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Protecting Medicines and Reaching Vulnerable Communities During Extreme Heat and Flooding: A Rapid Review of Community Pharmacy Communication, Preparedness, and Cross-Service Coordination

Elena Petrova[1]*, Thomas Andersen[2], Priya Nair[3]

[1]Department of Clinical Pharmacy and Public Health, Sofia University, Sofia, Bulgaria.
[2]Department of Clinical Pharmacy and Health Services Research, University of Copenhagen, Copenhagen, Denmark.
[3]Department of Pharmacy Practice and Precision Dosing, Indian Institute of Technology Bombay, Mumbai, India.

***E-mail** ✉ elena.petrova@uni-sofia.bg

Abstract

Extreme heat and flooding can threaten medicine integrity, interrupt medicine supply and access, and increase the difficulty of reaching communities already affected by geographic, socioeconomic, or health-related vulnerability. This rapid review examined evidence relevant to community-pharmacy protection of medicines, continuity of supply and access, communication with vulnerable communities, operational preparedness, and coordination with other services during extreme heat and flooding. A rapid-review design was used with transparent methodological streamlining and domain-based narrative synthesis. Four targeted PubMed-indexed search streams and supplementary targeted searches were executed on 14 September 2026. Evidence from 2017–2026 was screened using two analytically distinct strata: direct evidence concerning heat, flooding, extreme weather, medicine integrity, access, or community-pharmacy operations; and transfer evidence from other emergencies where it informed preparedness or cross-service coordination. Study design, setting, hazard, population, operational domain, methodological limitations, contradictory findings, and applicability boundaries were extracted. Design-appropriate critical appraisal informed interpretation without being used as an automatic exclusion threshold. Fifty-six records were captured, 10 duplicate occurrences were removed, and 46 unique records entered screening. Thirteen were excluded during initial screening, leaving 33 for detailed eligibility assessment; 19 were subsequently excluded and 14 evidence units were included. Direct evidence was limited and geographically concentrated. Temperature-excursion evidence showed that medicine-integrity risk is product- and exposure-specific rather than uniformly determined by ambient heat. Flood and hurricane evidence documented disruption to premises, logistics, medicine access, and service continuity. Preparedness and coordination findings were supported partly by transfer evidence from other emergencies and were heterogeneous rather than uniformly favorable. Community pharmacies can function as important continuity points during climate-related disruption, but the evidence does not support universal preparedness standards or simple assumptions about heat-related medicine damage. Heat-related medicine-integrity mechanisms and flood-related supply/access disruption should be managed as related but analytically distinct problems, with preparedness and coordination measures interpreted according to local infrastructure, population vulnerability, medicine characteristics, and evidence quality.

Keywords: Community pharmacy, Extreme heat, Flooding, Medicine integrity, Emergency preparedness, Vulnerable communities

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Introduction

Extreme weather creates medication-safety and access problems through several mechanisms that do not necessarily occur together. High environmental temperatures may place temperature-sensitive medicines outside recommended storage conditions, whereas

flooding can damage premises, interrupt electricity and transport, disrupt wholesalers, isolate communities, and make routine medicine collection difficult. Climate-related medication risks therefore involve both pharmaceutical quality and the functioning of local access systems. Recent synthesis has also highlighted the possibility that extreme-weather disruption may intensify pre-existing pharmacy-access vulnerability, particularly where communities already depend on a limited number of accessible medicine sources [1, 2].

Community pharmacies occupy an unusual position within this problem. They are medicine-supply sites, sources of clinical advice, locally accessible health-service nodes, and intermediaries between patients, prescribers, wholesalers, public-health agencies, and emergency systems. Experience after Hurricane Maria illustrated how infrastructure disruption and medicine-access difficulties can converge at community-pharmacy level [3]. A patient survey conducted after the hurricane likewise documented unresolved medication needs and the continued importance of local pharmacists during the recovery period [4]. These observations make community pharmacy relevant to disaster continuity, but they do not establish that any single pharmacy response improves health outcomes or is transferable across hazards.

Preparedness research has consequently begun to move beyond generic business-continuity planning toward medication-focused emergency readiness. Recent expert-developed work has identified medication access, communication, local partnerships, and preparedness across disaster phases as potential areas of pharmacy action [5]. Yet the operational evidence remains fragmented. Heat-related medicine integrity, flood-related supply disruption, communication with vulnerable populations, internal pharmacy preparedness, and interorganizational coordination are often discussed together even though they involve different causal pathways and different evidentiary bases.

The present rapid review therefore asks: What evidence informs community-pharmacy protection of medicine integrity, supply and access, communication with vulnerable communities, preparedness, and cross-service coordination during extreme heat and flooding? The review deliberately separates physical medicine-integrity mechanisms from supply/access disruption and distinguishes direct heat/flood evidence from evidence transferred cautiously from other emergencies. Its purpose is operational synthesis rather than creation of a universal emergency-readiness standard.

