

1 **Case Investigation and Contact Tracing Efforts from Health Departments in the United**
2 **States, November 2020–December 2021**

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1 **Abstract**

2 **Objectives:** Sixty-four state, local, and territorial health departments (HDs) in the United States
3 (US) report monthly performance metrics on COVID-19 case investigation and contact tracing
4 (CI/CT) activities. We describe national CI/CT efforts during October 25, 2020–December 24,
5 2021 which included three peaks in COVID-19 case reporting.

6 **Methods:** Standardized CI/CT data elements submitted by the 64 HDs were summarized as
7 monthly performance metrics for each HD and the nation. These included measures of CI/CT
8 completeness, timeliness, and workloads. We calculated contact tracing efficacy as the
9 proportion of new cases that occurred in persons identified as contacts within the 14 days prior to
10 being reported as a case.

11 **Results:** A total of 44,309,796 COVID-19 cases were reported to HDs, of which 18,153,353
12 (41%) completed HD interviews. Less than half of interviews yielded ≥ 1 contact. A total of
13 19,939,376 contacts were identified; 11,632,613 were notified (58%), with 3,618,846 undergoing
14 SARS-CoV-2 testing within 14 days of notification. Of the total reported cases, 2,559,383
15 occurred in recently identified contacts.

16 **Conclusion:** We document the resource-intensive nationwide effort by US HDs to mitigate the
17 impact of COVID-19 through CI/CT before and after vaccines became widely available. These
18 results document the coverage and performance of CI/CT despite case surges and fluctuating
19 workforce and workloads.

20 **Keywords:** COVID-19, case investigation, contact tracing, public health surveillance, United
21 States

22

1 **Introduction**

2 Case investigation and contact tracing (CI/CT) have long been successful public health methods
3 to prevent and control the spread of infectious diseases [1]. Along with non-pharmaceutical
4 interventions, such as physical distancing and wearing masks, the Centers for Disease Control
5 and Prevention (CDC) has encouraged CI/CT for COVID-19 [2,3].

6 Through the Coronavirus Aid Relief and Economic Security Act of 2020, Paycheck
7 Protection Program and Health Care Enhancement Act of 2020 and Coronavirus Response and
8 Relief Supplemental Appropriations Act of 2021 CDC's Epidemiology and Laboratory Capacity
9 for Prevention and Control of Emerging Infectious Diseases (ELC) distributed >\$40 billion to
10 the 64 state, local, and territorial health departments (HDs) which include the 50 states, five U.S
11 territories, three freely associated states in the Pacific, and six localities (Chicago, Houston, Los
12 Angeles County, New York City, Philadelphia, and Washington, DC). This funding supports a
13 variety of COVID-19 response activities, including CI/CT [4]. All HDs receiving ELC funding
14 are expected to report data elements that can be used to calculate performance metrics in core
15 areas including surveillance, laboratory, and health information systems.

16 Monthly ELC data collection began in August 2020. CI/CT performance metrics were
17 revised in November 2020 to capture denominator data [5]. This analysis describes the
18 nationwide CI/CT effort during the subsequent 14-month period, which included three national
19 peaks in COVID-19 cases.

20

21 **Methods**

22 As part of the COVID-19 response, ELC collects standardized data elements from 64 HDs
23 receiving funding through ELC (Figure 1). All HDs are expected to report data elements that can
24 be used to demonstrate performance over several core areas including surveillance, laboratory,
25 and health information systems. Data elements are submitted through the Research Electronic
26 Data Capture (REDCap) data collection system [6]. If data elements could not be reconciled or
27 validated in a timely manner, they were excluded from the analysis. HDs reporting no new cases
28 for any number of months in the fourteen-month reporting period were removed from this
29 analysis, leaving 59 HDs potentially assessed. However, not all HDs reported each data element

1 per month, therefore, the number of HDs assessed varies per analysis. To include the most HDs
2 in our analysis, all HDs that reported greater than 7 months of each data element during the
3 fourteen-month reporting period remained in the analysis. The analysis uses descriptive statistics
4 to describe HD case investigation and contact tracing activities during a fourteen-month period.

5 The monthly reporting periods in this analysis began October 25, 2020 and ended December 24,
6 2021. To simplify, data reporting periods are aligned with calendar months in this analysis. For
7 example, the data reporting period from December 25, 2020 through January 24, 2021 is labeled
8 January 2021. The reporting period is therefore analyzed as 14-months from November 2020 to
9 December 2021.

