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A State Health Department and Health Information Exchange Partnership: an Effective Collaboration for a Data-Driven Response for COVID-19 Contact Tracing in Maryland

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Abstract

Background—Accurate, complete, timely data were essential to effective contact tracing for COVID-19. Maryland Department of Health partnered with Maryland's designated health information exchange, Chesapeake Regional Information System for Our Patients (CRISP), to establish data enhancement processes that provided the foundation for Maryland's successful contact tracing program.

Methods—Hourly, electronic positive COVID-19 test results were routed through CRISP to the contact tracing data platform. CRISP matched reports against its master patient index to enhance the record with demographic, locating, fatality, vaccination, and hospitalization data. Records were de-duplicated and flagged if associated with a congregate setting, select state universities, or recent international travel. Chi-square tests were used to assess if CRISP-added phone numbers resulted in better contact tracing outcomes.

Results—During June 15, 2020-September 1, 2021, CRISP pushed 531,094 records to the state's contact tracing data platform within an hour of receipt; of those eligible for investigation, 99% had a phone number. CRISP matched 521,731 (98%) records to their master patient index, allowing for deduplication and enrichment. CRISP flagged 15,615 cases in congregate settings and 3,304 cases as university students; these records were immediately routed for outbreak investigation. Records with an added phone number were significantly more likely to be successfully reached compared to cases with no added phone number (p=0.01).

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Conclusions—CRISP enhanced COVID-19 electronic laboratory reports with a near-instant impact on public health actions. The partnership and data processing workflows can serve as a blueprint for data modernization in public health agencies across the United States.

Summary

A robust collaboration between the Maryland Department of Health and Maryland's designated health information exchange resulted in effective, timely, data-driven COVID-19 contact tracing in Maryland.

Keywords

Health Information Exchange; Electronic Data Processing; Health Information Interoperability; Data Quality; Public Health Informatics

Introduction

The Maryland Department of Health (MDH) launched its statewide COVID-19 contact tracing program in June 2020 in response to the urgent need to stop the spread of COVID-19. To do this, MDH relied on its subject matter experts in contact tracing (from the sexually transmitted infections program) to lead and inform the development of the program to address COVID-19. Maryland's contact tracing program was established as a collaborative program led by MDH in coordination with Maryland's 24 local health departments (LHDs) and supported by a virtual call center for case investigation and contact tracing. LHDs could elect to be entirely responsible for conducting case investigations and contact tracing for all residents in their jurisdiction, without assistance from the call center. Alternatively, LHDs could elect to have the call center make the first attempt for case investigation and contact tracing for their residents and the LHD staff would be reserved for the "higher touch" situations, such as those that involved high risk settings and outbreak investigation, insufficient locating data, or spoken languages other than English or Spanish. LHDs could elect to shift between these two models as the pandemic and its response evolved. The program relied on a Salesforce-based statewide contact tracing data platform to allow for data collection by and information sharing across the various partners. Accurate, complete and timely data were essential to accurate record routing and the effective implementation of the program. MDH partnered with Maryland's health information exchange (HIE), Chesapeake Regional Information System for Our Patients (CRISP), to establish the data processes and flows that provided the foundation for Maryland's contact tracing program.

CRISP is Maryland's designated HIE and its vision is to advance health and wellness by deploying health information technology solutions adopted through cooperation and collaboration. The HIE facilitates instant sharing of health information across doctors' offices, hospitals, laboratories, radiology centers, and other health care organizations, including MDH. CRISP maintains a master patient index of individual patients identified from disparate clinical and administrative data sources in order to organize healthcare data for Maryland residents.

CRISP was a critical partner in support of Maryland's COVID-19 response, across various topic areas. Here, we describe a robust collaboration between MDH and CRISP whereby CRISP enhanced electronic test records with additional data elements such that contact tracing for COVID-19 was effective, timely, and data-driven. The collaboration also served to strengthen the existing partnership between the two organizations and established infrastructure that is being leveraged for uses beyond COVID-19 contact tracing.

Materials and Methods

To identify the data requirements and establish the data processing infrastructure needed for COVID-19 contact tracing, MDH and CRISP held regular meetings (three times a week after initial launch) to review data quality and develop the data processing algorithms and infrastructure for new software features. These meetings were also used to quickly adapt to the rapidly evolving pandemic and associated guidance released (often without advance notice) by the Centers for Disease Control and Prevention (CDC). In addition, the regularly recurring meetings allowed for real-time monitoring of data flow issues and helped establish relationships such that stakeholders quickly came together on an ad hoc basis to troubleshoot and respond to emergencies.