Materials and Methods

A rapid-review design was selected because the question spans medication stability, community-pharmacy operations, disaster response, health-service access, and interorganizational coordination, while the intended output is an operationally useful synthesis rather than an exhaustive effectiveness review. Contemporary rapid-review methodology permits purposeful streamlining when the resulting restrictions are predefined, transparent, and reflected in interpretation [6]. Current rapid-review guidance also emphasizes that methodological shortcuts should be linked to the review question rather than treated as interchangeable reductions in rigor [7].

The primary question was the one stated in the Introduction. Five operational domains were specified for synthesis: medicine integrity during extreme heat; medicine supply and access during flooding or related extreme-weather disruption; communication with vulnerable communities; community-pharmacy preparedness; and cross-service coordination.

Two evidence strata were used. The direct stratum comprised evidence addressing extreme heat, flooding, severe weather, medication storage or integrity under temperature stress, post-disaster medicine access, or community-pharmacy operations during relevant extreme-weather events. The transfer stratum comprised emergency-preparedness and coordination evidence from other crisis settings only when it illuminated a mechanism relevant to the review question. Transfer evidence was never treated as if it were direct evidence of heat- or flood-specific performance.

Eligibility

Evidence was eligible when it was published from 2017 through 2026 and addressed at least one of the five review domains. Eligible direct evidence included studies, reviews, and other peer-reviewed reports examining medicine stability under relevant temperature excursions, extreme-weather effects on pharmacy access, hurricane or flood effects on community-pharmacy operations, or community-level medication continuity following major environmental disruption.

Because direct evidence on pharmacy preparedness and coordination during heat and flooding was sparse, a

secondary transfer stratum allowed evidence from other emergencies where the reported mechanism was plausibly relevant to medicine continuity, pharmacy preparedness, pharmaceutical supply chains, or cross-sector coordination. These records were coded explicitly as transfer evidence.

Records were excluded when the emergency or climate topic had no usable relationship to medicine integrity, pharmacy access, preparedness, communication, or coordination; when pharmaceutical stability evidence was too remote from the operational review question; when education or training was examined without an operational emergency outcome; or when the record addressed general workforce or service change without one of the prespecified domains. Journal quartile was not used as an eligibility criterion.

Information sources and targeted search

Searches were executed on 14 September 2026. The primary rapid-review route used four targeted PubMed-indexed search streams:

1. community pharmacy emergency preparedness disaster pharmacist flood heat 2017 2026
2. medication medicine stability storage temperature excursion heat extreme heat pharmacy 2017 2026
3. community pharmacy flood hurricane natural disaster medication access supply communication vulnerable 2017 2026
4. pharmacy vulnerable communities disaster emergency cross-sector coordination medication access social determinants 2017 2026

Each stream yielded 12 captured records, producing 48 records before supplementary searching. Eight additional records were identified through targeted named-item and citation-chain searches addressing newer emergency-pharmacy work, pharmaceutical supply-chain preparedness, vulnerable-community communication, climate-related medication risk, and cross-sector coordination. The total captured set before deduplication was therefore 56 records.

Search reporting and selection were structured to preserve reproducibility within the limits of the rapid-review environment. PRISMA 2020 informed selection reporting [8], while PRISMA-S informed documentation of information sources, search logic, and search-date transparency [9]. The search did not represent an unrestricted export from every potentially relevant bibliographic database; this restriction is addressed explicitly under Rapid-Review Limitations.

Streamlined screening

The 56 captured records were deduplicated at title and citation level. Ten duplicate occurrences were removed, leaving 46 unique records for screening. Screening proceeded in two stages. Initial title/abstract relevance screening removed records clearly outside the temporal window or operational scope. Detailed eligibility assessment was then applied to the remaining records using the direct and transfer evidence definitions established above.

Thirteen records were excluded during the initial screen. Five were outside the 2017–2026 window; three concerned generic social-determinant or referral activity without a relevant emergency or hazard link; and the remainder addressed generic medicine shortage, education or curriculum, protocol-only work, hospital-only disaster activity without a usable community-pharmacy or medicine-integrity contribution, or non-emergency transition-of-care activity.

Thirty-three records entered detailed eligibility assessment. Nineteen were excluded at this stage: seven lacked sufficient direct heat/flood relevance or a defensible preparedness/coordination transfer mechanism; four did not provide an outcome relevant to medicine integrity, access, communication, preparedness, or coordination; three were generic storage studies too remote from the operational question; two were education or training reports without emergency operational outcomes; two addressed workforce or service change without the specified domains; and one provided climate context but no eligible empirical or review evidence.

No artificial full-text-retrieval stage was inserted. Eligibility was determined from indexed abstracts, publisher records, and extended or full-text information available through the executed search route. The final included set comprised 14 evidence units.

The executed selection pathway is summarized in **Figure 1**.