10 Data elements are collected monthly to capture HD efforts in key CI/CT areas including case
11 investigation and contact identification, contact tracing, timeliness of the CI/CT process,
12 workload of the staff conducting CI/CT, and the efficacy of CI/CT. To portray these efforts,
13 using the collected data elements, a proportion is calculated individually for every HD and then
14 the mean (average) of those percentages is presented to describe the national effort to conduct
15 CI/CT.

16 To portray the performance and effort around case investigation and contact identification, the
17 following indicators were calculated: 1) mean percent of cases completing an interview; 2) mean
18 percent of cases that provided at least 1 contact during their interview; 3) mean number of
19 contacts identified per case completing an interview 4) mean number of contacts identified per
20 case providing at least 1 contact.

21 Two percentages were calculated to assess impact of contact tracing efforts: 1) mean percent of
22 identified contacts notified of exposure; 2) mean percent of notified contacts tested within 14
23 days of notification.

24 Timeliness of CI/CT efforts was captured by three data elements: 1) the median number of days
25 between specimen collection and report of case to the HD; 2) the median number of days
26 between the report of a case to the HD and case interview completion; and 3) the median number
27 of days between case interview completion and contact notification. The mean of the sum of the
28 medians was calculated to give a national overview of the timeliness of CI/CT. This national
29 calculation is referred to as the mean number of reported days.

1 CI/CT staff and workload for case investigators and contact tracers was shown by four
2 indicators: 1) the total number of case investigators per month, 2) the total number of contact
3 tracers per month, 3) the mean number of case investigators per HD, 4) the mean number of
4 contact tracers per HD, 5) the number of cases reported to the HD per the number of case
5 investigators, and 6) the number of contacts notified divided by the number of contact tracers.

6 Contact tracing efficacy is defined as the percent of new COVID-19 cases identified among
7 contacts during the self-monitoring quarantine [3]. In this analysis, contact tracing efficacy was
8 calculated using the number of new cases that were previously known or identified as contacts
9 divided by the number of cases reported to the HD.

10 All analyses were conducted using Microsoft Excel or SAS (version 9.4; SAS Institute). This
11 activity was reviewed by CDC and was conducted consistent with applicable federal law and
12 CDC policy (45 C.F.R. part 46.102(l)(2), 21 C.F.R. part 56; 42 U.S.C. Sect. 241(d); 5 U.S.C.
13 Sect. 552a; 44 U.S.C. Sect. 3501 et seq).

14

15 **Results**

16 *COVID-19 Cases Reported by Health Departments to ELC:*

17 Over the fourteen months, a total of 44,309,796 cases were reported by HDs to CDC through
18 ELC. From November 2020 through December 2021, the number of confirmed and probable
19 COVID-19 cases reported by HD ranged from a low of 444,318 (n=54 HDs) in June 2021 to a
20 peak of 6,078,802 (n=52) in December 2020 (Supp Table 1, Figure 2).

21 *Case Investigation and Contact Identification:*

22 A total of 18,153,353 cases completed an interview (Supp Table 1). Of cases reported to HDs,
23 the mean percent of cases completing an interview was lowest in December 2021 at 32.4% (n=
24 50) and highest in June 2021 61.6% (n=53). The mean percent of cases providing at least 1
25 contact during their interview ranged from a minimum of 38.8% (n=48) reported in December
26 2021 and maximum of 54.8% (n=50) in June 2021 (Supp Table 2, Figure 3).

27 Of the 18,153,353 cases completing an interview, 8,170,580 cases provided at least 1 contact.
28 Case investigations identified 19,939,376 contacts (Supp Table 1, Figure 2). The mean number

1 of contacts identified per case interviewed ranged from 0.9 contacts (n=50) in December 2021 to
2 1.6 contacts (n=52) in May 2020 (Supp Table 2, Figure 4) Across all months, a mean of less than
3 2 contacts were identified per case completing an interview. However, this number increased
4 when the denominator is restricted to the number of cases that provided at least 1 contact during
5 their interview. The mean number of contacts identified per case among those providing at least
6 1 contact ranged between 2.4 to 2.9 contacts (Supp Table 2, Figure 4).