Hourly, electronic laboratory reports with positive COVID-19 test results were routed through CRISP to the contact tracing data platform (Figure 1). CRISP used a weighted matching algorithm on first name, middle name, last name, date of birth, address, and phone number against its master patient index to enhance the record with demographic (e.g., race and ethnicity), locating (e.g., standardized address, latest home, work, and cell phone numbers), fatality (provided by the MDH Vital Statistics Administration), vaccination (collected in the state's immunization information system), and hospitalization data (if hospitalized any time from seven days before specimen collection to 28 days after). This approach to matching is similar to how data from various sources are matched to create the CRISP master patient index, whereby a score is generated based on how well various data elements match. Records are considered a match if a certain score threshold is met, and new information is constantly being incorporated into the matching process. This algorithm matches records when exact matching would fail to identify matches (such as with name misspellings or transposed digits in phone numbers or dates of birth), although it does allow for a few false positive matches. Such false positives are continuously minimized as a result of the ever-maturing master patient index, as well as both automated and manual quality control processes that result in improvements to the algorithm's matching scheme and output.

Processes were developed to ensure complete record capture, to de-duplicate records, and to update records as new information was available. This included establishing daily true-up processing each morning with a file that looked back 90 days and contained updated hospitalization status and vaccination information as well as any missing records from the previous day. This also included setting up an application programming interface (API) connection between the contact tracing data platform and CRISP's master patient index that prevented the creation of duplicate records when cases were created manually in the contact tracing data platform before the electronic laboratory result was received.

CRISP flagged any record associated with a congregate setting based on matching the address on the test order against a roster of nursing homes, assisted living facilities, hospices, some group homes, and correctional facilities. After entering into appropriate data sharing agreements, CRISP also flagged any student record associated with ten state universities by reconciling the name and date of birth on the test order against a roster of student names provided by the university. The records that were flagged as congregate settings or university students were immediately routed for outbreak investigation by experienced investigators without requiring an initial interview by contact tracers. Starting in June of 2021, CRISP flagged any cases that matched (by first and last names, date of birth, street address, city, state, and zip code) individuals on rosters of recent international travelers that were provided daily by the CDC's Division of Global Migration and Quarantine, thereby allowing specimens to be prioritized for genetic sequencing and subsequent investigations into new circulating variants. CRISP geocoded all addresses using a combination of publicly available address APIs and Maryland specific APIs to identify county of residence, ensuring accurate routing of records to the call center or the appropriate LHD for prompt investigation (Figure 2).

As point of care rapid tests were rolled out to private healthcare practitioners (who do not typically report laboratory results to MDH as commercial laboratories do), CRISP developed an online reporting portal for providers to directly and electronically report rapid test results. And as guidance was issued for the interpretation of rapid antigen tests (e.g., when a rapid test is followed within 48 hours by polymerase chain reaction (PCR) tests), CRISP flagged records that had a negative PCR test collected within 48 hours of a positive antigen test. As the potential for COVID-19 reinfection became apparent, CRISP flagged records with a positive PCR test at least 90 days after the initial positive test. Enriching the records with vaccination data led to recognition of post-vaccination infections and allowed for public health actions to be taken accounting for vaccination status. Table 1 lists the data elements added by CRISP to support COVID-19 contact tracing in Maryland.

Contact tracing data were analyzed for the period June 15, 2020-September 1, 2021 and the following were determined: the aggregate number of results pushed to the contact tracing data platform; the number of data elements added to records; and the number of records flagged as congregate settings, universities, and reinfections. We determined the proportion of PCR-positive and antigen test positive cases with a phone number, the proportion of cases "successfully reached" (the phone was answered), and the proportion of cases with a completed interview. To assess if phone numbers that were added by CRISP resulted in better contact tracing outcomes, we examined data for the period October 2021-December 2021, which was a period when our data collection methods were stable and consistent and case volume was sufficient for performing statistical analyses. Using SAS version 9.4, we conducted chi-square tests (at the 95% confidence level) to compare whether there was a significant difference in the proportion of records that were successfully reached by whether CRISP added a phone number to the record. We also compared whether the "best number to call" (when documented during the contact tracing interview) was the CRISP-added phone number or the number included on the electronic laboratory result. Finally, we examined the number of electronic laboratory results that did not have any phone number, and determined the proportion that had a phone number added by CRISP.