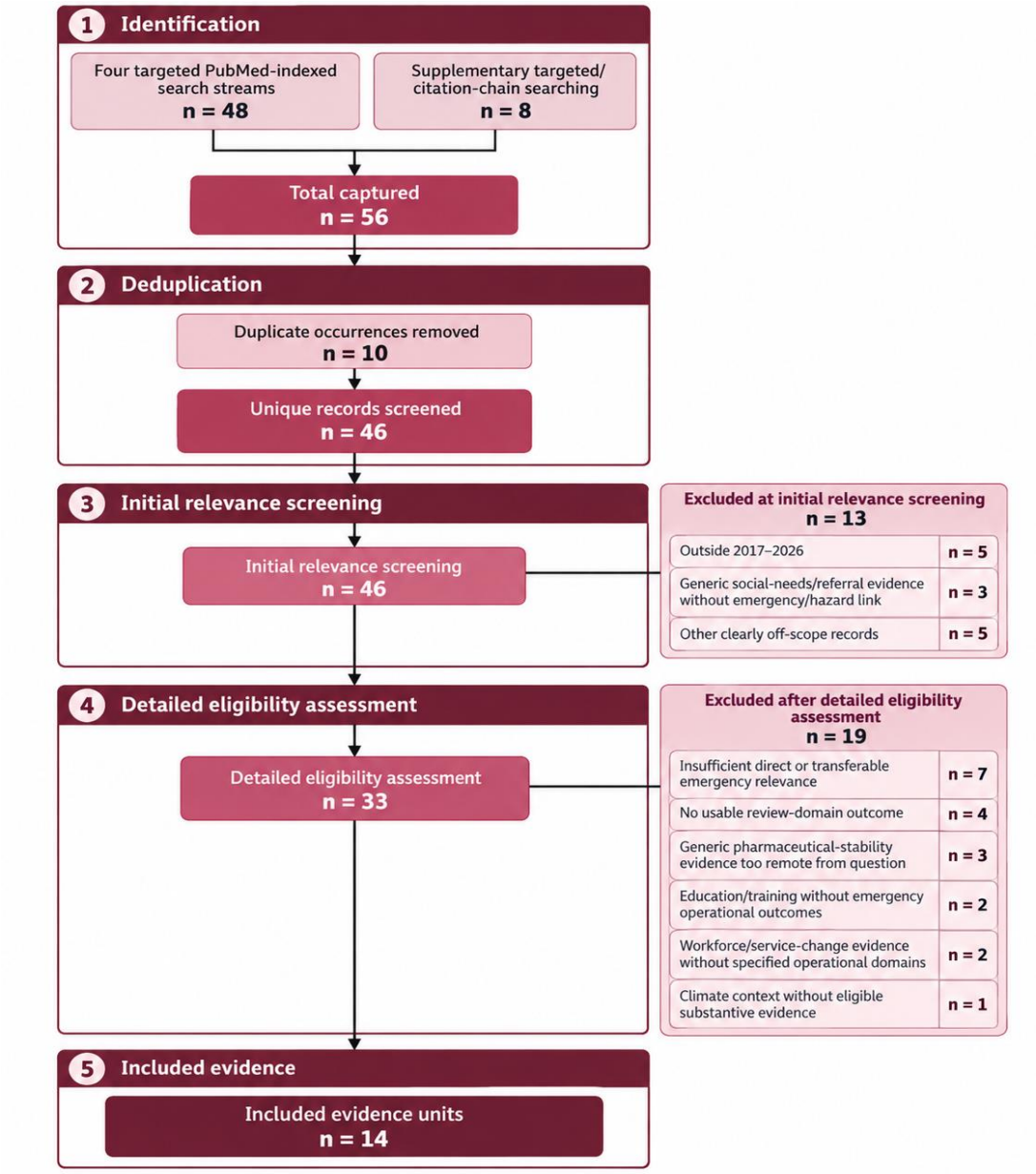

Figure 1. Rapid-review identification and selection of evidence concerning community pharmacy, extreme heat, flooding, preparedness, and coordination

Data extraction

Included evidence was extracted into a structured matrix designed to preserve both substantive findings and the limits of what each design could support. Fields included citation identifier, study or report design, country or region, healthcare or pharmacy setting, population or participants, sample size where reported, relevant exposure or service, comparator where applicable, operational domain, outcome or construct definition, measurement method, temporal design, main reported finding, reported direction or magnitude where available, transfer or equity dimensions, methodological-quality considerations, contradictory or null findings, authors' stated limitations, applicability boundaries, and permitted versus impermissible claims.

Every included unit was additionally coded as direct evidence or transfer evidence. Missing information was retained as unreported rather than inferred. Evidence

used solely to support methods or broader manuscript context was maintained separately from the 14 included evidence units so that the final reference allocation could not be mistaken for the review inclusion count.

Critical appraisal

Critical appraisal was design-specific. Cross-sectional studies were considered in relation to sampling approach, response, measurement, self-report, and the inability of cross-sectional associations to establish causality. Qualitative studies were assessed for participant breadth, analytic fit, contextual specificity, and transferability. Expert-consensus and framework-development reports were interpreted according to their development process but were not treated as evidence of outcome effectiveness. Pharmaceutical stability and simulation studies were assessed with particular attention to product specificity, exposure assumptions, manufacturer information, and the difference between modeled risk and observed clinical consequences. Reviews were interpreted according to their search breadth, heterogeneity, and synthesis design.

