

Barriers and best practices for inclusive emergency alerts and warnings

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ABSTRACT

Recent disasters showed major gaps in emergency alerting—the process of sending emergency information to communities rapidly—where people with limited-English proficiency (LEP) and auditory or visual (AV) disabilities experience issues receiving alerts in their preferred language or formats. In this paper, we review academic literature, agency reports, and news articles to synthesize barriers and develop best practices for inclusive alerting. The barriers identified include: (1) lack of capacity from agencies distributing alerts and warnings; (2) delay or lack of information in multiple languages; (3) channels used to distribute information are often inaccessible; (4) inaccurate translations; (5) lack of trust in government authorities; and (6) communities' lack of familiarity with U.S.-based hazards and various cultural beliefs. Despite the barriers, the literature also identifies a series of recommendations that can be summarized into six best practices: alerting authorities should (1) participate in regular training in cultural competency and how to communicate with diverse audiences; (2) actively involve diverse community partners in the process of alert dissemination; (3) distribute alerts via multiple channels; (4) avoid jargon, use plain language, and translate the meaning of alerts; (5) disseminate alerts via well-informed, trusted sources and incorporate participation of diverse populations and communities; (6) and tailor communication to diverse populations and communities by developing language access plans. We present actionable recommendations and considerations for alerting authorities. We anticipate that alerting authorities, researchers, and decision makers can use these findings to improve inclusivity of alerts and warnings for all communities.

1. Introduction

Equal access to alerts and warnings¹ is a human right. Unfortunately, recent disasters—defined as “events, observable in time and space, in which societies ... incur physical damages and losses and/or disruption of their routine functioning” [[2], p. 312]—showed major gaps in authorities' ability to get emergency information to communities rapidly, especially to those with limited-English proficiency (LEP) and auditory or visual (AV) disabilities. For instance, during Winter Storm Uri in 2021, lack of timely and

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¹ Public alerts and warnings are defined as messages that “provide the necessary information to warn the public and effect the necessary actions that will lead to their safety and to deliver the messages to populations at risk of imminent threats with the goal of maximizing the probability that people take protective actions and minimize the delay in taking those actions” [[1], p. 2].

translated alerts for Asian American and Pacific Islander communities and people with disabilities led to the death of 246 people across Texas [3]. This is just one example of many short falls in language and disability access with emergency alerting [4–8].

During emergencies, people with LEP and AV disabilities experience issues receiving information in their preferred language [9–16] or in accessible formats [8,17,18]. If populations with LEP or those with AV disabilities are unable to access emergency information, they may be unaware of the warning, not take protective action, or respond inadequately [14,19–21].

Without accessible emergency information, populations with LEP or AV disabilities instead rely on unofficial sources for disaster information that is often delayed or inaccurate [12,21]. As a result, populations with LEP and AV disabilities are less prepared before a disaster [15] and are less able to respond [14,19,21]. This contributes to the disproportionate vulnerability of populations already at higher risk of disaster impacts [22].

Despite increased attention to this topic [23], there are still enormous limitations in getting lifesaving information to diverse populations in formats communities can understand and act upon. It is also unclear which barriers to inclusive alerting are pervasive and must be addressed to improve systems. Moreover, recommendations and best practices described in the literature remain disparate and broad, which makes applying them in practice challenging. To address these gaps, we conducted a literature review to synthesize barriers identified in the literature and compile actionable best practices to help alerting authorities improve the inclusivity of emergency alerts. These results can also assist researchers in understand the state of inclusive alerting, supporting further research into understudied topics.²

2. Background on risk communication and alerts and warnings

Understanding why people perceive and respond to risks differently is essential for effective disaster preparedness and response. The Protective Action Decision Making (PADM) model [24] theorizes that people make decisions about protective actions based upon environmental, official, and social cues. People's response to threats will vary depending on socialization, social networks, and trust in institutions (i.e. government alerts and warnings).

Foundational research by Mileti and Sorensen [25] on multi-hazard warning systems revealed five crucial elements of multi-hazard emergency alert messages that promote understanding and trust and inspire protective action. Known as the Warning Response Model, these elements include: (1) the nature of the hazard, (2) guidance on the protective action to take, (3) location of the hazard, (4) time remaining to take protective action, and (5) the risk information source (see Table 1).

Kuligowski et al. [26] built upon this work by expanding to eight components of message completeness. They conducted an extensive review of 90- and 360-character wireless emergency alerts (WEAs) sent to public audiences. According to Kuligowski and colleagues, none of the wildfire WEAs sent between January 2020 and April 2022 contained all eight components. For instance, the risk information source was excluded from more than half of WEAs. Sutton et al. [23] similarly found that source and timing information were included less often than hazard, location, and guidance information in WEAs sent from 2012 to 2022. Sutton et al. [27] revealed that post-alert messages were also typically incomplete.

Understanding how emergency information reaches diverse communities is a growing area of research [8–15,17,18,28]. This research raises additional issues with technical and non-technical aspects of emergency alert systems in the United States, which include challenges with software, resources constraints and more. (For more information on the emergency alerting system in the United States, including channels used to disseminate alerts and warnings, see Appendix A.). This foundational research, and understanding of current capability landscape, is paramount to understanding inclusive emergency communication and risk communication best practices. Our research team uses inclusivity for people with limited-English proficiency (LEP) and with auditory or visual (AV) disabilities to develop a resource for these best practices using a literature review.

3. Identifying relevant literature

To identify and review the literature on alert and warning systems, language, and disability access, we developed eligibility criteria focused on how people access, receive, and respond to alerts and warnings rather than the technical aspects of those systems. To be eligible, documents had to be: (1) written in English; (2) focused on the United States, U.S. Territories, or Tribal Nations; (3) a peer-reviewed article, systematic review of the literature, dissertation or thesis, conference paper, agency report, or news article; (4) published between 2003 and 2023; and (5) focused primarily on the distribution of emergency alerts and warnings, specifically for populations with LEP and those with AV disabilities. We excluded papers before 2003, 20 years prior to the start of this study. We recognize the various technological changes occurring within the last 20 years—such as the advent of smartphones—as changing the landscape significantly for emergency alerts and communication. Although there is relevance to prior literature, to account for these technological advancements and to further scope our literature review to a manageable number, we narrowed it by this time frame.