Results

For the period June 15, 2020-September 1, 2021, CRISP pushed a total of 531,094 records (438,620 positive PCR test results and 92,474 positive antigen test results) to the contact tracing data platform within an hour of receipt; of these, 99% of the records had a phone number. CRISP matched 521,731 (98%) records to their master patient index, which allowed for deduplication and data enrichment. Race was added to records missing that information such that the proportion of records with race increased from 54% to 85.6%, and ethnicity was added such that the proportion of records with ethnicity increased from 34.9% to 92.8%.

CRISP flagged 1,952 records that had a specimen test negative by PCR that was collected within 48 hours of a positive antigen test, which allowed individuals to be released from isolation and quarantine when appropriate. When records were flagged as reinfections (n=530), case investigators and contact tracers were able to ask specific questions to better understand the patient's clinical course. To facilitate investigations of COVID-19 in high risk settings, CRISP flagged 15,615 cases in congregate settings including nursing homes, assisted living facilities, hospices, some group homes, and correctional institutions. Ten Maryland public universities entered into data sharing agreements with CRISP and provided student rosters; 3,304 cases were flagged as students enrolled in those Maryland public universities. Between June 2020 and September 2021, CRISP flagged an average of 0–11 cases a day with recent international travel that prompted specimen retrieval from commercial laboratories, thereby facilitating prioritization for sequencing and variant investigations. CRISP geo-coded 99.6% of addresses to route cases for case investigation and contact tracing by patient county of residence, which was critical in ensuring records were routed appropriately to the patient's LHD or to the call center.

Cascades illustrating contact tracing outcomes for PCR-confirmed cases and for exposed contacts were published weekly to the MDH website on Wednesdays with data collected through the previous Saturday (Figure 3). Of 498,739 cases pushed to the contact tracing data platform and eligible for investigation through Saturday, August 28, 2021, 99% had a phone number, 79% were successfully reached and 71% completed an interview.

In order to determine if CRISP-added phone numbers improved contact tracing outcomes and to maximize data quality, we narrowed our focus to the period October 2021-December 2021. During that time, CRISP matched 258,207 case records to its master patient index. Of those, 153,163 (59.3%) had a complete phone number added by CRISP that differed from what was reported on the electronic laboratory result. CRISP added a phone number to 78% of the 11,587 cases that were reported during this same time period with no phone number on the electronic laboratory result. 70.4% of the 153,163 case records with an added phone number were marked as successfully reached, compared to 69.6% of cases with no added phone number, which was a statistically significant difference (p=0.01) by chi-square analysis.

Of the 153,163 records with a complete phone number added by CRISP, 12,033 (7.9%) listed the CRISP phone number as the best number to call or text, although 67% of the 153,163 records did not indicate a "best number to call," which is captured by the contact

tracer during the interview. When focusing the analysis on only cases with a best number to call or text, 23.7% of records with a CRISP-added phone number listed that number as the best number to call or text.

Discussion

Throughout the pandemic, the robust collaboration between CRISP and the MDH contact tracing program allowed for timely and data-informed case investigations and contact tracing. Having multiple, regular meetings each week laid the foundation for effectively handling a variety of topics: solving immediate problems, requesting analyses that informed decision making, creating requirements for and rapid demonstrations of new functionality, and quick resolution of data issues. These meetings (held virtually because of the pandemic) were an important forum where all issues were discussed and dealt with quickly, which was critical to support the hourly data feeds to the system. The information exchanged at the meetings enabled both MDH and CRISP to effectively prepare and adapt for upcoming changes, such as once COVID-19 vaccines were available and when the potential for reinfection was recognized.

CRISP's ability to integrate data from multiple sources allowed positive COVID-19 case records to be enhanced with accurate, up-to-date information before they were pushed to the contact tracing data platform for case investigation and contact tracing. CRISP's matching and deduplication algorithms reduced the burden on contact tracers and Maryland residents by reducing repeated outreach attempts stemming from serial or persistent positive results or variations in the spelling of names. The system was particularly scalable, having been designed for hourly batch volumes of 200–400 electronic reports and sustaining through multiple surges when hourly batches reached many thousands of cases.

Cases were efficiently routed for investigation based on their address of residence, either to the state-contracted call center or to the LHD, depending on LHD preference. Regardless of whether the LHD relied on the call center for the first outreach attempt, when records were flagged as being in a nursing home, assisted living facility, correctional institution, or one of the participating universities, the records bypassed the call center and were directed to the hands of those with specialized skills to conduct outbreak investigations and work with specific vulnerable populations.

This data integration and linkage translated into more complete records and greater success in locating and interviewing Maryland cases than observed in many other jurisdictions. (1) (2)

The enhanced records also provided greater ability to assess disparities and inequities in contact tracing outcomes across Maryland populations (e.g., by race and ethnicity) in order to implement targeted outreach. Targeted outreach took the form of tailored messaging about contact tracing, making specific provisions of resources for isolation and quarantine, and establishment of testing sites where they were needed most.

