

Using DNA to Reunify Families Separated by Disasters

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October 14, 2024

ABSTRACT | *In the aftermath of disasters, prompt and safe family reunification is crucial, especially for pre-verbal children separated from their families. Settings may remain unsafe in the aftermath of disasters, and without the application of technology, traditional efforts to reunify families can be prolonged. DNA technologies offer a powerful tool for facilitating family reunification after disasters with high accuracy, building on their long-standing use in disaster victim identification. While DNA data can expedite a safe reunification process, its use carries distinct risks, such as privacy concerns, potential misuse, and the revelation of sensitive information. Careful planning to build partnerships and infrastructure and to address ethical considerations is essential to mitigate these risks, ensuring that DNA-led reunification protocols uphold the best interests of children and families.*

Literatures Salient to the Experiences of Children Separated from Their Families During Disasters

In disasters (defined as events that overwhelm existing infrastructure to adequately respond), children are at risk of family separations, which are harmful to the health of both children and adult family members (Blake and Stevenson, 2009; Mace et al., 2010; Rodriguez-Llanes et al., 2013). Children separated in their infancy or early childhood are unlikely to be able to recount contact information of family members. Given that every day of a separation matters to a child’s health and well-being, that children—especially young children—might be at risk of kidnapping or exploitation following a disaster, and that disasters are becoming increasingly common, the global community must be prepared to reunify families following a disaster as quickly and as safely as possible, in line with the best interest of the child (Dreby, 2015; Starmer et al., 2010; Whitaker et al., 2005). DNA technologies might provide a powerful tool to reconnect separated families. However, access to DNA technologies should be distributed equitably, and resulting data or reports delivered through a trauma-informed approach that advances children’s and families’ rights in a manner that is both ethical and secure (Barnert et al., 2021). Children develop best in the context of safe, nurturing relationships, especially with caregivers (World Health Organization, 2009). Parents’ impact on

their children’s well-being is significant in the earliest years of life, and parental relationships provide a protective shield against childhood traumas, with effects observed across the life course (MacKenzie et al., 2017; Miranda and Legha, 2019). Thus, the separation of families after disasters and subsequent reunification can have significant ramifications, which can be understood within theoretical rights frameworks as well as through empirical evidence.

Theoretical and Legal Frameworks

Existing frameworks from the fields of child development, trauma, and human rights can be applied to help understand children’s experiences with separation after a disaster, underscoring the importance of prompt, safe reunification. Examples include the following:

- John Bowlby and Mary Ainsworth’s *attachment theory* attests to parents’ quintessential impact on children’s well-being (Ainsworth and Bell, 1970; Bowlby, 1973). The theory posits that in healthy child-parent relationships, children undergo a critical process of attachment to their parents in early years that forms a secure base for children’s lifelong healthy attachments and exploration of the world. When children become separated from their parents, a failure to form healthy attachments—including to re-engage in attachment when reunited (i.e., detachment)—might occur, negatively impacting children’s internal working model

of the world, their exploratory behaviors, and their adaptability. Thus, when disasters separate families, the disruption in the process of healthy attachment can have lifelong implications. The disruption of attachment might be especially harmful if sudden and/or unexpected, which frequently occurs in disasters.

- Pauline Boss's theory of *ambiguous loss* addresses situations characterized by uncertainty about a family member's fate or whereabouts (Boss, 1999). Ambiguous loss is defined as a grief that is unclear or indeterminate because the outcome is unknown, resulting in a "tormenting or stressful" loss, intensified by its ambiguity (Boss, 1999). Because children and their family members can experience significant ambiguous loss when separated in disasters, often not knowing if their missing loved one is alive or dead, family separations caused by disasters can be extremely traumatic, underscoring the importance of reunification.
- The *life course health development framework*, which demonstrates that health trajectories are the product of risk and protective factors operating in genetic, biological, behavioral, social, and economic contexts, addresses how early life experiences have lasting effects on health (Halfon and Hochstein, 2002). Early life experiences of being separated from family due to a disaster can negatively affect lifelong health trajectories.
- As framed by Judith Herman, *trauma* is an experience that "overwhelms the ordinary human adaptation to life" (Herman, 2015). The experience of family separation can be categorized as a profound trauma that poses a destructive threat to children's healthy development (Agorastos et al., 2019). The trauma of family separation can be compounded by the trauma of the disaster event itself, and reunifying children with their families is paramount to the steps necessary for healing.