We used the Web of Science, EBSCOhost, and ProQuest, and Google Scholar, and agency websites for journal articles, agency reports, dissertations, master's theses, and news articles. The search strategy involved a combination of key search terms related to hazards and disasters, alerts and warnings, and language and disabilities. After identifying the key search terms, we conducted two searches, one for populations with LEP and the second for communities with AV disabilities (see Appendix B for search queries). The

² This study was sponsored by the Colorado State Legislature (House Bill 23-1237) to assess inclusive alerting in the state [[39], MacPherson-Krutzky et al. (Forthcoming), Painter et al. (Under Review)]. See the full report here: <https://hazards.colorado.edu/research-projects/colorado-inclusive-language-and-access-in-emergency-alerts>.

Table 1
Components of message completeness.

Mileti and Sorensen's [25] Model	Components Identified by Kuligowski et al. [26]
Nature of the Hazard	• The name of the impending hazard type, threat, or event • Information describing the hazard • Information about the potential consequences from the hazard
Guidance on Protective Action	• Information about how people should protect themselves or the actions they should/could perform
Location of the Hazard	• Information about location, including relevant landmarks; town/city/county; road/intersection/highway or zones
Time Remaining to Take Protective Action	• When message receivers should expect hazard impact and when they should act • When the message expires
Risk Information Source	• Name of the organization providing the information

initial search produced 3261 unique documents (see Fig. 1).

After screening for relevancy, 455 documents remained. We then subjected each document to the eligibility criteria resulting in 57 documents³—38 focused on language access and 19 on disability access⁴. We reviewed the documents for themes related to language and disability access best practices for distributing alerts and warnings to populations with LEP or AV disabilities. The project team analyzed each document, noting key findings related to essential components of alerts and warning systems, best practices for hiring multilingual staff or providing translation services, best practices for engaging local community organizations that serve populations with LEP or AV disabilities, and other emergent findings. After each researcher completed their review, the lead author completed a secondary, thematic analysis to assess and synthesize trends.

In total, we identified six barriers and six best practices (see Table 2). These are organized into authority- and community-level findings. Authority-level findings are associated with alert and warning *providers* and include barriers and opportunities to improve systems and practices at a local level, where alert systems are typically determined. Community-level findings are associated with the experiences of the people *receiving* alerts.

4. Barriers to inclusive emergency alerting

4.1. Lack of capacity from agencies distributing alerts and warnings

Capacity refers to the ability and resource needs of alerting authorities to distribute inclusive alerts. Alerting authorities face challenges when it comes to receiving accurate and timely information for decision-making when crafting and translating alerts and warnings [29]. Moreover, many alerting authorities lack the capacity to ensure their communication is inclusive due to a lack of funding, staff, or training [8,11,18,30–34]. Lack of bilingual or multilingual staff and personnel can further hinder communication, especially if they are not trained in disaster risk communication best practices [30,34]. Unfortunately, including translation and interpretation may burden bilingual staff who feel they are not qualified to interpret technical terms [35]. Additionally, agencies cite lack of knowledge about the communities' cultural and language needs [12,36] or non-existent coordination between state, county, and local staff [30] as reasons for being unable to prioritize inclusive alerting.

Due to limited resources, language translation during emergencies is often carried out by many different people in real-time, such as first responders, news agencies, and community members, leading to inconsistencies [37]. In some cases, agencies rely on Artificial Intelligence (AI) to address their lack of capacity, but AI translations can lead to errors, privacy and ethical concerns, and erosion of trust [38]. Often, AI translates information literally rather than contextually, leading to improper translation. While platforms like Google Translate have integrated AI for years and are effective with translating basic language, they are limited when it comes to technical language and geographies. For instance, emergency managers in Eagle County, Colorado used Google Translate to send out emergency information. The message incorrectly translated the county name into “Bird County” [39]. This is just one example of how AI translation can confuse message receivers.

4.2. Delay or lack of information in multiple languages

The lack of capacity for agencies to send out inclusive alerts and warnings in multiple languages and modalities leads to delays in distributing messages. Options for translating alerts include use of official translation services, translation by trained employees, automatic translations, translation by external partners, and informal translations. The availability of these options depends on alerting authority resources. Agencies may have access to translation services but official translation is time consuming [9,12,38]. Instead, emergency responders sometimes rely on bilingual family members or neighbors to translate emergency information for them [12,40]. Alerting authorities may release information in English to media outlets expecting them to translate and distribute to their diverse audiences [12,40], without a guarantee that outlets will translate materials and information. At times, non-English messages

³ 4 of these were Colorado-focused, as the study was sponsored by the Colorado State Legislature (House Bill 23-1237).

⁴ You can find both annotated bibliographies (Villarreal et al., 2023a, b) at: <https://hazards.colorado.edu/research-projects/colorado-inclusive-language-and-access-in-emergency-alerts>.