Appraisal informed the strength and transferability of conclusions but was not used as an automatic exclusion threshold. Contradictory and null findings were retained. In particular, evidence suggesting that preparedness structures or collaboration were not consistently associated with improved operational outcomes was preserved for later synthesis rather than removed as inconsistency.

Domain-based narrative synthesis

Because the included evidence varied substantially in hazard, design, outcome, geography, and level of analysis, statistical pooling was neither planned nor appropriate. Evidence was synthesized narratively within five domains corresponding to the review question: extreme heat and medicine integrity; flooding and supply/access; communication with vulnerable communities; preparedness in community pharmacy; and cross-service coordination.

Within each domain, synthesis distinguished directly reported findings from review-level interpretation. Direct heat and flood evidence received interpretive priority when available. Transfer evidence was used to clarify preparedness and coordination mechanisms only when its emergency context had a plausible relationship to the community-pharmacy problem being examined. Contradictory findings were retained, and missing evidence was treated as uncertainty rather than proof of no risk or no effect.

Results and Discussion

The executed search captured 56 records: 48 from the four targeted PubMed-indexed streams and eight from supplementary targeted searching. Removal of 10 duplicate occurrences left 46 unique records. Thirteen records were excluded during initial relevance screening, leaving 33 for detailed eligibility assessment. Nineteen additional records were excluded after application of the detailed eligibility criteria. Fourteen evidence units were therefore included in the review.

The final set should not be interpreted as 14 interchangeable studies of climate-related community-pharmacy effectiveness. It contains a smaller direct evidence base addressing extreme weather, flooding, medicine access, and pharmaceutical temperature excursions, together with explicitly identified transfer evidence informing preparedness and coordination. **Figure 1** preserves this arithmetic and the streamlined selection logic.

Evidence characteristics

The included evidence was heterogeneous in both design and proximity to the review question. Direct evidence included an extreme-weather pharmacy-access scoping review, post-hurricane community-pharmacy and patient-access reports, pharmaceutical temperature-excursion studies, and a qualitative study of community-pharmacy operations during flooding. The preparedness and coordination evidence broadened the emergency context to include earthquake and pandemic experiences, expert-informed preparedness tools, observational studies of pharmacy readiness, and cross-sector pharmaceutical supply-chain research.

Geographically, direct community-pharmacy evidence was concentrated in the United States, Puerto Rico, and Australia, with additional transferable emergency evidence from Türkiye, Finland, Brazil, and broader international syntheses. Designs ranged from cross-sectional surveys and qualitative interviews to scoping reviews, expert consensus, product-information review, simulation, and conceptual framework development. No single design dominated the evidence base sufficiently to justify a uniform hierarchy of findings.

A central interpretive feature was therefore evidence directness. Temperature-excursion research could

directly inform medicine-integrity reasoning without directly demonstrating community-pharmacy behavior during a heatwave. Flood and hurricane studies could directly describe disruption to pharmacy access and operations without establishing an intervention effect. Pandemic and earthquake studies could inform preparedness or coordination mechanisms but could not be relabeled as evidence that the same mechanisms improve heat- or flood-specific outcomes.

Table 1 characterizes the evidence base according to hazard or emergency context, setting, design, population, pharmacy role, and operational domain.

Table 1. Operational characteristics and directness of the evidence informing community-pharmacy response to extreme heat, flooding, and related emergencies

Evidence unit	Hazard or emergency context	Country/region	Pharmacy or healthcare setting	Design	Population or evidence source	Principal pharmacy relevance	Operational domain	Evidence directness
Sahota 2023	Extreme weather and pharmacy-access disruption	United States	Community pharmacy access	Scoping review	Extreme-weather/pharmacy-access literature	Availability of local pharmacy services	Supply/access; vulnerability	Direct synthesis
Melin 2018	Hurricane Maria	Puerto Rico	Community pharmacy	Field-informed peer-reviewed commentary	Community-pharmacy disaster response	Continuity of pharmacy services	Supply/access; preparedness	Direct
Jiménez-Mangual 2019	Hurricane Maria	Puerto Rico	Three community pharmacies	Descriptive cross-sectional survey	65 pharmacy patients	Post-disaster medication needs and access	Supply/access; communication	Direct
Schneider 2026	Multiple emergency types	Community-focused pharmacy	Expert tool development	Consensus/development study	Nine disaster-experienced pharmacists	Medication-focused readiness	Preparedness; partnerships	Transfer
Orth 2022	Temperature excursions	United States medication market	Pharmaceutical storage	Product-information review	Refrigerated medicines	Product-specific excursion tolerance	Medicine integrity	Direct mechanism
Jenkins 2022	Simulated temperature excursions	International health-program context	Pharmaceutical storage	Simulation/risk assessment	Modeled storage scenarios	Temperature-risk interpretation	Medicine integrity	Direct mechanism
Singleton 2025	2019 Townsville floods	Australia	Community pharmacy	Qualitative interviews	Six pharmacists	Flood effects on operations and logistics	Supply/access; coordination	Direct
Dinçer 2025	2023 earthquakes	Türkiye	Community pharmacy	Phenomenological qualitative study	15 pharmacists	Drug safety, cold chain, supply	Preparedness; supply continuity	Transfer
Latonen 2024	COVID-19	Finland	Community pharmacy	Survey with qualitative responses	221 pharmacy owners	Crisis planning, resources, resilience	Preparedness; coordination	Transfer
Aruru 2021	COVID-19 and broader emergencies	Pharmacy emergency response	Conceptual framework	Published emergency literature	Pharmacy professionals	Roles across emergency phases	Preparedness	Transfer
Carpenter 2021	COVID-19	United States	Rural community pharmacy	Cross-sectional survey	Rural pharmacists	Training, planning and supply response	Preparedness; access	Transfer
Moreira Dos Santos 2024	COVID-19	Brazil	Pharmacy and health facilities	Cross-sectional study	376 pharmacists	Perceived preparedness	Preparedness	Transfer
Latonen 2023	COVID-19	Finland	Pharmaceutical supply chain	Qualitative interviews	31 cross-sector stakeholders	Shared knowledge, resources and coordination	Cross-service coordination	Transfer

