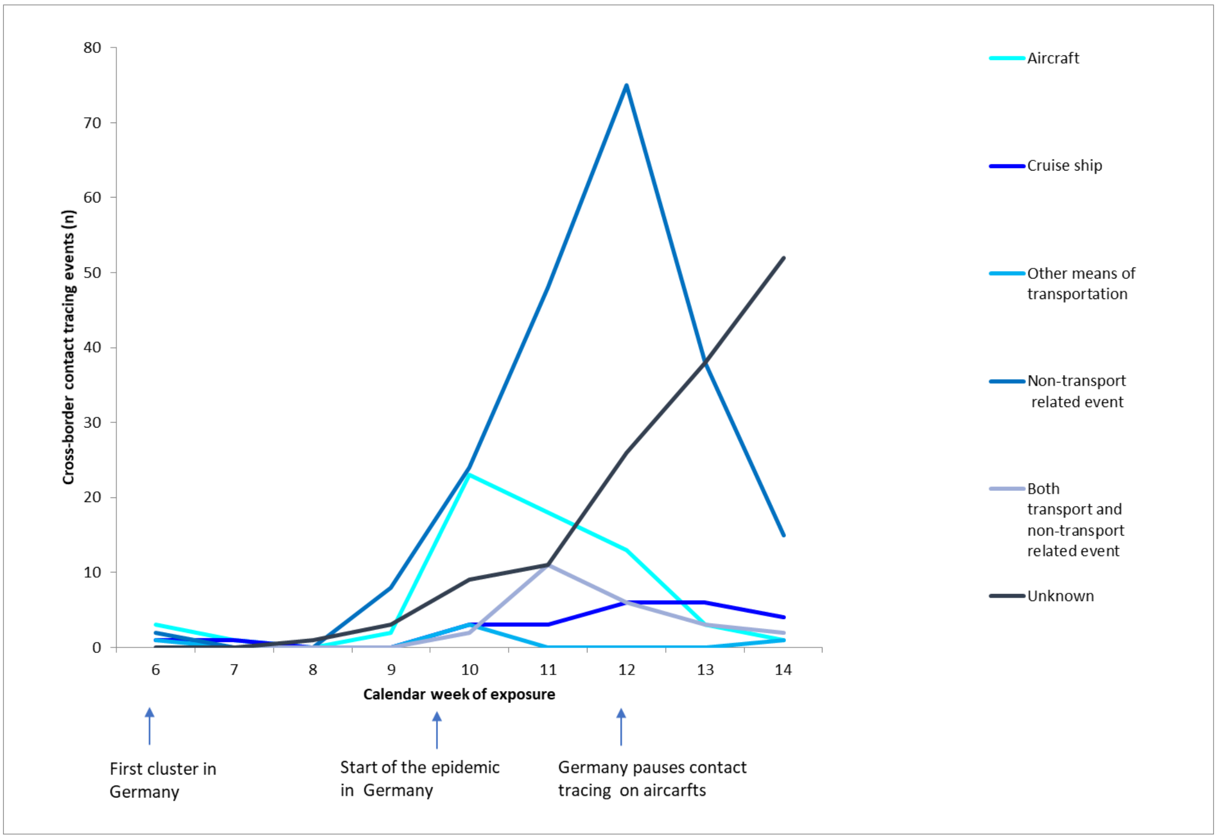


Figure 3: Number of cross-border contact tracing events by exposure context by calendar week of activity start, 03 February to 05 April 2020, n=467

The average number of persons working per day increased steadily and showed a peak in calendar week 13 with 7 [min 5 - max 8] persons.
The increase of incoming information from February 2020 onwards required the expansion of the team to accommodate the workload. Staff was recruited from all units of the Department for Infectious Disease Epidemiology at the RKI. To maintain high quality standards, training sessions as well as weekly team meetings and regular feedback groups were implemented.

Case studies
The following selected case studies illustrate three of the major COVID-19 cross-border contact tracing events involving Germany.

On 07 March 2020, the RKI was informed by a German regional PHA of a person who had attended a business meeting with 24 persons in preparation for an expedition. The day after the meeting the person tested positive for SARS-CoV-2 and reported a skiing holiday in South Tyrol, Italy from 21 to 24 February 2020 and symptoms from 28 February 2020. Since the meeting, the case had already travelled through Germany by train and taken a flight to Egypt. The respective IHR NFP was immediately informed of the case's travel for contact tracing on the flight and known contacts in Egypt. Contact tracing for the train was not possible since the tickets for the neighboring seats had been booked anonymously. The data on contact persons exposed during the business meeting were transmitted via EWRS to three EU/EEA countries. Information on fellow travellers on the ski holiday was forwarded to the respective German federal states. Among them, three persons had become symptomatic in the meantime.