In addition to the theoretical frameworks discussed above, a human rights framework provides both a conceptual and legal lens for understanding children's rights and experiences in separation after a disaster. Reunifying families separated by disasters upholds fundamental human rights, which is important to underscore because disasters are expected to continue to increase (Chung and Blake, 2014; Starmer et al., 2010). The integrity of the family unit is protected by international human rights and humanitarian law. Articles 8, 9, and 18 of the United Nations (UN) Convention on the Rights of the Child (a treaty which, notably, the United States is the only nation in the UN yet to ratify) address the importance of preventing familial separation and promoting

family reunifications, in line with the best interest of the child standard (United Nations General Assembly, 1989). The rights of families also are protected by the UN International Covenant on Civil and Political Rights and on Economic, Social, and Cultural Rights, which maintain the right to the protection of the family unit and the right to the highest attainable standards of physical and mental health, including provision of necessary steps "for the healthy development of the child" (United Nations General Assembly, 1966). Thus, developing and implementing methods to reunify families separated after a disaster is critical to upholding fundamental human rights.

Empirical Evidence on Family Separation

In alignment with the above frameworks, mounting empirical evidence demonstrates the persistent harm of family separation (except when necessary for child safety). Growing evidence demonstrates that separating families, even for a short while, is harmful to children's health and well-being (Shadid and Sidhu, 2021). Children's responses to family separation include emotional distress, anger, feelings of abandonment and insecurity, attachment difficulties, developmental regression, anxiety, depression, and post-traumatic stress disorder (Lovato et al., 2018; Miller et al., 2018; Wood, 2018). Family separation also negatively affects children's academic success, peer relationships, and other social outcomes (Gindling and Poggio, 2012; Lovato et al., 2018), and causes negative effects on health and well-being that reverberate across the life course (Delgado et al., 2021; Schapiro et al., 2013). The effects on physical health likely occur in large part by triggering toxic stress pathways that could increase the risks of cardiovascular disease, cancer, and premature mortality, among other negative health effects, into adulthood (Bucci et al., 2016; Kalmakis and Chandler, 2015; Krushas and Schwartz, 2022). The examination of life histories of young adults who had been forcibly separated from their families as children during war and underwent reunification decades later indicates that the harm family separation imposes on children's health is likely to be lifelong (Barnert et al., 2019; Barnert et al., 2015). While these studies are not specific to the context of disasters, given the fundamental nature of the parent-child bond to child development and well-being, it is likely that separations caused by war create a universality of effects as with separations caused by disasters, exacerbated by the trauma from the separation event (Barnert, 2023). Overall, given the demonstrable and likely lifelong harm of family separations to children, multiple expert groups have issued public statements that denounce the separation of families and prioritize the prompt reunification of children with their

families (American College of Emergency Physicians, 2019; Disaster Preparedness Advisory Council & Committee On Pediatric Emergency Medicine, 2015; McNutt et al., 2018).

Children, Disasters, and Family Separation

Disasters are a major risk to the well-being of children because disasters can cause sudden family separations and can be of considerable magnitude in terms of the number of children separated from their families, the number of fatalities, and the resultant effects of infrastructure. A review of the disaster literature with respect to children's experiences with separations illuminates the public health importance of addressing children's experiences with separation after disasters. Children are especially vulnerable, and their needs differ from those of adults in disasters, given children's physical, behavioral, and developmental states (Disaster Preparedness Advisory Council & Committee On Pediatric Emergency Medicine, 2015). For example, children might not understand risk of or be able to flee from hazardous situations, nor care for themselves via feeding, toileting, and clothing. Further, disasters can cause family separations of sizeable magnitude. Thousands of children were separated from their parents in the aftermaths of the Haiti earthquake of 2010 and the Southeast Asia Tsunami of 2004 (Balsari et al., 2010; Inter-agency Working Group on Unaccompanied and Separated Children, 2005; International Rescue Committee, 2011). With disasters expected to increase in frequency and severity due to global climate change, population growth, worsening pollution, and political instability, more children are expected to become separated from their families as a result of disasters (Chung and Blake, 2014; Starmer et al., 2010). Whether a disaster occurs by a force of nature or as a man-made result of human intent, preparation for family separations and prioritization of prompt, accessible, and safe tools to facilitate family reunifications are necessary (Chung and Blake, 2014).