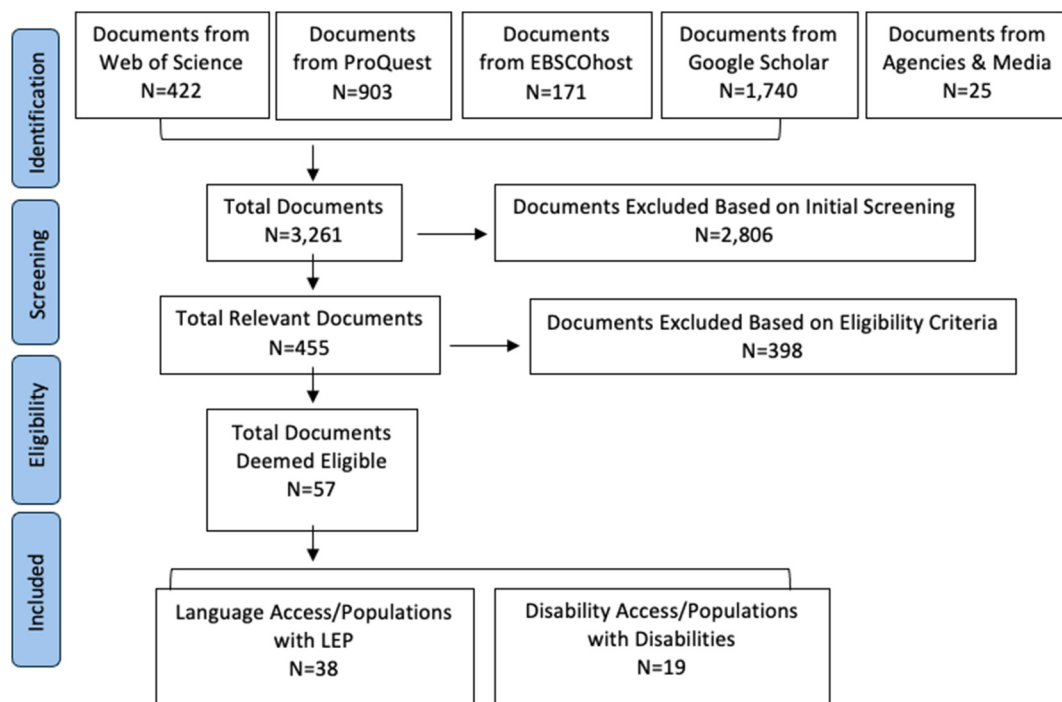


Fig. 1. Document Selection Diagram

This figure shows the sequence of document selection for the literature review. Adapted from Painter et al., 2024.

Table 2

Barriers and best practices identified in the literature.

Barriers	Best Practices
Authority-Level	
1. Lack of Capacity from Agencies Distributing Alerts and Warnings	Participate in regular training in cultural competency and how to communicate with diverse audiences.
2. Delay or Lack of Information in Multiple Languages	Actively involve diverse community partners in the process of alert dissemination.
3. Channels Used to Distribute Information are Often Inaccessible	Distribute alerts via multiple channels.
4. Inaccurate Translations	Avoid jargon, use plain language, and translate the meaning of alerts.
Community-Level	
5. Lack of Trust in Government Authorities	Disseminate alerts via well-informed, trusted sources and incorporate participation of diverse populations and communities.
6. Communities' Lack of Familiarity with U.S.-Based Hazards and Various Cultural Beliefs	Tailor communication to diverse populations and communities by developing language access plans.

do not get sent at all [6]. Other times, alerts are only shared in additional languages or modalities, including American Sign Language (ASL), if requested or in special circumstances [32,34]. Additionally, websites often fail to provide emergency information that is accessible for those using screen readers [32].

As a result of delayed or inaccessible emergency information, individuals with LEP and communities with AV disabilities rely on a diverse set of information resources, including family and friends and social media [6,14,40]. Some of these unofficial resources may not be timely or reliable. Searching across many sources for information to confirm or translate can slow response times in an emergency [41]. This delay in taking action is called “milling,” defined as searching for and confirming information about a hazard prior to engaging in protective action [42,43]. Milling is well documented in the literature on protective action decision-making and can hinder people without enough information into getting “stuck,” leading to inaction [5,25,44–46]. Without social ties to English speakers, some individuals miss these messages or lose a sense of urgency and ignore the information [5,19]. Inaction may put these populations at greater risk during emergency events.

4.3. Channels used to distribute information are often inaccessible

Various alert systems have limitations in terms of character length, type, and formats that are supported. For example, Wireless Emergency Alerts (WEAs)—a system that uses cellular towers to send messages under 360 characters to cellphones in a designated geographic area—are not currently designed to support languages other than English and Spanish. This makes it impossible for

counties and municipalities who use WEAs to expand the number of languages for information distribution [47]. Additionally, the WEA system, according to the Federal Emergency Management Agency [48], is unable to correctly process special characters in Spanish, such as accents and tildes, which leads to misspelling errors in messages. This confusion may cause Spanish speakers to perceive the message as less credible, choosing to ignore the message instead of taking protective action [49]. WEAs also do not include an option for video for ASL.

That said, additional languages are planned [50]. In October 2023, the Federal Communications Commission (FCC)—the agency responsible for regulating interstate and international communications in the United States—required wireless providers to make WEAs available in the thirteen most spoken languages in the U.S., including ASL WEAs [51]. However, this is in its very early stages and implementation has yet to begin [51].

Alerting authorities may contract with other alert vendors to disseminate emergency information in multiple languages. However, while WEAs are automatically disseminated to all cellphones within a certain geographic radius, these other alert types rely on people opting-in Ref. [39]. For example, New York City's Notify NYC is available in 14 languages but requires people to sign up for the service online or via phone; thus, many community members are unaware of it [47]. Sign-up information may also be unavailable in other languages, further creating barriers.

Not all communication channels are fully accessible or preferred by populations with LEP and those with AV disabilities. Alerts and warnings get distributed through channels that often fail to fully integrate communication needs of those with AV disabilities [34]. Many Deaf/Hard of Hearing individuals do not read or speak English due to ASL being an independent language not derived from English [8]. Text-based alerts and warnings that are not available in ASL remain inaccessible to these individuals [8,52]. People with AV disabilities may not be able to hear radio, TV, or siren alerts or see a warning text on screens [53]. Some populations with LEP may not have consistent internet. For instance, the Joan Ganz Cooney Center [54] reported that 10 % of immigrant Hispanic families have no internet access, compared with seven percent of U.S.-born Hispanics, five percent of white households, and one percent of Black households. Instead, these households access information through their preferred language radio stations or TV channels [6,12,13,30,36,55], which may or may not have local emergency information available.