Tosangua n 2026	Public-health emergencies	International	Pharmaceutica l supply chains	Scoping review/framew ork synthesis	Published preparedness literature	Integration of emergency and supply-chain readiness	Coordination; preparedness	Transfer

Extreme heat and medicine integrity

The clearest heat-relevant evidence concerned pharmaceutical exposure to temperatures outside specified storage conditions. This literature argues against treating a temperature excursion as a binary event in which any deviation automatically makes a medicine unusable. A 20-year review of US-approved products found substantial product-level variation in allowable room-temperature excursions among medicines normally requiring refrigeration [10]. For emergency pharmacy practice, the important implication is that medicine disposition after heat exposure cannot be determined reliably from the fact of exposure alone.

Risk interpretation instead depends on characteristics such as the medicine, permitted excursion conditions, duration and pattern of exposure, and the availability of product-specific stability information. Mean kinetic temperature modeling provides another way to examine cumulative thermal exposure, but simulation results depend on the assumed storage history and pharmaceutical characteristics [11]. Such evidence may support structured risk assessment; it does not establish that a modeled temperature history guarantees preserved potency or clinical effectiveness under real disaster conditions.

This distinction is particularly important during prolonged heat events, electricity disruption, transport interruption, or temporary relocation of medicines. Community-pharmacy decision-making may involve medicines stored on site, products received through a disrupted distribution chain, medicines transported by patients, and temperature-sensitive products kept in domestic environments. The present evidence base does not justify a universal heat threshold across products or settings. Instead, it supports product-specific assessment and careful documentation of known exposure conditions, while recognizing that relevant stability information may be incomplete.

Heat can also influence medicine access indirectly through infrastructure, transport, staffing, and patient mobility. Those service-continuity mechanisms are conceptually different from physical or chemical medicine integrity. **Table 2** therefore separates heat-related integrity mechanisms from the access and supply pathways that become more prominent during flooding and other infrastructure-disrupting events.

Table 2. Distinct hazard pathways affecting medicine integrity and medicine access in community-pharmacy emergencies

Hazard–pharmacy configuration	Primary mechanism	Immediate object at risk	Evidence form available in the review	Decision information required	Reported or defensible response logic	Key uncertainty
Elevated temperature affecting refrigerated medicines	Thermal exposure outside labeled storage conditions	Product stability and integrity	Product-information review	Medicine identity, exposure duration, permitted excursion information	Assess product-specific excursion tolerance before disposition	Stability information differs substantially between products
Repeated or prolonged temperature excursion	Cumulative thermal burden	Remaining shelf life or product quality	Simulation and risk-assessment evidence	Temperature history and model assumptions	Use exposure history in structured risk assessment	Modeled risk does not demonstrate clinical potency
Power interruption during extreme heat	Loss of controlled storage environment	Refrigerated or otherwise temperature-sensitive stock	Mechanistic inference supported by excursion evidence	Duration of outage, storage conditions, product-specific requirements	Prioritize exposure documentation and product-specific verification	Field evidence from community-pharmacy heatwaves is sparse
Flooding of pharmacy premises or surrounding infrastructure	Physical access and operational disruption	Ability to dispense or provide	Direct community-pharmacy flood evidence	Premises status, utilities, workforce, transport and local access	Adapt continuity arrangements to local disruption	Evidence is highly context-specific

		pharmacy services				
Flood/hurricane disruption to transport or wholesalers	Supply-chain interruption	Availability and replenishment of medicines	Disaster-access and pharmacy-operation evidence	Stock position, wholesaler access, transport routes and alternative sources	Coordinate supply and continuity options across services	Comparative effectiveness of specific arrangements is largely untested
Flooding or severe weather isolating patients	Reduced physical reach to medicines and pharmacy advice	Patient access and continuity of treatment	Post-disaster patient and access evidence	Geographic access, mobility, communication and medicine urgency	Identify access problems and establish feasible local continuity routes	Vulnerability is uneven and incompletely measured
Compound heat plus infrastructure disruption	Simultaneous integrity and access pressures	Medicine quality and continuity of supply	Cross-domain review synthesis	Both exposure history and service-continuity information	Keep integrity assessment and access planning analytically distinct while coordinating response	Direct compound-event pharmacy evidence is limited

Flooding and supply/access

Flooding affects medication continuity through pathways that differ from temperature-related pharmaceutical degradation. Hurricane and flood evidence describes interruption to pharmacy premises, transport, supply lines, communications, and patient access, with effects varying according to local infrastructure and pre-existing service availability [3, 4, 12]. These disruptions can occur even when medicine integrity itself is not compromised, because patients may be unable to reach pharmacies, pharmacies may be unable to receive stock, or normal prescribing and dispensing links may be interrupted.