Settings may be unsafe in the aftermath of disasters, and efforts to reunify families can be prolonged, which can especially be the case for very young and nonverbal children. Young children, especially preverbal children, are likely to have difficulty speaking for themselves to adults and are unlikely to be able to identify themselves or their family members. Because traditional document and investigative-based efforts (e.g., review of birth certificates and hospital records) are time-consuming, there is a need for tools that do not rely on children recalling and verbalizing facts about their family's identity to support prompt reunifications. Delays in reunification can be prolonged, including in the domestic US context. During the hurricane season of 2005, that saw both Hurricane Katrina and Hurricane Rita

devastate the Gulf Coast region, over 5,000 children were separated from their parents, and document-based and investigative efforts took over six months to reunify families (Broughton et al., 2006). The chaos of disasters also may mask efforts to kidnap or traffic children. There were reports of child kidnapping and trafficking following the 2004 tsunami in South Asia, the 2010 Haiti earthquake, and the 2013 typhoon in the Philippines, further underscoring the susceptibility of children to family separations in disasters (Branigan, 2013; Evans, 2010; Whitaker et al., 2005). In sum, methods that facilitate prompt, safe post-disaster family reunifications are needed to help protect the best interest of children.

Use of DNA and Other Tools for Post-Disaster Identity Management

There are existing tools for identifying disaster victims (including non-DNA biometrics and DNA for deceased victim identification) to better elucidate the positionality of DNA data for post-disaster reunifications of living family members.

Current Tools for Identity Management in Disasters

Existing tools to support identification of displaced people or decedents in disasters can be grouped into: traditional metrics (e.g., date of birth, weight, height, hair color, tattoos, and clothing), technological tools (e.g., web-based people locator, photograph-based tools, barcodes, geographical information systems, and global positioning systems), and biometric measures (e.g., fingerprints, facial recognition technology, iris scans, gait recognition, DNA data, and palm prints) (Chung et al., 2012; Pate, 2008; Pearson et al., 2012). Biometric tools have the benefit, in comparison to circumstantial evidence, of being difficult to falsify. Biometrics should not be used in isolation but can supplement other evidence to identify individuals and to re-connect family members (Barnert et al., 2021). Further evaluative research is needed to empirically understand the utility, risks, and benefits of each of these approaches (Pate, 2008). The use of technology to support identification of children after disasters can be important to unequivocally verify children's identity (e.g., to protect from kidnapping), or to unequivocally identify living children where there is not utmost confidence in their physical recognizability (e.g., a relative receiving an infant in instances when the parents are deceased or otherwise unavailable, or if a significant time lapse has occurred between the separation and identification such that the child's physical appearance has substantially changed).

DNA Data for Identity and Kinship

The only biometric tool that can be used for both identification and kinship verification is DNA data, which comes with privacy and confidentiality risks, but also a high degree of accuracy. DNA data for identification usually relies upon the analysis of short tandem repeats (STRs), regions of the genome that are highly polymorphic and thereby variable among individuals and are not linked to evolutionarily selected traits, such as visible traits or health conditions (Katsanis and Wagner, 2013; Wyner et al., 2020). A common set of 20 STRs are used in the United States for forensic analysis in the criminal legal system and for relationship testing. The 20 STRs are always informative for genetic parent-child relationships, usually informative for verifying full sibling relationships, and sometimes informative for verifying more distant relationships, such as with grandparent-grandchild and half-sibling relationships. Y-chromosome STRs and mitochondrial DNA analysis also can be useful for kinship analyses. More distant relationships are better established using single nucleotide polymorphisms (SNPs) to compare haplotype patterns, but some SNPs and haplotypes are associated with visible traits and health conditions (Katsanis and Kim, 2014; Lee et al., 2008). DNA data can be used for verifying identity and close genetic relationships quickly (e.g., using rapid DNA technology) and with a high degree of accuracy, which is pertinent to disasters when families are displaced and when reunifications of displaced family members require both identification and kinship verification (Turingan et al., 2020).