4.4. Inaccurate translations

Inaccurately translated messages or messages that lack cultural context create barriers for populations to access and understand alerts. Certain languages have multiple words for similar phenomena or words with different meaning depending on context [19,56]. Even within the same language—like Spanish—dialect, education, region, or other societal factors affect interpretation [53]. Bitterman et al. [58] discovered that Spanish speakers misinterpreted three of the five risk categories used by the National Weather Service's Storm Prediction Center (SPC), prompting a change in terminology [58]. For instance, the SPC originally translated "high" (the highest level of risk) as "alto," but Spanish speakers consistently interpreted "alto" to be the *second* highest level of risk. Instead, Spanish speakers rated "elevado" as expressing the highest level of risk, even though the SPC had previously used it to represent a middle level of risk. Trujillo-Falcón et al. [15] determined that certain government agencies used the Spanish translations for "watch" and "warning" interchangeably, which, in English, are used to describe different levels of risk and timing [15]. These nuances with language and interpretation can lead to different levels of disaster response [15].

Even individuals that are familiar with English may be less familiar with grammatical nuance, technical language, and disaster terminology used in alerts [5,15,19,29,56]. Further, simply receiving warnings in a non-native language can make it more difficult to process the meaning of the message for non-native English speakers [59]. Translated warnings and messages may also miss important cultural context or emotional impact needed to inspire action [19,56,59].

4.5. Lack of trust in government authorities

Some populations with LEP and communities with AV disabilities do not trust government authorities due to histories of neglect and harm, especially those that are immigrants and undocumented [5,60] or that have negative past experiences [6]. In turn, these populations may hesitate to trust alerting authorities, limiting the extent to which they believe and heed emergency alerts. Some may be unwilling to respond to emergency information and seek help due to fear of having their immigration status questioned and of deportation [12]. Others may perceive government authorities and media as not credible and biased [38]. Additionally, populations may trust some authorities over others. For example, Carter-Pokras et al. [61] find that Latin American immigrants reported trusting firemen and police, the Red Cross, doctors, community leaders, television and radio announcers, and Spanish-language newspapers. de Onís et al. [60] similarly discovered that first responders were a trusted source for Latine⁵ immigrants. Despite these findings, other authorities responsible for sending alerts, such as sheriff's offices, may be less trusted by these communities. Not providing translated materials or messages in an accessible format further erodes trust in government and alerting authorities [9]. This lack of trust leads populations to rely on word-of-mouth or community leaders for sources of reliable information rather than authorities [36].

Negative prior experiences with emergency officials and messaging can contribute to lack of trust and the likelihood that individuals will use emergency messages for protective action decision-making [24]. Racial and ethnic discrimination and disparities exist in disaster response and recovery and contribute to these trust issues [38]. For example, some Latine and Chinese people in the U.

⁵ Latine is used to refer to a group of people of multiple genders as the -e ending isn't masculine or feminine. Latine is commonly used among Spanish speakers as its easily pronounced [62].

S. received emergency messages that felt discriminatory and stigmatizing during the COVID-19 pandemic⁶ [6]. Similarly, disabled individuals who have experienced poor communication in previous emergencies perceive governmental authorities as not caring about their well-being [18].

4.6. Communities' lack of familiarity with U.S.-Based hazards and various cultural beliefs

Immigrant communities—who are a subset of populations with LEP and include people with AV disabilities—may lack of familiarity with U.S.-based hazards, which can contribute to issues understanding emergency alerts [4,13,18,52]a, [56,57,61]. Because immigrants come from countries with various hazard types [5,20,60,61] and warning systems [66], immigrant communities may lack crucial knowledge about how and where to access emergency information and how to prepare for and respond to certain disasters.

Cultural beliefs may also influence how people understand and respond to emergency alerts [65]. For example, religious beliefs may lead communities to dismiss taking protective action, trusting that God would prevent the hazard from occurring in the first place or would keep them safe if it did occur [20]. After the Grizzly Fire in Colorado in 2018, a team of responders at a mobile home park asked displaced people for “green cards” to verify information after the evacuation before allowing them to return to their homes [67]. Responders were referring to information printed on green cardstock, but immigrant populations believed they were referring to the U. S. permanent resident card. Fearful of deportation, they were unwilling to return to their homes [67]. See [Appendix C](#) for a list of cultural elements affecting inclusive alerts and warnings that were identified in the literature.

5. Best practices and recommendations for inclusive alert systems

Below, we summarize six best practices for inclusive emergency alerting consistent across the literature, provide actionable steps to meet them, and present a real-world example for each⁷ (see [Table 3](#)). These practices can help alerting authorities overcome barriers and better reach populations with LEP and those with AV disabilities. Little difference exists between those that are and are not disabled regarding their ability to understand, believe, personalize, and respond to warnings [7,34,68]. By addressing barriers for communities with disabilities and those with LEP—we can also address issues for the broader population. In other words, practices should cater to those with LEP and AV disabilities to ensure full inclusivity.

5.1. Participate in regular training in cultural competency and how to communicate with diverse audiences

Alerting authorities need training to develop inclusive practices and procedures for emergency alerts, which may not be available through traditional emergency response programs. These trainings should focus on employing cultural competency, working with interpreters, identifying people who may be at higher risk during an emergency, and building relationships with populations with LEP and people with disabilities through ongoing communication [18,34,48,69,70]. There should also be Deaf awareness training for emergency responders [71]. Training should include the involvement of vulnerable community members—including populations with LEP or disabilities—in the development and implementation processes to develop cultural competence and trust [12]. Additionally, alerting authorities can emphasize the importance of emergency drills for communities with disabilities and populations with LEP.