Rapid identification and investigation of post-vaccination COVID-19 infections and reinfection cases allowed for timely outreach to the case to provide appropriate guidance

and a more nuanced investigation. In addition, it allowed for important, time-sensitive public health actions (e.g., requesting specimens from commercial laboratories that are often held for a limited time only) so that genetic sequencing could be conducted. The ability to take swift action contributed to developing, as early as possible, an understanding of the characteristics of emerging coronavirus variant lineages, (3) and provide valuable insight to inform whether additional public health action was needed. When records were flagged that a negative PCR test had been collected within 48 hours of a positive antigen test (with the interpretation that that individual was negative for COVID-19), individuals were flagged for release from isolation. This removed the reliance on human investigators having to identify and access a complete set of laboratory results, having to correctly interpret test results and map those results to rapidly evolving guidance, and subsequently taking appropriate public health actions.

Since their promotion through the Health Information Technology Economic and Clinical Health (HITECH) Act, a core function of HIEs has been to improve coordination with public health agencies. (4) These initial public health efforts, however, focused almost exclusively on development of electronic lab reporting, vaccination registries, and sentinel surveillance systems, driven, in part, by Centers for Medicare and Medicaid Services reporting requirements. (5)(6) Although early advocates of HIE-public health partnerships recognized their potential to support a broader set of activities, (7) there are limited such use cases in the published literature. A 2014 analysis of regional, state, and multi-state HIEs found that only 35% of HIEs identified a public health agency as one of their participating organizations. (8) Similarly, a 2017 systematic review of HIE use, comprising 58 studies published during 1990 and 2015, found low rates of public health participation or awareness of HIEs. (9) The recognition of the need for a more central role for HIEs (such as CRISP) in public health infrastructure has been heightened during the COVID-19 pandemic. (10)

The workflows developed for COVID-19 contact tracing are not special or unique to COVID-19 and could easily be adapted to other use cases or diseases, including sexually transmitted diseases. These workflows could be applied to other diseases that require similar actions when a case is detected, such as monitoring returning travelers from Ebola-affected countries or the identification and contact tracing of syphilis and HIV cases. Even if data enhancement is not required for immediate public health action, it can contribute to a more complete understanding of disease in the population so that longer-term interventions can be developed and targeted appropriately (e.g., more complete race and ethnicity data allow for improved understanding of health inequities and the development of interventions focused on affected populations). Moreover, establishing similar workflows could potentially contribute to dismantling data silos that have kept sexually transmitted diseases and other infectious diseases separate from each other and have created barriers to information sharing and collaboration across public health programs.

This is not the first effort whereby data enhancement by an HIE improves the data completeness and quality of laboratory data used for public health purposes; (11) (12) however, this is the first effort that describes how an HIE can enhance data with a near-instant impact on the public health actions that are taken. The effort involved in establishing and maintaining this effective data processing infrastructure for contact tracing does run the

risk of being a single purpose effort. However, even if this specific technology is abandoned, the relationships that were forged and approaches to data linkage and provision will serve longer-term purposes as the CRISP-MDH partnership is only growing.

The federal government has made a commitment to investing in public health infrastructure, and specifically data modernization, and this work puts Maryland in a great position as it embarks on a more strategic, global approach to data modernization efforts. In 2016, the US Department of Health and Human Services launched the Public Health 3.0 initiative and offered recommendations and a description of the environment needed to support health departments as they evolve towards the Public Health 3.0 model. In one of the five main recommendations, the model encouraged public and private stakeholders' collaborations towards enabling "real-time and geographically granular data to be shared, linked, and synthesized to inform action." (13) More recently, the Essential Public Health Services (EPHS) Framework was revised during the pandemic. Under its Assessment domain, the framework emphasizes the importance of assessing and monitoring the population's health through "maintaining an ongoing understanding of health in the jurisdiction by collecting, monitoring, and analyzing data on health and factors that influence health to identify threats, patterns, and emerging issues." (14)

As MDH pursues strategic initiatives to strengthen public health infrastructure, the groundwork that was laid for COVID-19 contact tracing provides a strong foundation for data modernization and public health efforts. It also clearly demonstrates that expanding the scope of the collaboration, data aggregation, and enrichment between CRISP and MDH holds the promise of unlocking great potential for the secondary use of clinical data for public health purposes beyond COVID-19. In 2022, CRISP's role as a public health data utility for Maryland was formalized in legislation (Article – Health – General § 19–145 Annotated Code of Maryland), cementing the role that the health information exchange in Maryland plays in advancing disease control through the collection, aggregation and analysis of clinical, public health and administrative data and by facilitating the communication between public health officials and clinical providers. Even as the need for COVID-19 contact tracing wanes, the data enhancement workflows described here have been adapted to support the public health response to monkeypox in Maryland; hopefully they will serve as a useful blueprint for data modernization in public health agencies across the United States.