7 *Contact Tracing:*

8 Of the 19,939,376 contacts identified, 11,632,613 contacts were notified (Supp Table 1). The
9 number of contacts identified from case investigations ranged from a low of 271,626 (n=53) in
10 June 2021 to a high of 2,935,489 (n=54) in November 2020. The mean percent of contacts
11 notified ranged from a low of 46.0% in December 2021 to a high of 66.9% in June 2021 (Supp
12 Table 2, Figure 3). A total of 3,618,846 notified contacts were tested within 14 days of
13 notification (Supp Table 1). The mean percent of notified contacts that were tested within 14
14 days of their notification ranged from 27.5% (n=41) in May 2021 to 36 % in December 2021
15 (n=39) and January 2021 (n=42) (Supp Table 2, Figure 3).

16 *Contact Tracing Efficacy:*

17 Of the 44,309,796 cases reported to HDs over the 14-month time period, 2,559,383 cases were
18 known to be contacts within the previous 14 days (Supp Table 1). The mean percentage of cases
19 reported to HDs known to be contacts within the previous 14 days ranged from 3.1% (n= 49) in
20 December 2021 to 11.0% (n=44) November 2020 (Supp Table 2, Figure 3).

21 *Timeliness:*

22 Across reporting HDs, the mean number of days between specimen collection and report of a
23 case to the HD, report of a case to the HD and the completion of a case interview, and the
24 completion of a case interview to notification of contacts remained consistent. The mean number
25 of days between specimen collection and report of a case to the HD ranged from 1.4 days (n=51)
26 in June and July 2021 to 2.5 (n=48) days in November 2020, the mean number of days between
27 the report of a case to the HD and the completion of a case interview ranged from 1.1 days in
28 March, May and June 2021 to 2.7 days (n=47) in November 2020 and for the number of days

1 between the completion of a case interview and contact notification ranged from 2.0 days (n=47)
2 in February 2021 to < 1 day from April 2021 to December 2021 (Supp Table 2).

3 *Workload:*

4 The number of staff assigned to case investigations ranged from 26,393 (n= 53) in June 2021 to
5 54,651 in December 2020 with the mean number of case investigators per HD ranging from 487
6 (n= 54) in July 2021 to 1,072 (n=52) in December 2020. The workload associated with the staff
7 conducting case investigations ranged from 32.0 cases per investigator (n=53) for the month of
8 June 2021 to 266 cases per investigator (n=50) in the month of December 2021 (Table 1).

9 The number of staff assigned to contact tracing varied from 22,929 (n=50) in November 2021 to
10 54,905 (n=52) in December 2020. The mean number of contact tracers per HD ranged from 425
11 contact tracers (n=55) in July 2021 to 1,077 contact tracers (n=52) in December 2020. The
12 workload associated with staff conducting contact tracing ranged from 34 contacts per contact
13 tracer (n=54) in July 2021 to 114 contacts per contact tracer (n=55) in November 2020 (Table 1).

14 **Discussion**

15 This analysis chronicles the US CI/CT delivery and performance over a 14-month period that
16 includes several months prior to vaccine rollout, during multiple holiday –associated surges, and
17 the emergence of both the Delta and Omicron viral variants. During this time, CI/CT was
18 delivered with consistent coverage and performance alongside other non-pharmaceutical
19 interventions (NPI) and nationwide vaccine rollout. Despite scaling of perhaps the largest
20 public health workforce in history and efforts to prioritize at-risk populations, nationwide CI/CT
21 performance metrics remained generally stable. Performance levels dropped slightly during peak
22 incidence periods, but such drops were less than might be expected given increases in cases.

23 Timeliness of case reporting and subsequent case interviews improved modestly early on and
24 plateaued; case interviews were completed for less than half of reported cases during this period.
25 There were minimal fluctuations in mean number of contacts identified per case patient, mean
26 percent of contacts notified, or mean percent of contacts tested and consequently mean percent of
27 case patients that were previously known as contacts.