5.2. Actively involve diverse community partners in the process of alert dissemination

There are several avenues for involving different partners, including communities with LEP and AV disabilities, in the alerting process [32,33,36,52,72,73]. These partners can include news outlets, local organizations, interpreters, government agencies, among others. Alerting authorities can develop a network of partners who share a stake in emergency response [33] by hosting forums and focus groups oriented toward reaching populations with LEP and AV disabilities with emergency information [74]. Authorities can work with and hire promotores—trusted community health workers in Latine communities with specialized training in health education [60]. Alerting authorities can also develop relationships with relevant news outlets to streamline communication to the public [32,48]. When working with communities and local community organizations, partnerships should be established prior to disasters [12], such as through formal agreements, and government agencies and local communities should be equal partners [75]. Castro [75] names these partnerships between government agencies and local communities as being characterized by shared responsibility, wherein government, individuals, households, and businesses are all responsible in the development of a message strategy. Although “shared responsibility is not always equal or balanced, it [should take] advantage of all levels in building resilience within communities” [75], p. 54.

5.3. Distribute alerts via multiple channels

Different channels exist for sending emergency information and should be strategically leveraged to reach diverse populations. Examples include sending alerts via Spanish language television stations, adding scrolling text to the chyron at the bottom of English

⁶ While COVID-19 is a public health emergency, it also fits the definition of disaster provided earlier [[2], p. 312]. Further, pandemics and epidemics have been considered as natural hazards in other studies as they “produce larger contexts of risk” [[63], p. 7271], [64].

⁷ Potential sources of funding to achieve these best practices are included in [39].

Table 3

Best practices and actionable steps to improve inclusive alerting.

Best Practices for Alerting Authorities	Actionable Step(s) for Alerting Authorities	Example
Authority-Level		
1. Participate in regular training in cultural competency and how to communicate with diverse audiences.	-Host and participate in trainings focused on cultural competency, working with an interpreter, identifying people who may be at higher risk during an emergency, and engaging effectively through continual and lasting communication and relationship building.	The Federal Emergency Management Agency (FEMA) and the Integrated Public Alert and Warning System (IPAWS) previously held annual roundtables with the office of Disability Integration and Coordination to discuss disability-related concerns. The roundtables included leading organizations representing people with disabilities [48].
2. Actively involve diverse community partners in the process of alert dissemination.	- Host forums and focus groups oriented toward reaching LEP populations with emergency information. - Work with and hire promotores, trusted community health workers, to assist in outreach. - Establish partnerships with communities and local organizations prior to disasters; government agencies and local communities should be equal partners.	Following the 1994 Northridge Earthquake in California, “one nonprofit emergency provider had a LEP strategy which involved working with the city and faith-based institutions in order to target minorities and special needs populations ... [this] helped establish a network of organizations advocating for and providing services to the Latino community.” [12, p. 11]
3. Distribute alerts via multiple channels.	- Send alerts via Spanish language television and non-English social media. - Add scrolling text to the chyron at the bottom of English television broadcasts in multiple languages; use closed captioning alongside a video of an ASL interpreter. - Engage in face-to-face strategies and ensure interpreters are present at public meetings and events. - Post translated information online for free. - Establish telephone voicemail menus with language assistance.	Notify NYC is New York City’s official emergency communications program that sends multilingual messages spanning a variety of emergency situations. Subscribers have access to messages in 13 different languages, audio format, and ASL. The program also has two non-English Twitter (X) accounts: @NNYCSpanish and @NNYCChinese [47].
4. Avoid jargon, use plain language, and translate the meaning of alerts.	- Work with certified translators to use clear and plain language. - Use graphics. - Develop ready-to-use message templates ahead of crises. - Avoid culturally insensitive words.	ReadyPhiladelphia Platform: Users are able to sign up for emergency alerts in one of 10 languages; messages are pre-translated to fit dozens of different emergency situations that could occur [40].
Community-Level		
5. Disseminate alerts via well-informed, trusted sources and incorporate participation of diverse populations and communities.	- Work with community organizations and leaders to develop plans for disaster communication prior to crises. - Hire multilingual staff and staff with disabilities. - Hire multilingual staff with a degree in language or translation. - Incentivize multilingual staff to get certified by a respected translation association.	The National Council on Disability [34] found that some disabled individuals develop and provide pocket-sized guidebooks to first responders, which include tips on communicating with people with disabilities and picture manuals to allow the person to communicate by showing a picture that corresponds to their current problem.
6. Tailor communication to diverse populations and communities by developing language access plans.	- Use task forces or other guiding bodies—and consult with local organizations—to better understand language and disability access, including how communities prefer to receive information. - Language access plans should include proposals for educational campaigns to help explain disaster terminology, how to opt-in for alerts, emergency procedures, and where to find shelter and resources.	Roseville, Minnesota conducted research with property managers to identify best communication channels to use with tenants. Based on their input, the City created door hangers in multiple languages and work with property management staff to keep residents informed [10].

Adapted from [39]

television broadcasts in multiple languages, and engaging in face-to-face strategies with interpreters [30,41,76]. Alerts should prioritize both text and voice translations as many may not have the appropriate literacy skills to interpret text-based messaging [29]. Alerts should be routed through devices that will notify people through their preferred mode (e.g., vibration, visual cues, text, etc.) [34, 71,73]. When using multiple channels and languages, it is critical to ensure consistency. If an alert is issued via certain channels, an “all clear” alert should also be issued in those same modalities.

For the Deaf/hard of hearing community, closed captioning should be used alongside a video of an ASL interpreter as an inclusive option for televised emergency information sharing. Other suggestions include making sure interpreters are present at public meetings and events [8,18,33,34,52,68,71,73,77,78], as well as setting up telephone voicemail menus with language assistance [69]. This requires pre-planning to ensure interpreters are available and ready when an emergency begins. Emergency information can be shared in translated written formats, such as through non-English social media channels [57] or websites [32,77,79], as well as spoken formats, such as through radio, which is preferred by some populations with LEP [6,12–14].