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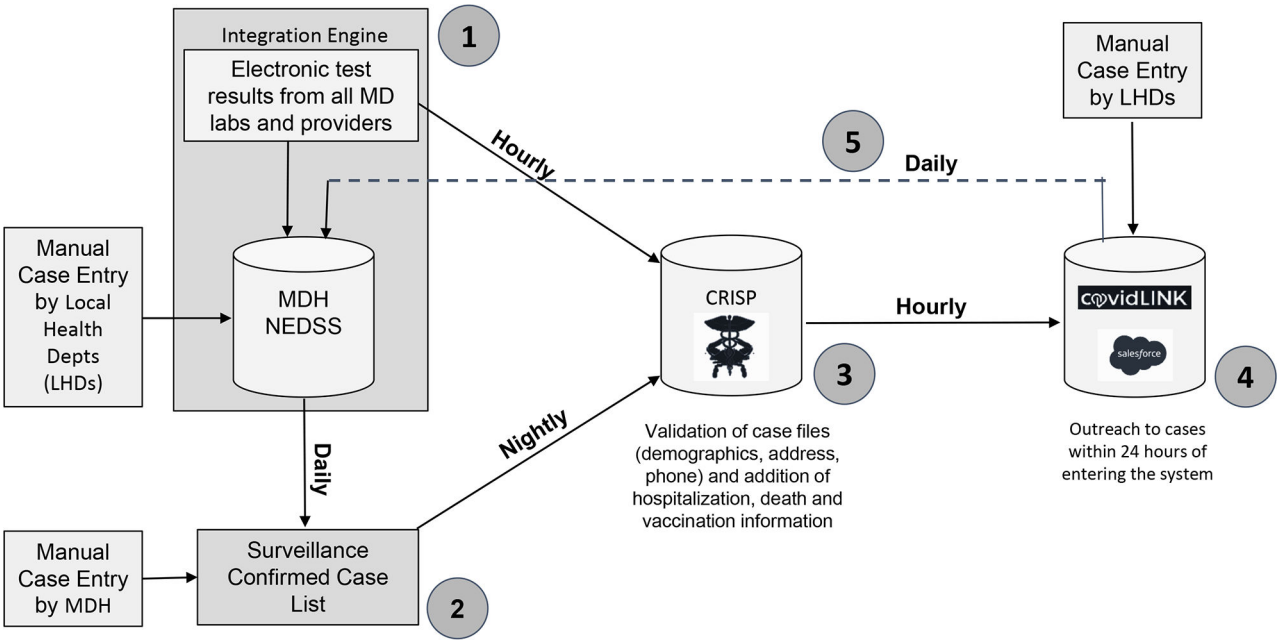

Figure 1. High level data flow for contact tracing data in Maryland

COVID-19 electronic laboratory results (ELRs) reported to the Maryland Department of Health (MDH) are received electronically in HL7 format from the majority of providers by a Rhapsody integration engine (#1). ELRs are pushed simultaneously to the state communicable disease surveillance database (NEDSS=National Electronic Disease Surveillance System) for further processing and to the Chesapeake Regional Information System for Our Patients (CRISP, Maryland's health information exchange) (#3). Cases can also be manually entered and are pushed to a confirmed case database (#2) which is pushed to CRISP nightly for reconciliation. CRISP enhances the reports and pushes the enhanced reports to the contact tracing data platform (covidLINK) (#4) hourly, where a first outreach attempt is made for contact tracing within 24 hours of receiving the data. Once a case has been traced and cleared from isolation, records flow back to NEDSS daily to improve the completeness of case data (#5).