28 The general stability in indices in the face of multiple pandemic surges, as well as challenges in
29 procurement and hiring processes for many HDs early in the pandemic, suggest substantial

1 flexibility and adaptability among HDs and community partners to deliver CI/CT throughout this
2 evaluation period [7]. HDs have implemented various methods to employ CI/CT staff to build a
3 public health workforce and conduct CI/CT [8]. Moreover, some of the CI/CT workforce were
4 reassigned to vaccine rollout efforts. Even with the influx of funding, engaging individuals and
5 communities in COVID-19 mitigation efforts has been resource intensive and hampered by the
6 unwillingness of many people to speak to public health staff or participate in CI/CT which is
7 reflected in the proportion of cases completing interviews and providing contacts. HDs have
8 reported low public trust and an unwillingness to engage as major challenges for CI/CT. [9, 10].
9 For example, in July 2020, only about half of Americans expressed a willingness to speak with
10 public health staff about their contacts and quarantine if advised to do so [11]. The level of
11 engagement between public health programs and community members suffered further erosion
12 through the course of the pandemic [9, 10].

13 The performance of CI/CT reported by these HDs mirrors that of other U.S.-based evaluations
14 [12-14]. Health departments used myriad methods to augment, expand and improve case
15 investigation and contact tracing [8] along with other non-pharmaceutical interventions [15]. In
16 settings of COVID-19 case surges and declines, CDC has encouraged prioritization of CI/CT,
17 [16], source investigation [17] and education of persons with COVID-19 to notify their contacts
18 [18]. The effect of cases informing contacts directly, even when not providing contact names to
19 HDs is difficult to account for but likely contributed to prevention, an estimation issue faced in
20 contact tracing for STD/HIV [19-21]. The various approaches to CI/CT and guidance published
21 all rely on individuals' willingness and ability to comply with testing, isolation, and quarantine
22 measures for CI/CT to be considered effective [22]. The potential impact of CI/CT on
23 prevention of COVID-19 was not captured through ELC performance measures but has been
24 estimated in recent publications that have included timeliness of notification and other NPIs [23-
25 28]. In the setting of COVID-19 case declines and waning support, HDs have scaled back
26 universal CI/CT towards more targeted approaches including focal outbreak response and
27 targeted case investigations in accordance with CDC and partner guidance [16, 29].

28 Our analysis of CI/CT performance metrics was subject to some limitations. First, many of the
29 64 HDs reporting these ELC data incorporated new information technology systems to handle
30 the large influx of COVID-19 case reports [30]; errors and lack of interoperability between new

1 and existing systems might have led to incomplete or erroneous data. Second, there are also
2 limitations in what can be derived from the metrics that are collected by ELC. For example, the
3 number of contacts that were notified is captured, yet there is no visibility on whether contacts
4 completed their quarantine period. Finally, this analysis was designed to describe an overview of
5 CI/CT activities executed by HDs within which structures and procedures vary across the county,
6 and this variability likely affected CI/CT performance among jurisdictions and over time, a topic
7 needing further evaluation.

8 These U.S. HDs implemented the largest recorded CI/CT response alongside other COVID-19
9 prevention interventions and delivered consistent coverage and performance using innovative
10 methods of delivery to engage individuals and affected communities. Such benefits articulate the
11 need to maintain the strong workforce infrastructure for public health services, including but not
12 limited to CI/CT, and to further build public trust and engagement in public health prevention
13 activities. Additional evaluation to understand the methods used by HDs, as they undertook
14 COVID-19 CI/CT, and their relationship to CI/CT performance metrics across HDs is underway
15 to provide insight into best practices that would inform future public health responses . In
16 addition, we plan to evaluate individual behaviors of persons following notifications by HDs of
17 an infection or exposure related to their willingness and ability to isolate or quarantine. Our
18 findings also emphasize the importance of having both workforce and technological
19 infrastructure, as well as established community engagement, to respond to and effectively
20 combat future public health threats and to address ongoing public health needs.

21 **Acknowledgments**

22 The authors thank the entire ELC Evaluation team; all ELC recipients, including state, local and
23 territorial health departments; Contact Tracing and Innovations Section, State, Tribal, Local and
24 Territorial Support Task Force, COVID-19 Response, CDC.

25 **Disclaimer:** The findings and conclusions of this report are those of the authors and do not
26 necessarily represent the official position of the Centers for Disease Control and Prevention.