5.4. Avoid jargon, use plain language, and translate the meaning of alerts

To ensure clear messaging in all languages, alerting authorities can work with certified translators, use graphics, and avoid culturally insensitive words [5–7,21,32–34,38,58,59,73]. Agencies can develop or use ready-to-use message templates [9,12,32,34,48,80]. Indeed, the FCC has finalized multilingual alert templates intended for alerting authorities to use with WEAs. Specifically, “the agency has created templates for the 18 most commonly issued and time-sensitive alerts in the 13 most commonly spoken languages in the U.S., plus English and ASL” [81], p. 1. Additionally, agencies should only use automated translation when messages can be reviewed and corrected before dissemination [9,32,69,74].

5.5. Disseminate alerts via well-informed, trusted sources and incorporate participation of diverse populations and communities

Government agencies can develop relationships, collaborate with, and compensate nonprofit organizations, interpretation agencies, and community leaders for assisting with disaster communication [5,12,16,33,36,38,59,71,73–75,77,80,82]. By developing these relationships, alerting authorities can share the responsibility of getting alerts to communities and ensure that people receive information from trusted sources [75]. Relatedly, alerting authorities should encourage and create forums for people with LEP and AV disabilities to communicate and advocate for their needs [34]. Alerting authorities can also facilitate emergency drills with populations with LEP and AV disabilities. Building a culture of preparedness in communities by involving them in the alert dissemination process can help improve systems [75].

Hiring multilingual staff and staff with disabilities should be prioritized [12,72]. These staff should hold a certain level of language translation and interpretation proficiency and be prepared to provide these services during crises [9,37]. Multilingual staff could be incentivized and receive funding to get certified by a respected translation association to ensure translations meet standards [83]. These positions should be permanent [73] and come with additional pay [36,69,82].

5.6. Tailor communication to diverse populations and communities by developing language access plans

“One-size-fits all” suggestions for alerts and warning systems are not likely to be effective, as those in charge of distributing messages must be aware of local demographics [32]. Populations with LEP and communities with AV disabilities are not homogenous [56,60]. Some disabled individuals may be Deaf/Hard of Hearing, Blind, have intellectual disabilities, have mobility disabilities, or have more than one of these disabilities making their communication needs unique. Languages have a variety of regional dialects and different words for similar meanings. Careful attention needs to be given to the words chosen to communicate emergency information [58]. Messages should be tailored with cultural competency—“work[ing] effectively in cross-cultural situations” [84], p. 13—to address the unique information and cultural needs of these populations [6,37,38,41].

Alerting authorities can create task forces or other guiding bodies to identify how local populations with LEP and disabilities prefer to receive information [7,9,20,32,59,60,70,80,82,85]. Additionally, community organizations can be consulted by alerting authorities using needs assessments [8,32,34,52,68,71,75,80,86]. Specifically, these needs assessments can help alerting authorities understand what language(s) to use and when, as well as what channels are preferred for receiving emergency information.

Language access plans can be developed to encourage state and local agencies to improve language translation and interpretation of emergency information [82]. These plans can provide explicit guidance for agencies and alerting authorities engaging with people with AV disabilities and LEP during disasters [72,75]. Plans should be developed with community engagement and the legislative testimony [82]. This guidance should be specific, translated into multiple languages [82], and shared as part of emergency personnel training.

Language access plans should include proposals for educational campaigns, or concerted efforts to improve understanding of alert systems and processes for communities. Educational campaigns should be tracked, assessed, and regularly conducted [34,48,57,73,80]. These campaigns can help explain disaster terminology, how to opt-in for alerts, emergency procedures, and where to find shelter and resources [14,20,41,57,60,65]. Alerting authorities should encourage and support communities, caregivers, and families to create individual, home, and facility plans for communication to assist in accommodating individuals with LEP and those with AV disabilities [32]. These communication plans should be specific and include plans for redundancy [32]. These plans can be supported with the help of community leaders, who can be trained in how to disseminate emergency information and knowledge to their communities using appropriate terminology [33,77].

6. Limitations and future research

As with all research, there are limitations to this study. First, the research papers included in this study were only in English and focused on the United States. Given that the focus of the study is addressing issues for populations with limited English proficiency, it is likely we are missing relevant information from research conducted in other languages or countries. Second, despite the valuable lessons learned from this research, the best practices identified are limited. Recommendations directly informed by community knowledge and perspectives are needed to ensure they are applicable to the target communities. Third, we did not find any papers that directly looked at the intersection of LEP and AV disabilities. Future research should include perspectives of community-based organizations and members of communities with LEP and/or AV disabilities, particularly research that takes intersectionality into consideration.

Future research should also investigate emergency alerting and access for those that speak languages other than Spanish. Although

there is limited study of Spanish speakers, there is even less on communities that speak other languages such as Chinese and Vietnamese. Further, researchers should aim to document what actions different agencies are engaging in to reach communities with emergency information. What are the avenues by which agencies are successfully sending inclusive alerts? Third, one recommendation that emerged in this study was to utilize pre-translated templates to speed up dissemination of non-English alerts without relying on AI. Future research should examine how well these pre-translated templates work and what challenges, if any, emerge with this approach. Relatedly, another recommendation suggests avoiding culturally insensitive words, but there is no consensus on what these words are. Future research should work toward identifying and compiling a list of words to avoid in alerts and warnings. More case studies should also be conducted on specific events to provide a more in-depth look at the process of emergency alerting and how a community reaches its most vulnerable members.