DNA for Disaster Victim Identification (DVI)

In considering the role of DNA in post-disaster family reunifications, it is useful to note that DNA is already widely accepted by the international community as a reliable method to verify decedents in DVI (International Committee of the Red Cross, 2009; Interpol, 2023; Parsons et al., 2019). Specifically, DNA data have been useful for identifying victims and repatriating human remains to families in closed disasters (events resulting in a known number of victims from an identifiable group), open disasters (events resulting in an unknown number of victims without prior records of victims), and mixed disasters (events having components of both closed and open disasters). For example, DNA data were used to identify victims in events not limited to but including the MH17 airplane crash in 2014 (closed disaster), the 2004 Indian Ocean Tsunami (open disaster), and the 9/11 World Trade Center attacks (mixed disaster) (Brenner and Weir, 2003; de Boer et al., 2018; Deng et al., 2005). When DNA

data are used for DVI, the genetic information is typically gathered from *post mortem* (PM) DNA from victim samples and *ante mortem* (AM) DNA from family members at a family assistance center on or near the site of the disaster (Montelius and Lindblom, 2012; Prinz et al., 2007; Vigeland and Egeland, 2021). Once samples are collected, different approaches to verify identity and/or kinship are used. A one-to-one DNA test comparison can confirm or disprove a hypothesized relationship (e.g., a presumed relationship based on attributed information that cannot verify identity, like clothing). In contrast, a database strategy enables one-to-many or many-to-many searches between PM and AM databases. A resulting match of DNA data between two related individuals can facilitate the resolution of a death record and repatriation of remains to family.

Recently, DVI DNA identifications have been expedited via rapid DNA technologies (Turingan et al., 2020). Rapid DNA technologies are portable and automated, producing results in a few hours (Carney et al., 2019; Gin et al., 2020; Jovanovich et al., 2015). Rapid DNA technologies, available through several private companies, are time- and cost-efficient since the process avoids the time- and labor-intensive effort of a traditional forensic laboratory (Bowman et al., 2022). Rapid DNA equipment and reagents are more expensive than the equipment and reagents in a traditional laboratory; however, the time saved in resolving an identification can lessen the costs of remains storage, burial/exhumation, and other processes that an unidentified person might undergo in efforts to identify them (de Boer et al., 2018). US government agencies, including the Department of Homeland Security and the Federal Bureau of Investigation, have applied rapid DNA technology to kinship situations in which quick identification is advantageous, such as booking stations and immigration enforcement.

A DNA-led approach in DVI after disaster could be preferable compared to other biometric tools. Fingerprints might not always be useful in disaster contexts where they might be easily damaged or improbable to collect. While DNA also might be damaged in disasters, more abundant sources of DNA exist, and only a minimal amount is needed for analysis. Facial recognition software is a frontline method, but it is unclear how well it works for decedents, for people with traumatic injuries, and for children whose facial features develop over time (Broach et al., 2017). Additionally, other methods of identification (e.g., tattoos, scars, and dental records) might be subjective and have room for error, making the indisputable identification from a DNA-led approach fitting in DVI contexts.

Applying DNA Data for Family Reunifications in Disasters

While use of DNA data is a leading approach for DVI, DNA data also can play a pivotal role reunifying *living* family members. There are advantages to using DNA data for verifying kinships since other biometrics only verify identity and not relationships. The chaos of disasters might allow opportunities for trafficking, but DNA data, which are accurate and indisputable for genetic relationships, can disprove or detect dishonest claims of genetic relationships and potentially prevent trafficking efforts (Lorente et al., 2021). Additionally, DNA data can be used for DVI in tandem with living family member reunification—for example, after a disaster to verify identify and simultaneously test kinship of a child by comparing his or her DNA to a deceased father and living mother. In this way, DNA might be particularly useful when a high proportion of those impacted by a disaster are deceased but there is still a need to identify and test the kinship of living children. DNA data also hold high discriminatory power and reduce error. Importantly, recent advances in rapid DNA technologies make DNA analyses quick, thereby reducing the length of separations, which is critical for reunifications (Madden and Katsanis, 2021).

In sum, the use of DNA facilitates the identification of a child in relation to a genetic family member to expedite possible reunifications that might not have occurred or might have been delayed without the use of DNA. Reunifications operate on a continuum, from the initial establishing of a kinship “match,” to the reunion event, to the lifelong process of reintegration (Barnert et al., 2019; Barnert et al., 2015). Successful application of DNA for the identification aspect of reunification resolves the ambiguous loss, including for family members untraceable through other means, thereby facilitating healing from the trauma of separation by giving children and families the opportunity for reunion (Barnert, 2023).