On 09 March 2020, the RKI was informed by a local PHA about a person who tested positive for SARS-CoV-2 and became symptomatic on 01 March 2020, and an asymptomatic fellow traveller. Both had taken part in a Nile cruise with 45 guest cabins from 15 to 22 February 2020 and spent a one-week beach holiday afterwards. Subsequently, the IHR NFP Egypt was informed. The contact details of all persons participating in the cruise and residing at the hotel at the same time as the case were collected and forwarded to the respective countries. Neighboring passengers on the flight from Egypt to Germany were also investigated. Overall, data on 189 contacts residing in Germany were transmitted to 15 responsible health authorities. Moreover, five EU/EEA countries and one additional country outside the EU/EEA were informed about 44 respectively 9 contacts via EWRS and the IHR NFP.

The RKI was notified on 25 February 2020 by Italy about an Italian citizen, who was tested SARS-CoV-2 positive and had attended a business meeting in Munich from 19 to 21 February 2020 with 13 close contact persons. The case became symptomatic on 20 February 2020. All participants had left Munich by 21 February 2020. Four contact persons had travelled by plane by the time of notification. One took as many as 7 flights. Data on contact persons was transmitted to Spain, France, the Netherlands, Denmark and Sweden via EWRS, as well as to the respective German local PHA. To our knowledge, 8 of 13 contacts at the business meeting were later tested SARS-CoV-2 positive.

Discussion

This work describes cross-border contact tracing activities within Germany's containment strategy of COVID-19 [8] focusing on active case finding, early detection and isolation of cases and contacts in order to prevent and control the spread of infection. Additionally, the case studies present examples of the complexity of contact tracing due to global mobility and multiple exposures during travel, business meetings or vacations.

The increase in cross-border contact tracing activities from the calendar week eight onwards reflects the increase of COVID-19 cases reported in countries outside of China [9]. The decrease after calendar week 12 can be attributed to international travel restrictions, the travel warnings issued by the German Federal Government and national travel related quarantine measures. Worldwide increasing case numbers and limited personnel resources of local PHA as well as the pause of contact tracing on flights in Germany on 18 March 2020 might have also contributed to the decreasing number of incoming contact tracing activities after calendar week 12. Moreover, limited time for backtracking transmission routes might have led to the increasing number of events with an unknown exposure from calendar week 11 onwards. The proportion of events with reported exposure in Germany increased

from calendar week 13 and reflects the increasing autochthonous case numbers in Germany.
The time delay from last possible exposure to start of RKI activities surpassed the median incubation period of COVID-19 [10, 11]. This could be explained by the time it takes until a person seeks medical care, gets tested, is notified to the competent health authority and the initiation of investigations including forwarding of data to the RKI. Considering all these factors, such a time delay can be expected but still allows to identify potential secondary cases and to interrupt transmission.
Traveling activities contributed to the geographical spread of SARS-CoV-2 infections [12-14] and therefore need to be considered as important events for contact tracing. While transport related events did not represent the majority of the contact tracing events in our analysis, they were challenging and caused a high time duration of RKI activities. Many international travelers in and from Germany generated numerous cross-border contacts in the transport sector. Moreover, the spatial proximity between passengers due to limited space in public transport resulted in a high number of close contacts. Consequently, a large amount of personal data had to be distributed to different IHR NFPs, EU/EEA member states and/or local PHAs in Germany. In this context, the communication with commercial transport companies and tour operators and timely receipt of complete personal data including contact details of passengers was one of the main challenges.
Air travel made up 69% of events within the transport-related exposures. In aircraft, passengers seated in the same row and those seated in the two rows in front of and the two rows behind a confirmed COVID-19 case were classified as close contacts. This based on the assumption of higher risk of infection and was also applied for contact tracing in aircraft in the context of other infectious diseases transmitted by droplets in the past [15-19]. Since passengers in aircraft usually remain seated, the number of contacts needing follow-up after air travel was lower than in other means of transport. Still, the workload and consequently the time duration of RKI activities was higher when the respective flight had a destination in Germany as in this case Germany was responsible to retrieve the passenger data from the airline.
After careful considerations the RKI decided to pause contact tracing related to air-travel during the first peak of COVID-19 pandemic in March 2020 due to limited evidence of SARS-CoV-2 transmission on aircraft at this time and the need of an efficient use of human resources. Up to date, SARS-CoV-2 transmission events on

flights have been reported sporadically [20-23]. More conclusive studies on in-flight transmissions are needed to estimate the associated risk. In addition, currently implemented measures such as wearing of masks in aircraft need to be considered and evaluated. With the surge in travel activities Germany has restarted contact tracing activities related to air travel exposure in calendar week 29 but adjusted its recommendation and defined as close contact the persons who were seated in the neighboring seat of a confirmed COVID-19 case, others seated in the two rows in front of or behind an index patient were considered as low risk exposure contact persons.