27 Disclosures

28 SZ, MT, KDS, AS, AS, and MH, report no conflicts of interest.

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Table 1: Number of Case investigators and Contact Tracers and Case Investigator and Contact Tracer Workloads per Month, November 2020-December 2021

	November 2020	December 2020	January 2021	February 2021	March 2021	April 2021	May 2021	June 2021	July 2021	August 2021	September 2021	October 2021	November 2021	December 2021
Total # of Case Interviews	45,964	54,651	54,587	51,794	43,401	42,009	32,989	26,393	26,288	28,578	29,657	30,094	26,868	31,720
Total # of Contact Tracers	45,363	54,905	52,114	50,066	45,374	42,095	33,662	29,628	23,383	23,967	25,213	24,437	22,292	23,997
Mean # of Case Investigators per health department	867	1072	1011	977	819	778	622	498	487	539	570	568	560	634
Mean # of Contact Tracers per health department	856	1077	948	927	840	765	623	549	425	444	467	453	455	471
Mean Workload for Case Investigator	113	135	133	72	56	71	56	32	66	208	242	124	117	266
Mean Workload for Contact Tracer	114	104	91	77	58	78	64	34	52	108	110	85	67	98

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FIGURE LEGENDS

Figure 1: Flowchart of Selected Case Investigation and Contact Tracing Performance Metrics Collected by CDC through the Epidemiology and Laboratory Capacity (ELC) for Infectious Diseases Cooperative Agreements

Figure 2: Nationwide COVID-19 Case Investigation (CI) and Contact Tracing (CT) Totals from Reporting Health Departments, November 2020-December 2021

Figure 3: Calculated COVID-19 Performance Measures (mean) for CI/CT from Reporting Health Departments, November 2020 -December 2021

Figure 4: Mean Number of COVID-19 Contacts Identified and Notified by Case Investigation and Contact Tracing from Reporting Health Departments, November 2020 - December 2021

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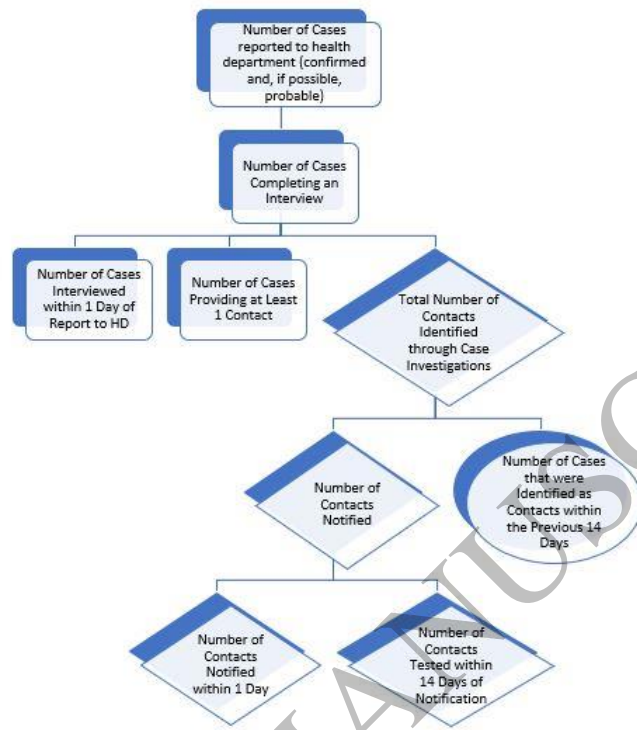


Figure 2: Nationwide COVID-19 Case Investigation and Contact Tracing Totals from Reporting Health Departments, November 2020-December 2021