Suggested Strategies for DNA Data Use for Family Reunifications

Reconnecting family members after a disaster can be done using non-genetic tools and strategies. In DVI efforts, a DNA-led approach is invaluable since a decedent cannot voice their relations. In post-disaster reunifications, however, photographs, scars, tattoos, and many other measures of a person’s record can be sufficient guides to a family relationship. Nevertheless, DNA data can supplement and even expedite these post-disaster connections. Despite the potential power of DNA for family reunification, the use of genetic information as an identification or kinship tool

carries risks distinct from other biometrics and raises ethical concerns. Considerations for DNA data uses include: the risk of misuse of DNA data for secondary purposes other than family reunification, revelation of sensitive information, exclusion of non-genetic families since family is a social construct, logistical and practical concerns (such as time and costs of processing DNA), and development of trauma-informed consent strategies for various contexts as a key ethical consideration to resolve. Careful consideration of these barriers and proposed mitigation strategies are warranted prior to implementing DNA data for family reunifications in the aftermath of disasters.

First, there is a risk of potential misuse of DNA data for purposes other than family reunification. Potential misuses include comparisons to criminal DNA databases and use to justify deportation (Makhlouf, 2020). This risk engenders fear of providing DNA samples. Fears are amplified by lack of clarity in the DNA process, which can further mask potential abuses of power. Lack of clarity was particularly noticeable in the public response to the use of DNA to reunify families separated because of the Trump administration’s 2018 Zero Tolerance policy (Monico et al., 2019; Wagner et al., 2019). Fears, misconceptions, and misunderstandings—such as the novelty of federally-collected DNA and lack of coverage on the science behind a DNA test—were politicized and magnified by media attention (Wagner et al., 2019). Another example of fear of DNA data misuse was reflected in families’ hesitation behind governmental jurisdiction over DNA storage in the identification efforts of the 9/11 attacks on the World Trade Center, where families ultimately formed their own interest groups so that their loved ones could be identified extra-governmentally (Aronson, 2016; National Institute of Justice, 2006).

However, potential misuse can be mitigated with careful planning. A distinct and unambiguous mission specific to the task of family reunification in disasters, separate from federal mandates to find criminals, would be helpful to keep uses accountable and to dispel public confusion about DNA usages. Additionally, a standard, coherent, ethical, developmentally appropriate, and trauma-informed consent protocol is imperative that covers the following: provides a clear justification for the DNA use, clarifies what information would be gathered from the DNA sample, specifies what information would be shared and with whom, with potential for robust non-disclosure agreements, identifies where DNA samples will be collected and describes how samples will be destroyed, describes the consenting process itself, offers viable alternatives while outlining risks and benefits of doing so to promote decision-making autonomy, and

provides sensitive approaches appropriate across child developmental stages in the context of trauma to ensure that the best interest standard is being met. Partnerships with trusted extra-governmental third parties can also safeguard measures to address fears of governmental DNA data misuse (Barnert et al., 2021).

Second, a significant concern for DNA data use for family reunifications is the possible revelation of sensitive information. DNA data contain sensitive information such as genetic relationships that might be secret or unknown, ancestral attributes, and health predispositions (Katsanis and Kim, 2016; Madden et al., 2022). The possible revelation of sensitive information leads to concerns for privacy protections, and relatedly, questions of rights to incidental findings (Granados Moreno et al., 2017; Parker et al., 2013). Misattributed parentage can be a threat to the family unit, and information about ancestral attributes could lead to stigmatization or discrimination. One-to-one genetic testing (i.e., one alleged parent to an alleged child) could reveal unexpected relationships to families and could penalize non-genetic families. Instead, a privacy-preserving approach that involves a database-to-database comparison rather than one-to-one comparisons of individuals would limit the inferences that can be made about individual families, preserving the privacy of non-genetic families.

A third barrier of DNA data use for reunifications is that DNA data can only be used for verifying genetic relationships, but families are social constructions, not biological entities (Katsanis et al., 2014; Taitz et al., 2002). Because only genetic relatives can be verified via STR fragments, proximity of kinship is critical for successful DNA analysis. However, the definitions of “family” hinge on cultural contexts and norms—what might be considered family can differ in various parts of the world. In some cultures, “family” can include a wide range of biological relatives as well as members who share religious, cultural, and social relationships (Parker et al., 2013; Taitz et al., 2002). What might appear to a DNA analyst as a misattributed relationship might in actuality be a miscommunication of terms to define relationships in a family (Parker et al., 2013). Particularly for children, caregivers may extend beyond parents and can include extended family members and adoptive parents. In such cases, other approaches like social networks, interviews, and reviews of legal documents should be employed for verifying a range of relationships. For these reasons, a lack of kinship from DNA data alone should never be used to disprove a stated relationship and a DNA database comparison approach is imperative for limiting the revelation of non-genetic relationships.