The post-Hurricane Maria evidence illustrates this distinction. Patients presenting to community pharmacies reported medication-related needs during a period of extensive infrastructure disruption, while pharmacy-based observations emphasized the local continuity role of community pharmacists. These studies are important because they document real disaster conditions, but they are descriptive and geographically bounded. They cannot establish the prevalence of medication disruption across Puerto Rico or determine the comparative effectiveness of particular emergency-pharmacy interventions.

The Townsville flood study adds direct qualitative evidence from community pharmacists experiencing a flood event. It indicates that pharmacy continuity can depend simultaneously on premises, logistics, medicine supply, communication, and coordination with other actors. Its small qualitative sample is appropriate for identifying operational experiences but not for estimating the frequency or magnitude of disruption across community pharmacies.

The available evidence also suggests that flood impacts interact with baseline access conditions. A community that already has limited pharmacy availability, transport constraints, financial barriers, or high dependence on a small number of medicine-access points may experience disruption differently from a well-connected urban area with multiple alternatives. The review therefore treats vulnerability as an interaction between hazard exposure and pre-existing service conditions rather than as a uniform patient attribute.

This evidence supports a bounded conclusion: flooding can interrupt community-pharmacy supply and patient access through several concurrent mechanisms, but the strength and configuration of those mechanisms depend on local infrastructure and service organization. Evidence is insufficient to assign universal disruption probabilities or to prescribe one standardized continuity model across settings.

Communication with vulnerable communities

Extreme-weather communication is useful only when people can receive, understand, and act on it under disrupted conditions. Direct evidence indicates that medicine-access vulnerability can be amplified when transport, pharmacy availability, electricity, or routine healthcare links are already constrained [2]. Post-hurricane patient evidence likewise shows that medication needs persist while ordinary access routes are impaired [4]. Communication should therefore be understood as part of medicine continuity rather than as message transmission alone.

Transfer evidence reinforces that communication capacity depends on the operational condition of the

pharmacy and its surrounding system. Pharmacists working after the Türkiye earthquakes reported medicine-supply, cold-chain, and drug-safety problems that could alter what information was available to patients at a given moment [13]. Community-pharmacy crisis-management research similarly shows that local resources and organizational arrangements shape the ability to maintain services [14]. Emergency-preparedness frameworks place communication alongside medication access and coordination functions [15], while rural-pharmacy evidence demonstrates variation in emergency planning and response capacity [16]. Training and guideline familiarity have also been associated with pharmacists' perceived preparedness, although perceived readiness cannot be equated with demonstrated emergency performance [17]. Sustained crisis work can additionally impose substantial professional and emotional burden, creating another constraint on prolonged patient-facing response [18].

For vulnerable communities, the evidence consequently supports a conditional principle: information must be connected to a feasible route for obtaining medicines, clarification, or further care. **Table 3** separates the communication requirement from the preparedness and coordination conditions that make that requirement actionable.

Table 3. Communication, preparedness, and coordination conditions shaping medicine continuity for vulnerable communities

Operational situation	Vulnerable-community need	Community-pharmacy preparedness function	Cross-service dependency	Evidence status	Principal evidence gap
Pharmacy access disrupted by severe weather	Know where and how medicines can still be obtained	Maintain current continuity information and alternative access options	Wholesalers, nearby pharmacies, prescribers, emergency services	Direct disaster evidence supports the access problem; response effectiveness remains weakly tested	Comparative evaluation of alternative-access communication
Temperature-sensitive medicine exposed to heat	Understand whether continued use, replacement, or verification is required	Record exposure history and obtain product-specific stability information	Manufacturers, wholesalers, clinical services where needed	Mechanistic evidence supports product-specific assessment	Field studies during actual heatwaves
Transport or mobility disrupted	Receive information through a reachable channel and identify feasible collection/delivery routes	Identify patients whose usual access route may fail	Local health, social, transport, community and emergency networks	Access vulnerability is supported; specific emergency communication strategies are insufficiently evaluated	Reach, comprehension and actionability outcomes
Medicine supply is uncertain	Receive accurate, updated information without false reassurance	Monitor stock and communicate uncertainty explicitly	Supply chain, prescribers and alternative dispensing points	Disaster and transfer evidence supports supply disruption	Real-time coordination effectiveness
Patient has multiple social or health vulnerabilities	Obtain assistance that links medication needs with broader access constraints	Recognize needs beyond dispensing alone	Health and social-service referral pathways	Routine community-pharmacy evidence supports identification/referral feasibility	Emergency-specific equity and referral outcomes
Prolonged or compound disruption	Receive repeated updates as conditions change	Maintain staffing, information continuity and role clarity	Multi-agency and pharmaceutical-system coordination	Preparedness evidence is heterogeneous	Sustainability of communication during prolonged climate emergencies

Preparedness in community pharmacy

Preparedness in the included evidence is multidimensional. It includes medication-specific contingency planning, staff readiness, access to current guidance, supply awareness, preservation of temperature-sensitive stock, role clarity, and the capacity to adapt when normal operating assumptions fail. These elements should not be collapsed into a single preparedness score.