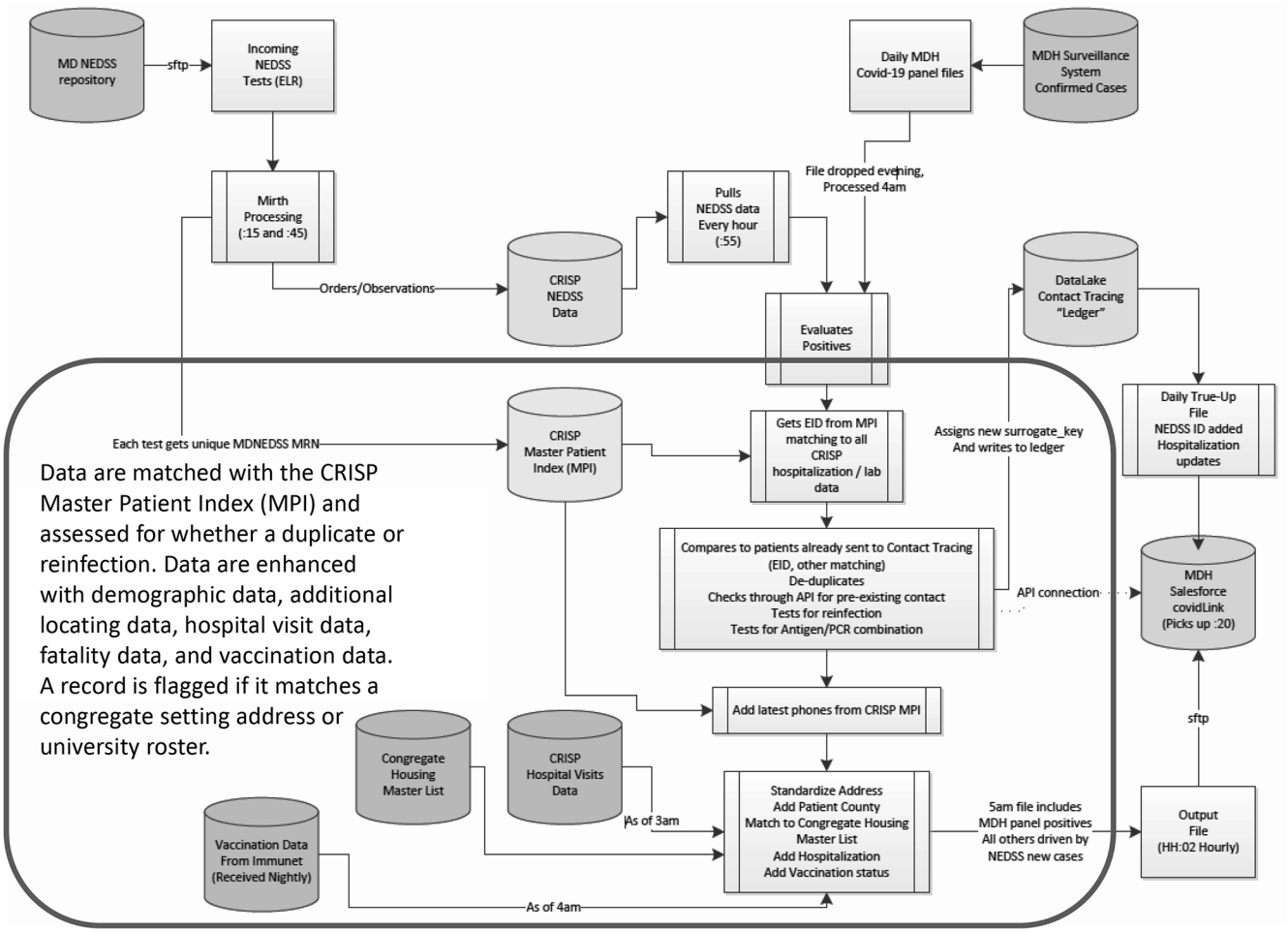

Figure 2. More detailed data flow for contact tracing data in Maryland

This diagram illustrates the same data flow as in Figure 1 but presents additional detail regarding Chesapeake Regional Information System for Our Patients (CRISP) processing and record enhancements. Data enhancements primarily occur within the black circle. API=application programming interface, CRISP=Chesapeake Regional Information System for Our Patients, EID=enterprise identifier, MDH=Maryland Department of Health, MPI= master patient index, NEDSS=National Electronic Disease Surveillance System, PCR=polymerase chain reaction.