Fourth, there are logistical and practical considerations, such as time of processing and costs for implementing the use of DNA data for family reunifications. Traditional DNA analysis in a forensic laboratory can take months or even years (Katsanis and Spradley, 2020). A long wait for DNA processing could stall family reunifications. Given that every day of separation matters, tragic consequences could begin to take shape for children during the delayed processes. As a solution, the rapid DNA technologies used in DVI could alleviate the delays (Carney et al., 2019; Jovanovich et al., 2015; Turingan et al., 2020). Additionally, questions of overall costs and of who bears the financial burdens might restrict the implementation of protocols to use DNA data. Using DNA technologies could be more cost-efficient than the costs of prolonged family separations (e.g., housing, facilitating communications, and trauma sequelae). Using rapid DNA technologies can be more cost-effective than more traditional and investigative efforts for verifying identities and family relationships, the substantial financial burden of caring for and housing displaced children, and the long-term burden on the healthcare system for the harmful health consequences of family separations on children.

Finally, there need to be robust consent protocols in place for any collection of biometric data from live individuals. For family reunification purposes, a consent process could be adapted from consent processes for DVI scenarios (International Committee of the Red Cross, 2009; Interpol: DNA Monitoring Expert Group, 2015; US National Institute of Justice, 2005). However, contexts are not uniform, and understanding nuances can strengthen a consent framework. Nuances include: the potential need to share data across borders (such as occurred after the 2004 Southeast Asia tsunami, the potential need for cooperation with authorities for permissions to use citizens’ data even though DNA data might or might not be entrusted to governmental or other authorities, and the care necessary to manage permissions, given that DNA data are unchanging over the lifetime of an individual, such as through rolling consent (i.e., periodically revisiting consent), assent protocols (i.e., for obtaining agreement from children), and re-consent protocols (i.e., seeking consent again after certain events or at specific milestones) (Barnert et al., 2021; Katsanis et al., 2018; Madden et al., 2022). Consent protocols also must consider theories of child development and principles of assent (Hein et al., 2015; Katz et al., 2016; Wendler and Shah, 2003).

In sum, the risks (i.e., unintended consequences) and limitations of DNA data use for family reunification warrant nuanced considerations to overcome their inherent limitations. DNA data have risks and barriers in

any context; the chaos, unpredictability, and sometimes the requirement to navigate cross-border/ transnational relationships demands empirically developed protocols to ensure the safety of families and expeditious reunifications. Risks include potential misuse of DNA data, the revelation of sensitive information, and the exclusion of non-genetic families, which can lead to negative outcomes such as privacy breaches, discrimination, and trauma. Limitations, on the other hand, constrain the utility or feasibility of using DNA for reunification and include logistical and practical concerns, such as the time and costs associated with DNA processing and the need for robust consent protocols. Addressing these distinct barriers through careful planning and incorporating safeguards is essential for implementing a DNA strategy that ensures safe and prompt post-disaster family reunification. The portability of rapid DNA equipment and the ability to handle a high potential of cases both allow families to be reunited more quickly, thus mitigating the harmful effects of prolonged family separations.

Prioritizing the mitigation of privacy breaches and the development of trauma-informed consent protocols is crucial. Government agencies, international organizations, and non-governmental organizations can collaborate to establish and enforce guidelines. Forums such as the UN, the International Commission on Missing Persons, and the World Health Organization can provide platforms for developing and disseminating best practices. Additionally, research institutions can contribute by providing empirical data to help refine DNA technologies and consent processes. The portability of rapid DNA instruments and the ability to handle a high volume of cases allow families to be reunited more quickly, promoting a speedy return to normalcy and mitigating the harmful effects of prolonged family separations. Having robust protocols in place with adequate planning remains a priority for implementing DNA data use for post-disaster family reunifications.