The evidence also resists the assumption that more formal planning invariably produces better outcomes. Observational crisis-management findings indicate that some collaborative or planning arrangements were associated with selected resilience outcomes while others were neutral or unexpectedly unfavorable. Preparedness should therefore be treated as a context-dependent capability whose value depends on whether resources, decision rights, information, and external dependencies remain usable during the event.

For extreme heat, preparedness requires advance knowledge of temperature-sensitive stock and practical procedures for documenting exposure. For flooding, the emphasis shifts toward premises, communications, stock replenishment, patient access, and alternative service arrangements. Compound events may require both sets of capabilities simultaneously.

Cross-service coordination

Community pharmacy cannot independently resolve many of the disruptions identified in this review. Pharmaceutical crisis-management research shows that coordination may involve pharmacies, wholesalers, manufacturers, healthcare organizations, government agencies, and professional bodies, with shared information and resource dependencies affecting response [19]. Broader emergency supply-chain synthesis similarly depicts preparedness as a system-level problem rather than an activity confined to individual healthcare organizations [20].

Routine medication-safety infrastructure demonstrates how community pharmacies can participate in organized system-level improvement outside disaster periods [21]. Research on health disparities also emphasizes that community-pharmacy capacity is shaped by social and structural conditions surrounding patients [22], while pharmacy-based screening and referral programmes show that identification of social needs can be linked to other services [23]. Community-network approaches provide another example of pharmacists participating in wider structures addressing access and adherence [24]. Hospital–community pharmacy communication mechanisms further illustrate how defined cross-setting channels can support transfer of medication information [25]. These examples do not prove effectiveness during heat or floods; they establish plausible coordination functions whose emergency performance requires direct evaluation.

The synthesis therefore supports a branching coordination logic rather than a mandatory pathway. Hazard conditions generate different medicine-integrity and access problems; pharmacy response depends on internal preparedness; vulnerable-community needs shape which responses are usable; and unresolved problems may require external supply, health, social, or emergency-service connections. **Figure 2** preserves these distinctions while marking areas where relationships remain transfer-based or insufficiently tested.