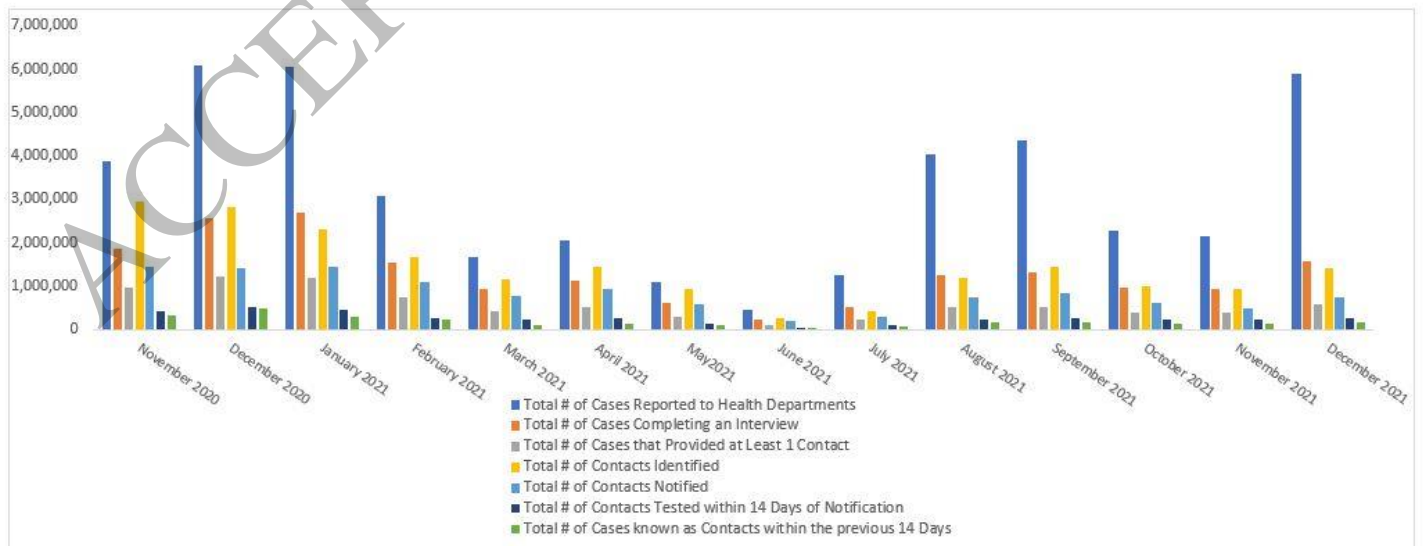


Figure 3: Calculated Means for Select COVID-19 Performance Measures for Case Investigation and Contact Tracing from Reporting Health Departments, November 2020 -December 2021

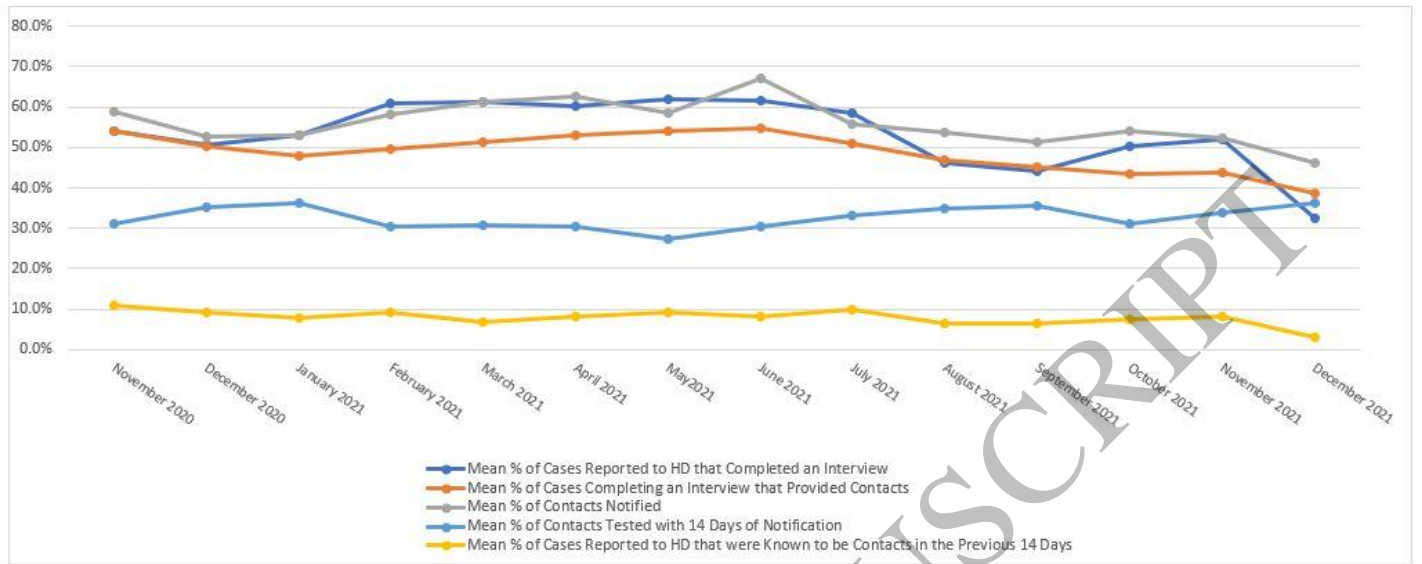


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