Research Priorities

There are suggested research priorities to make DNA-based post-disaster family reunification feasible, safe, and ethical to ensure prompt reunification in the best interest of the child so that DNA technologies be securely applied, when relevant. Key research topics and questions about translating what is known about DNA data for identification and kinship verification to disaster settings include:

- **Disaster contexts:** *What are the family reunification needs and experiences by disaster context? What is the optimal role of DNA and other biometric data by context?* Reunification science would benefit from
- a better understanding of: reunification needs and experiences by context, including disaster type, geographic location, magnitude of impact, duration of separation, child and family understanding of DNA data use for reunifications in disaster setting, and the role of DNA data within a protocol that includes use of other biometric and non-biometric data.
- **Sensitive rights protections:** *How can DNA processes best protect the rights and promote agency and healing of children and families? How can processes avoid re-traumatization, balance speed and accuracy, foster trust, and navigate any political tensions?* DNA data use for family reunifications in disasters can be better implemented by trauma-informed protocols that protect rights and promote agency.
- **Protocol and union of efforts:** *What are the elements of a robust protocol for privacy, confidentiality, and data security that is trauma-informed? How do we build a cohesion of efforts among all stakeholders to promote family privacy and agency? What do DNA data consent processes for children look like, depending on developmental age and understanding?* Detailed and robust protocols are needed prior to implementation of DNA data for family reunifications that account for nuances by context and that are developmentally aligned. For example, informed consent might look different for a separated 8-year-old than it would for a 2-year-old or a 17-year-old. Protocols also need to capture the optimal roles of the government, private sector, and humanitarian groups, both in domestic and international disasters.
- **Techquity:** *How do we ensure that DNA data and other biometric tools are used and applied equitably and globally? What are the barriers that prevent DNA data from achieving techquity?* Techquity involves the intentional effort to eliminate barriers to access to technologies that can advantage all people (Rhee et al., 2021). Access to DNA tools for reunification might be limited by cost or by the lack of awareness of potential DNA testing. A techquity solution will ensure that DNA data is accessible and affordable to all interested parties, and is necessary to reduce bias and serve all children and families in need (Sieck et al., 2021).

While research gaps remain for the specific application of DNA data for post-disaster family reunifications, there is also a notable breadth of knowledge regarding the harms of family separations and current DNA data used for identification and kinship verification, such as in DVI.

What is needed are efforts carried out in advance to understand, clarify, and address nuances of DNA data use for reunification after disasters. Doing so will ensure that meticulous protocols and partnerships are in place so that reunification can happen quickly as soon as safe to do so, which is crucial for child and family well-being and healing.

Conclusion

DNA technologies can enhance family reunifications in the aftermath of disasters by providing accurate and rapid identification and kinship verification. While traditional methods are often slower and less reliable, DNA technologies offer a powerful alternative. The main advantages include high accuracy and quick processing, which are crucial in chaotic post-disaster environments. Although DNA data use carries limitations and risks, such as privacy concerns and logistical challenges, these can be addressed through careful planning, ethical guidelines, and trauma-informed consent protocols. Establishing robust protocols and partnerships is essential to ensure safe and prompt reunification, especially for separations involving young children. Addressing these issues will delineate the optimal role of DNA, allowing for its quick activation when needed, ensuring that families can be reunified quickly and safely.

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DOI

<https://doi.org/10.31478/202410a>

Suggested Citation

Barnert, E., J. Lee, and S. Huston. 2024. Using DNA to reunify families separated by disasters. *NAM Perspectives*. Discussion Paper, National Academy of Medicine, Washington, DC. <https://doi.org/10.31478/202410a>.

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Acknowledgments

Richard Selden, MD, PhD, Founder and Chief Scientific Officer at ANDE; **Thomas White, PhD**, Advisor to the Human Rights Center, School of Law, University of California, Berkeley; **Diana Madden, MA**, Behavioral Research Coordinator at Lurie Children's Hospital; and the DNA Bridge Consortium all provided valuable support for this paper.

This paper benefited from the thoughtful input of **Nancy Blake, PhD, RN, CCRN-K, NHDP-BC, NEA-BC, FACHE, FAONL, FAAN**, UCLA School of Nursing.

Conflict-of-Interest Disclosures

Elizabeth S. Barnert and Sara Huston are officers for DNA Bridge, a nonprofit 501(c)(3) organization advising use of biometric technologies for family reunifications.

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Sponsor(s)

Dr. Barnert's time is supported by the UCLA Children's Discovery and Innovation Institute.

Disclaimer

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