Importantly, recent research shows the benefits of collaborations between academic researchers and alerting authorities or state governments on the topic of inclusive alerting [15,39,57,58]. These partnerships have led to the development of recommendations that are grounded in both social science research as well as the practical needs of alerting authorities. Alerting authorities, as well as local and state governments, should consider collaborating with researchers more often to develop evidence-based risk communication products and policies.

7. Conclusions

Through our literature review, we identified six barriers to inclusive alerting for populations with LEP and people with AV disabilities and summarize six best practices that alerting authorities can use to address them. Issues with alert systems include software and agency limitations, inadequate translations, distrust of authorities and risks, and lack of cultural competency. The best practices include a series of ways to consider and create space for people with lived experiences to inform systems and policies that affect them. Indeed, the best practices outlined in this paper align with existing policy recommendations proposed by the EU-funded INTERACT project in international, multilingual contexts, reflecting the robustness of these suggestions [87,88].

We recognize there are challenges to directly applying the lessons learned from this study and that these best practices cannot be implemented without support from federal, state, and local governments, research institutions, community organizations, and more. Nonetheless, the first step to change is acknowledging the barriers and exploring ways to reduce, and perhaps eliminate, them.

This research expands what we know about emergency alerts and risk communication. While previous research has helped to improve alerting more broadly [25,26], more specific consideration needs to be given to components of *inclusive* alert systems. Alerting authorities, researchers, and other stakeholders can use these research findings to improve inclusivity of alerts and warnings. By making alerts more accessible, we improve alerting for *all* communities.

CRediT authorship contribution statement

Melissa Villarreal: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Carson MacPherson-Krutsky:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Data curation, Conceptualization. **Mary Angelica Painter:** Writing – review & editing, Methodology, Funding acquisition, Data curation, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix D. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijdr.2025.105581>.

Appendix A

Background on emergency alerting in the United States.

To send an alert in the United States, an alerting authority—a jurisdiction that sends emergency communication to their respective area—must make a series of decisions around a threat and what type of communication is required (see [Figure A.1](#)). Typically, alerting authorities comprise agencies involved in emergency response, such as county emergency managers, sheriff's offices, police stations, 911 dispatch operators, among others.

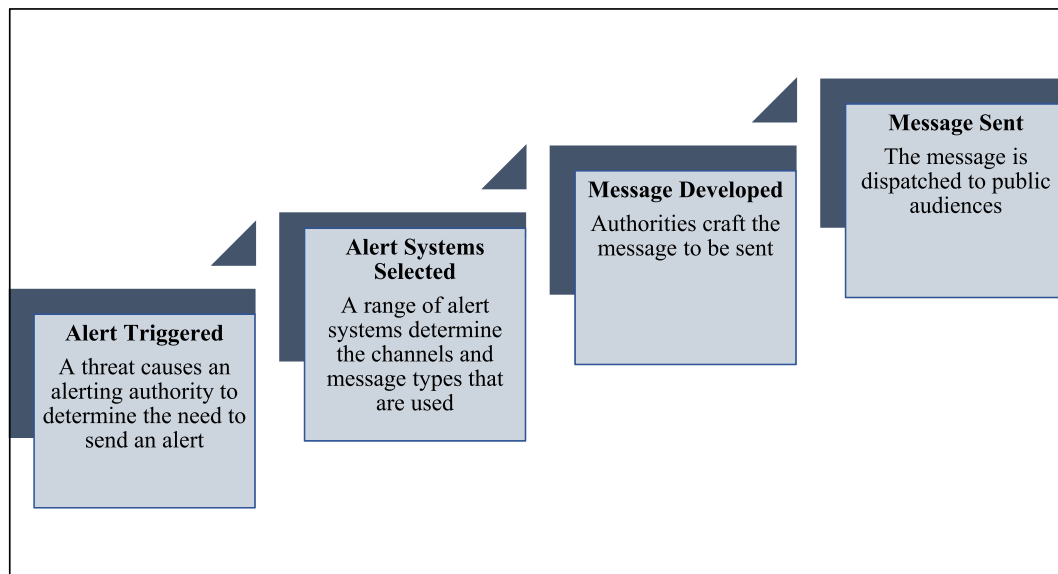


Fig. A.1. The Alerting Process in the United States

Few states have a statewide alerting system. Usually, each county and municipality can decide which types of alerting systems they use based on their specific resources and community demographics (see [Table A.1](#)). These systems encompass people (alerting authorities, alert receivers), infrastructure (software, broadcast towers, etc.), and the technology needed to distribute alerts about different types of threats (sirens, text messages, etc.).

Table A.1
Emergency Alerting System and Channel Options

Alert Options	Description
Alert Vendors	Third-party systems and software that support alerting across a number of channels that include in-house services and the Integrated Public Alert and Warning System (IPAWS). Alerting authorities contract with these vendors for their services. Examples of vendors include Everbridge, CodeRED, and Genesys.
Integrated Public Alert and Warning System (IPAWS) (since 2008)	A Federal Emergency Management Agency (FEMA)-provided system that allows alerting authorities to send emergency alerts through many channels at once including, text, phone call, WEA, EAS, and more. To use IPAWS, alerting authorities must go through a series of FEMA steps and trainings to become designated.
Wireless Emergency Alerts (WEA)	A system that uses cellphone towers to send messages under 360 characters to cellphones in a designated geographic area. Everyone in an area should receive an alert unless they have opted out. (Example: October 2023 National Test) (Must have alert vendor to send WEAs)
Emergency Alert System (EAS)	Broadcast through radios and TV (scrolling message and sometimes audio). Includes National Oceanic and Atmospheric Administration (NOAA) - Weather Alerts.
Specialized Providers	Software, systems, and applications that can integrate into alert vendor platforms or be used alongside them. These are typically intended to fill a certain audience gap (e.g., reach non-English speakers, the Deaf or Deaf-Blind). Examples include and Deaf Link AHAZ .
Text-Based Alerting	Websites*, email listservs*, and texting* can be used to provide emergency information to people. Often alerting authority websites will include pages for active alerts. Additionally, social media platforms* (e.g., Facebook, Twitter (X), Instagram, LinkedIn, TikTok) are used to distribute alert messages.
Sound-Based Alerting	Alerts can be sent through auditory means through sirens, phone calls*, radio* or television* broadcasts.
Face-to-Face	In-person alerting such as door knocking may be used for hyper local alerting needs (e.g., evacuations).