Especially high transmission among passengers and crew on cruise ships has been reported in literature [24-26]. In our analysis, the median number of contact persons related to ship travel was higher than related to air travel. This can be explained by the long period of time passengers stay on the ship and the various activities such as restaurant visits, sports or entertainment. The high number of contact persons and the extensive communication led, compared to other exposure contexts, to higher time duration of RKI activities and a higher number of contacted stakeholders. The communication involved the German Federal Foreign Office and its embassies abroad and resulted in a long process of receiving and forwarding personal data of cases and contact. Moreover, information on international travel routes of contact persons who had already disembarked had to be requested and followed up since the stay on a cruise ship was often only one part of a vacation route.

For many other means of transport including buses and trains, conveyance operators do not systematically store passenger lists, seat reservations or the actual seat taken which complicated the identification of close contacts.

Due to the lack of standard procedures to handle passenger data, communication with conveyance and tour operators required significant amount of time and human resources. Moreover, the completeness of the data varied widely across providers.

The effectiveness of communication with national and international PHA largely depended on the existing communication channels. The EWRS platform, which provides a single-window messaging system, facilitated direct communication with national PHA of EU/EEA countries and the UK as well as the safe transfer of personal data in compliance with European Data Protection Regulation. In contrast, communication with PHA in Germany and IHR NFP outside the EU/EEA required the process of exchanging information by email and using an encrypted platform to share

personal data. This was time consuming and technically challenging since some recipients reported technical difficulties in retrieving data.
Due to the federal structure of Germany the legal responsibility of outbreak investigation is located on the municipal level. Within this task RKI supported the PHA in international communication related to cross-border contract tracing during the COVID-19 pandemic. This led to a novel extent of data exchange and adaption of the established communication routes with local PHA, which was, as described above, a main challenge without a single-window messaging system. Moreover, missing information on exposure context, test date and symptoms of confirmed cases contributed to the time duration of RKI activities. Still, the involvement of RKI as a national coordination point for international contact tracing activities was perceived as great support and an efficient way to pool and distribute relevant information on cross-border exposure events in time.

The data analysed was collected during the daily routine work of the RKI COVID-19 EOC and, thus, is subject to limitations. The number of contacts recorded did not reflect the total number of persons who had contact with a COVID-19 case in a cross-border context, since only information on contact persons who resided in Germany and abroad were reported by Germany and, respectively, foreign countries through the RKI EOC. Furthermore, the regional and local PHA legally do not have to involve the RKI in their outbreak investigation and contact tracing activities, therefore only events reported to the RKI were included. Still, we assume that during the COVID-19 pandemic the majority of cross-border exposure events related to Germany was processed by the RKI. It was not possible to calculate accurate attack rates or distinguish between high- or low-risk contacts since data on the intensity of the contact, the numbers of contacts per COVID-19 case and the number of subsequently infected contacts was not available. Furthermore, the country or context of exposure was not always clear.

To sum up, cross-border contact tracing in the current COVID-19 pandemic requires a lot of resources, but is a critical component of the outbreak response in Germany and should be considered as one of the pillars of national preparedness and response strategies. A large pool of continuously trained staff and constant feedback can foster efficient workflows and helps to spread the continuous high workload and

knowledge to a sufficient number of qualified professionals to secure sustainability. Travel-related exposure events play an important role in cross-border contact tracing and associated challenges should be further addressed including the need of efficient communication with all involved stakeholders. Consequently, national and international conveyance and tour operators should be legally obliged to store a minimal dataset of passenger data including name and contact details as well as seat or cabin information (as appropriate). Contact points for inquiries of competent PHA with provision of data within 24 hours should be required. In addition, the implementation of a global platform for data exchange between the transport sector and PHA should be evaluated on an international level.
EWRS was very efficient for the rapid and secure international data exchange, especially in the face of the high data protection law requirements. A similar protected global platform should be established for IHR NFPs and within Germany to avoid unnecessarily time-consuming data exchanges.
Additionally, a standard protocol for minimal information requirements could streamline the national and international exchange of personal data.

For the future, an evaluation of the effectiveness of cross-border contact tracing considering data and experiences from an EU/EEA- or WHO member state perspective could help to give guidance on the most efficient strategies and lead forward to a harmonised international approach of cross-border contact tracing.

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MadH, UR, IM, GS, RL, AM, AMR, TD, UK, SBS, JS, ST, TS conceptualised this study. MadH supervised the study. RL, AM, TS extracted the data. IM and GS performed the analyses. IM and GS drafted the manuscript. ST translated the first draft. All authors critically revised the manuscript and approved the final version.

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