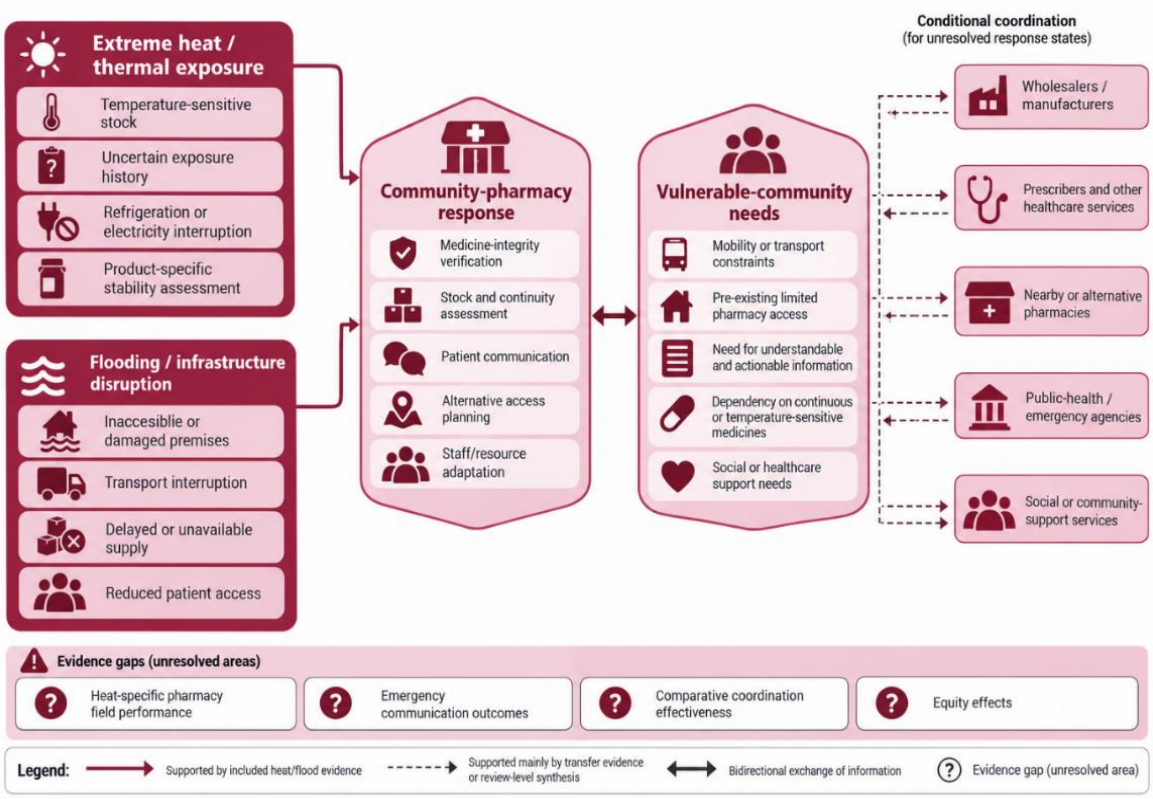

Figure 2. Hazard-specific pathways linking medicine continuity, vulnerable-community needs, pharmacy preparedness, and cross-service coordination

Evidence gaps

The most important gap is the scarcity of direct community-pharmacy research conducted during extreme heat. Medicine-stability evidence is substantially stronger than field evidence describing how pharmacies identify exposures, make disposition decisions, communicate with patients, or maintain cold-chain-dependent therapy during heat emergencies.

Flood evidence is also limited in geographical breadth and sample size. Communication outcomes are particularly underdeveloped: few studies test whether emergency messages reach vulnerable populations, are understood, alter medicine-use behavior, or successfully connect people to alternative access. Evidence on coordination largely describes structures and experiences rather than comparative effectiveness. Equity is frequently plausible as a concern but rarely measured as an emergency outcome.

The review supports a distinction between medicine integrity and medicine continuity. Extreme heat may threaten the physical stability of selected products, but risk cannot be inferred from ambient temperature alone. Flooding more visibly threatens continuity through premises, transport, supply, communications, and patient access. Compound events can create both problems at once.

Community pharmacies are positioned to contribute to both forms of continuity because they combine medicine expertise with local accessibility. The evidence nevertheless remains too heterogeneous to support a universal preparedness package. Preparedness measures that appear sensible—plans, partnerships, training, communication channels, backup supply arrangements—should be evaluated according to whether they remain functional under the specific hazard and local service configuration.

A second implication concerns vulnerability. Vulnerability is not adequately represented as a fixed category of patient. It can arise from the interaction of medicine dependence, mobility, geography, service scarcity, communication barriers, economic constraints, and the severity of local disruption. Emergency pharmacy planning is therefore stronger when it identifies concrete access dependencies rather than relying solely on broad population labels.

Operational implications for pharmacy and emergency planning

Community pharmacies can operationalize the available evidence without converting it into untested standards. Before heat events, pharmacies can identify temperature-sensitive stock, clarify product-specific excursion information, and determine how exposure histories will be documented. Before flood risk, planning can focus on stock continuity, alternative dispensing routes, communication channels, staff access, and links with nearby services.

During disruption, medicine-integrity decisions should remain product specific, while access decisions should be based on current local conditions. Communication should state what is known, what remains uncertain, and what practical route is available to the patient. Cross-service escalation is most relevant when required information, medicines, transport, clinical authority, or social support lies outside the pharmacy's control.

Rapid-review limitations

The rapid review used targeted PubMed-indexed retrieval and supplementary searching rather than an exhaustive unrestricted multi-database systematic search. Captured search counts therefore describe the executed retrieval environment, not the total universe of potentially relevant literature. Screening and eligibility were streamlined, and no separate conventional full-text-request stage was performed.

The evidence base also required a transfer stratum because direct heat/flood pharmacy research was sparse. Pandemic and earthquake evidence was useful for preparedness and coordination mechanisms but cannot establish hazard-specific effectiveness. Heterogeneous designs and outcomes precluded quantitative synthesis, while several directly relevant studies were small, descriptive, or geographically concentrated.

Research priorities

Future research should directly observe community-pharmacy operations during heatwaves and floods, including temperature-exposure decisions, medicine replacement, supply continuity, staffing, communications, and patient access. Multisite studies should examine how baseline pharmacy availability and social vulnerability modify disruption.

Emergency communication research should measure reach, comprehension, actionability, and successful connection to medicines or care. Comparative evaluations of coordination arrangements are also needed, especially where pharmacies depend on wholesalers, prescribers, emergency agencies, social services, or alternative pharmacy sites. Compound heat–flood or heat–power-failure scenarios deserve particular attention because they may combine integrity and access problems that are currently studied separately.

Conclusion

Community pharmacies can serve as important medicine-continuity nodes during extreme heat and flooding, but the available evidence is uneven and does not justify universal preparedness standards. Extreme heat primarily raises product-specific medicine-integrity questions, whereas flooding more clearly disrupts premises, supply, transport, and patient access; compound events may produce both. Effective response therefore depends on matching pharmacy actions to the actual hazard, medicine characteristics, local service conditions, and vulnerabilities affecting whether patients can obtain and use medicines safely. Preparedness, communication, and cross-service coordination are promising components of this response, but their effectiveness and equity effects require substantially stronger direct evaluation.

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