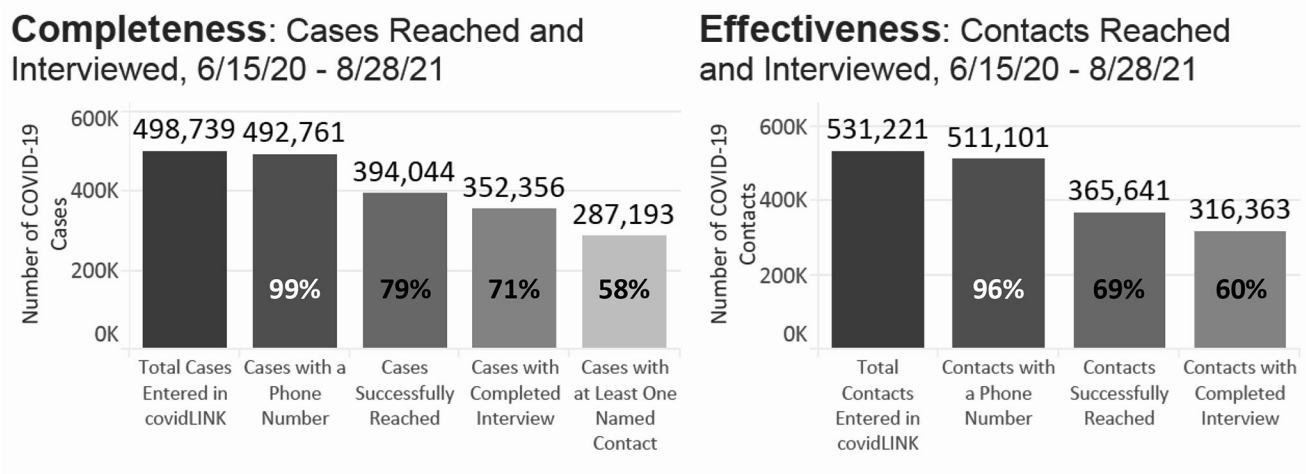

Figure 3. Contact Tracing Outcomes in Maryland, PCR- and Antigen Test-positive Cases

"Cascades" illustrating contact tracing outcomes for cases and possible contacts entered into the contact tracing data platform as published to the MDH website. The number of cases reflects those pushed to the contact tracing data platform and eligible for investigation. "Successfully reached" means that someone answered the phone (but might not have completed an interview).

Table 1.

List of data elements provided to the contact tracing program, including sources and frequency of delivery. Health Level 7 (HL7), in the context of the table, refers to the primary source, both when a case is reported to the Chesapeake Regional Information System for Our Patients (CRISP) directly or when reported to the Maryland Department of Health (MDH)'s National Electronic Disease Surveillance System (NEDSS) via electronic laboratory reporting (ELR). ImmuNet is Maryland's Immunization Information System. EID=enterprise identifier, MRN=medical record number.

	Data Element	Source	Frequency	Notes
Metadata				
	Surrogate Key (Unique ID)	CRISP	Hourly	Used for the daily true-up process
	Enterprise Identifier (EID)	CRISP's MPI		
	NEDSS ID	HL7	Daily	
	Case Source	CRISP	Hourly & Daily	Indicating whether case was received by CRISP through NEDSS or MDH Panel
	CRISP Date of Receipt	CRISP	Hourly & Daily	Includes timestamp
Test Details				
	Test Result	HL7/MDH Panel	Hourly	
	Observation ID (test result code)	HL7	Hourly & Daily	
	Observation Name (test result in full)	HL7	Hourly & Daily	
	Date of Result	HL7/MDH Panel	Hourly	
	Specimen Collection Date	HL7/MDH Panel	Hourly & Daily	
	Specimen Receipt Date	HL7/MDH Panel	Hourly & Daily	
	Result Reporting Date	HL7/MDH Panel	Hourly & Daily	
	Ordering Provider's Name	HL7/MDH Panel	Hourly & Daily	
	Ordering Provider's Phone #	HL7/MDH Panel	Hourly & Daily	
	Ordering Facility	HL7/MDH Panel	Hourly & Daily	
	Patient's MRN at the Facility	CRISP's MPI	Hourly & Daily	Facility's MRN # used for matching
	Reinfection Check	CRISP	Hourly	Flagged records with a positive PCR test at least 90 days after the initial positive test
PCR vs Antigen				
	PCR Accession # Triggering the Case	HL7	Hourly	
	Performing Lab of the PCR test	HL7	Hourly	
	PCR LOINC Code	HL7	Hourly	