*Alert vendors can provide these services. Options depend on vendor capabilities.

Source: [\[39\]](#)

When alerting authorities, processes, and software are different for every jurisdiction, communities and visitors may be unaware of the alerting system in their area and what to expect in case of an emergency. People may receive alerts differently where they live compared to where they work, where they or their children go to school, or where they spend leisure time.

Many jurisdictions adopt vendors that require community members to actively sign up for alerts. Relying on channels that require communities to opt-in is ineffective as it could lead to low registration rates or outdated contact information for those who do sign up [89]. For example, opt-in rates for emergency alert systems are below 40 % in Colorado [39]. This means almost two thirds of the population in Colorado is not prepared to receive information during an emergency. Indeed, during the 2021 Marshall Fire in Colorado, residents of one neighborhood expected to receive alerts via social media, TV, sirens, or calls to their landlines; however, Boulder County only sent out an alert via their opt-in system, Everbridge [39].

While opt-in systems are difficult for everyone, populations with LEP and AV disabilities are even less likely to know about these systems and to register to receive alerts due to language and accessibility barriers. For instance, the opt-in registration page may not always be provided in languages other than English, including ASL. Populations with LEP and AV disabilities are likely to be low-income [90,91] and face technological barriers—such as not having a reliable phone number, email address, or internet access—in signing up for alerts [55]. Additionally, populations with LEP who may be immigrants are not likely to trust the process of signing up for alert systems and sharing personal information with government agencies [36].

Appendix B

We ran two searches for the literature review. The following key words were used for each search.

Table B.1

Search 1 for Language Access/Populations with LEP

Theme	Key Search Terms
Hazards and Disasters	Hazard* OR "natural hazard*" OR disaster* OR risk* OR threat* OR emergenc* OR "climat* chang*" OR "climat* vari*" OR hurricane* OR storm* OR "extreme weath*" OR "severe weath*" OR earthquake* OR tsunami* OR volcan* OR flood* OR heat* OR landslide* OR fire* OR wildfire* OR "wild fire*" OR geohazard* OR "air qual*" OR pollut* OR "global warming" OR drought* OR contaminat* OR cyclon* OR avalanche* OR typhoon* OR catastroph* OR rockslid* OR mudslid* OR famine* OR scarc* OR crisis* OR crise* OR degrad* OR "tidal wave*" OR casual* OR "El Niño" OR "La Niña" OR tornado* OR hail* OR shock* OR seismic* OR "forest fire*" OR calamit*
Alerts and Warnings	"warning system" OR "emergency alert" OR "emergency message" OR "warning message" OR "wireless emergency alerts" OR "public alert" OR "integrated public alert" OR "integrated warning system" OR "emergency notification*" OR warning* OR emergenc*
Language Access and Populations with LEP	"minority language" OR "limited English proficient" OR immigrant* OR "linguistic isolation" OR "English as a second language" OR "linguistic* divers*" OR "cultural* divers*" OR "CALD" OR ethnic* OR "language barrier" OR migrant OR cultur* OR minorit* OR "language access"

Table B.2

Search 2 for Disability Access/Communities with Disabilities

Theme	Key Search Terms
Hazards and Disasters	Hazard* OR "natural hazard*" OR disaster* OR risk* OR threat* OR emergenc* OR "climat* chang*" OR "climat* vari*" OR hurricane* OR storm* OR "extreme weath*" OR "severe weath*" OR earthquake* OR tsunami* OR volcan* OR flood* OR heat* OR landslide* OR fire* OR wildfire* OR "wild fire*" OR geohazard* OR "air qual*" OR pollut* OR "global warming" OR drought* OR contaminat* OR cyclon* OR avalanche* OR typhoon* OR catastroph* OR rockslid* OR mudslid* OR famine* OR scarc* OR crisis* OR crise* OR degrad* OR "tidal wave*" OR casual* OR "El Niño" OR "La Niña" OR tornado* OR hail* OR shock* OR seismic* OR "forest fire*" OR calamit*
Alerts and Warnings	"warning system" OR "emergency alert" OR "emergency message" OR "warning message" OR "wireless emergency alerts" OR "public alert" OR "integrated public alert" OR "integrated warning system" OR "emergency notification*" OR warning* OR emergenc*
Disability Access and Communities with Disabilities	"American Sign Language" OR disabilities OR deaf OR "hard of hearing" OR accessibility OR "disability access" OR "Access and functional needs"

Appendix C

This appendix presents a list of cultural elements affecting inclusive alerts and warnings that were identified in the literature.

Table C.1

Cultural Elements Affecting Inclusive Alerts and Warnings

Cultural Element	Supporting Citations
1. Cultural context missing from direct translations	[6,15,19,32,34,38,58,85]
2. Mistrust of officials and/or alerting authorities	[6,36,38,59,61,74,76,85]
3. Prior hazard experience in home countries may differ from hazards in the U.S.	[5,20,56,60,65]
4. Mistranslation or lack of direct translation for some technical terms	[9,15,20,59,65]
5. Trusted information sources, such as community health workers (<i>promotores</i>), as message disseminators	[30,37,38,60]
6. Fear of deportation	[12,60,92]

(continued on next page)

Table C.1 (continued)

Cultural Element	Supporting Citations
7. Religious beliefs	[5,20]
8. Perception of messages as discriminatory	[6,36]
9. Homogenization of immigrants	[56,59]
10. Communication channel preference	[38]

Data availability

No data was used for the research described in the article.

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