	Data Element	Source	Frequency	Notes
	Result Date	HL7	Hourly	
	Presence of Negative PCR Check	CRISP	Hourly	Used for when initial test is antigen positive and is followed by negative PCR
	Result Classification	CRISP	Hourly	Probable/Confirmed, based on presence of PCR results within 48 hours prior to an antigen result
	History of Result Classification	CRISP	Hourly & Daily	Captures classification history, if different
Patient Demographics				
	Patient's First Name (as provided)	HL7/MDH Panel	Hourly	
	Patient's Middle Name	NEDSS	Hourly	
	Patient's Last Name (as provided)	HL7/MDH Panel	Hourly	
	Hispanic Last Name Check	Census Data	Hourly	Determining likelihood of spoken language for more effective contact tracing case management.
	Patient's Date of Birth (as provided)	HL7/MDH Panel	Hourly	
	Patient's Mortality Status	MDH Panel	Daily	
	Date of Death	MDH Panel	Daily	
	Patient's Race	HL7/MDH Panel/CRISP	Nightly	Based on other healthcare transactions, utilized when none was
	Patient's Ethnicity	HL7/MDH Panel/CRISP	Nightly	submitted via testing. Also provided to NEDSS.
	Patient's Gender (as provided)	HL7/MDH Panel		
Patient Contact Information				
	Patient's Address 1 (as provided)	HL7/MDH Panel	Hourly	
	Patien's Address 2 (as provided)	HL7/MDH Panel	Hourly	
	Patient's City (as provided)	HL7/MDH Panel	Hourly	
	Patient's State (as provided)	HL7/MDH Panel	Hourly	
	Patient's Zip (as provided)	HL7/MDH Panel	Hourly	
	Patient's Appropriate County	Google API	Hourly	Added for more effective case routing to local health departments
	Patient's Listed Phone	HL7/MDH Panel	Hourly	
	Patient's Latest Home Phone #	CRISP's MPI	Hourly	
	Patient's Latest Work Phone	CRISP's MPI	Hourly	
	Patien's Latest Cell Phone	CRISP's MPI	Hourly	
	Patient's Email	CRISP's MPI	Hourly	

	Data Element	Source	Frequency	Notes
	Patient Recent International Travel Check	CRISP	Daily	Based on pre-submitted CDC travelers list
Addresses Geocoding				
	Standardized Street Address	Google API	Hourly & Daily	To allow household grouping of cases, and overall address quality improvement
	Standardized Unit/Apartment	Google API	Hourly & Daily	
	Standardized City Name	Google API	Hourly & Daily	
	Standardized State Name	Google API	Hourly & Daily	
	Standardized Zip code	Google API	Hourly & Daily	
Hospitalizations				
	Patient Hospitalization Status	CRISP	Hourly & Daily	"Yes" or "No"
	Patient Hospitalization Admission Date	CRISP	Hourly & Daily	
	Patient Hospitalization Discharge Status	CRISP	Hourly & Daily	
	Patient Hospitalization Discharge Date	CRISP	Hourly & Daily	
Congregate Settings				
	Congregate Housing Address Check	CRISP	Hourly	Standardized address is checked against a list of congregate housing facilities
	Congregate Housing Facility Type	CRISP	Hourly	List includes Nursing Homes, Assisted Living, Shelters, Hospice, Correctional Facilities, etc.
	Congregate Housing Facility Name	CRISP	Hourly	
	Congregate Housing Facility Phone #	CRISP	Hourly	Updated regularly
Schools & Universities				
	Name of University or School	CRISP	Hourly	Based on pre-submitted school and university rosters
	Type of School	CRISP	Hourly	
	School County	CRISP	Hourly	
	Student Permanent Address	CRISP	Hourly	
	Student School Address	CRISP	Hourly	
	Student School Grade (as applicable)	CRISP	Hourly	
Immunization Information (for each dose)				
	ImmuNet ID	MD Immunet	Hourly & Daily	Included for match verification purposes
	ImmuNet Patient First Name	MD Immunet	Hourly & Daily	
	ImmuNet Patient Middle Name	MD Immunet	Hourly & Daily	

	Data Element	Source	Frequency	Notes
	ImmuNet Patient Last Name	MD Immunet	Hourly & Daily	
	ImmuNet Patient Date of Birth	MD Immunet	Hourly & Daily	
	Vaccination Date of Dose	MD Immunet	Hourly & Daily	Single dose immunizations will show under dose 1
	Vaccine Lot # of Dose	MD Immunet	Hourly & Daily	(e.g. EL9264)
	Vaccine Full Name for Dose	MD Immunet	Hourly & Daily	(e.g. COVID-19 mRNA LNP-S PF 0.3mL)
	Vaccine Manufacturer Code Dose	MD Immunet	Hourly & Daily	(e.g. PFR, MOD or JSN)
	Vaccine Dose Administering Organization Name	MD Immunet	Hourly & Daily	
	Cumulative Vaccine Doses	MD Immunet	Hourly & Daily	For management of different vaccination regimens

HL7, in the context of the table, refers to the primary source, both when a case is reported CRISP directly or when reported through NEDSS (ELR)

ImmuNet is Maryland's Information System