Continuous-Contact Bath Safety System (CCBSS): An Arkansas-Focused Validation and Implementation Framework for Preventing Pediatric Bathtub Submersion Events

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2026-02-04

Abstract

Arkansas child fatality review data for deaths occurring in 2023 report 12 unintentional drowning deaths among infants and children, with most occurring in open water and a smaller fraction in pool-or-bathtub settings. [1] National surveillance demonstrates that drowning remains a leading cause of death for young children and that in-home drownings disproportionately occur in bathtubs. [2, 3, 4] This paper presents a tightened, evidence-anchored rationale for the Continuous-Contact Bath Safety System (CCBSS), a combined behavioral-and-wearable intervention concept intended to reduce bathtub submersion risk during predictable supervision interruptions. The Continuous-Contact Bath Safety System (CCBSS)integrates (i) a standardized bath-time checklist (Touch-First Bath Protocol (TFBP)) that operationalizes "active supervision" into auditable steps and (ii) a rapid securing wearable concept (Rapid Extraction Apron (REA)) intended to reduce slip/handling risk *after* the child is removed from the water. Evidence grounding includes Arkansas ICDR reporting, CDC and NCHS surveillance, CPSC in-home drowning safety information, and a peer-reviewed bathtub submersion registry analysis describing common interruption triggers (e.g., towel/clothes retrieval). [1, 5, 3, 6]

Contents

1 Scope, Intended Use, and Safety Disclaimers

This document supports prevention research, program design, and stakeholder communication. It does *not* replace clinical advice, product certification, or caregiver judgment.

- **No substitute for supervision.** The Continuous-Contact Bath Safety System (CCBSS)is designed to strengthen supervision behaviors, not replace them. A child must never be left unattended in or near water.
- **Rapid Extraction Apron (REA)is not for in-water use.** The Rapid Extraction Apron (REA)concept is intended only *after* the infant is fully removed from the tub. It emphasized "secure-on-body after extraction," not "wear in water."
- **Product classification and testing.** If developed as a consumer product supporting an infant's weight on a caregiver's torso, the Rapid Extraction Apron (REA)may fall under federal safety requirements for soft infant/toddler carriers (16 CFR Part 1226, incorporating ASTM F2236). [7, 8]
- **Small parts / magnets.** If magnets or other detachable components are used, designs must prevent accessible small parts hazards and comply with applicable CPSC requirements (e.g., 16 CFR Part 1501) and relevant CPSC guidance. [9, 10]
- **Evaluation ethics.** Any pilot involving caregivers/infants should be reviewed for ethical compliance and appropriate oversight.

2 Arkansas Problem Statement (Primary Evidence Base)

The Arkansas Infant and Child Death Review (ICDR) annual report reviewing deaths occurring in 2023 reports:

- **12** infants and children died from unintentional drowning in 2023. [1]
- Drowning location distribution: **17%** pool-or-bathtub and **83%** open water. [1]
- For ages 1–4, the report notes that accidental drowning was the most common cause of injury-related death in that age group, and states that (in the cases reviewed) drownings occurred in open water; lack of adequate supervision was cited in all drowning deaths in that age group. [1]

2.1 Why Bathtub-Focused Prevention Still Belongs in Arkansas

While Arkansas pediatric drowning deaths in 2023 were dominated by open-water incidents, ICDR's documented pool-or-bathtub fraction indicates an ongoing household risk domain. [1] In addition, national consumer-safety surveillance emphasizes that in-home drownings disproportionately occur in bathtubs. [3] Therefore, a state-aligned strategy can legitimately address both:

1. **Open-water layers:** barriers, life jackets, swim skills, and designated supervision.
2. **Bath-time layers:** structured supervision behaviors and interruption procedures (the Continuous-Contact Bath Safety System (CCBSS)).

3 National Context (Supporting Evidence)

CDC estimates approximately 4,000 fatal unintentional drownings and 8,000 nonfatal drownings (ED visits) occur each year in the United States. [2]

For children and adolescents, nonfatal drowning adds substantial morbidity: CDC notes that for every child under age 18 who dies from drowning, another 7 receive emergency department care for nonfatal drowning, and nearly 40% of drownings treated in emergency departments require hospitalization or transfer for further care (compared with about 10% for all unintentional injuries). [11]

CDC also states that more children ages 1–4 die from drowning than any other cause of death. [5] Separately, CDC Vital Signs reports that more than 4,500 people drowned each year during 2020–2022 and that drowning among children ages 1–4 increased in 2022 compared with 2019. [12, 13]

3.1 Infant Bathtub Concentration (NCHS)

NCHS reports that during 2018–2019, most unintentional drowning deaths among children aged under 1 occurred in bathtubs (about 75%). [4]

3.2 In-Home Drowning (CPSC)

CPSC states that nearly 90 children drown inside the home every year, and two-thirds of these deaths occur in the bathtub; CPSC also states a child can drown in as little as 2 inches of water and that drowning is quick and silent. [3]

4 Failure Modes: The "Towel Gap" and the Supervision Gap

A critical operational distinction is *presence* versus *engagement*:

- **Presence:** an adult is nearby or in the room.
- **Engagement:** the adult is actively monitoring and able to respond instantly.

A peer-reviewed registry analysis of pediatric bathtub submersion events (Central Texas, 2014–2023) reports:

- In 91% of incidents, a caregiver intended to supervise; only 24% were engaged in supervising at the moment of the incident. [6]
- Common lapse triggers included retrieving a towel/clothes (39%) and caring for other children (20%). [6]

Table 1: Illustrative interruption triggers in bathtub submersion cases (registry analysis).

Caregiver activity during lapse (examples)	**Share**
Retrieving towel and/or clothes	$\sim 39\,\%$
Caring for other children	$\sim 20\,\%$
Other / non-specific lapse categories	remainder

Interpretation note: This evidence base is not Arkansas-specific; it is used here to inform design of a preventive intervention aimed at common household interruption patterns. [6]

5 The Continuous-Contact Bath Safety System (CCBSS): Concept, Components, and Operational Definitions

The Continuous-Contact Bath Safety System (CCBSS)is a combined behavioral and wearable intervention concept intended to function as a force multiplier for caregivers by reducing ambiguity, cognitive load, and decision latency during bath-time interruptions.

5.1 Component A: Touch-First Bath Protocol (TFBP)(Behavioral Standard Operating Procedure)

The Touch-First Bath Protocol (TFBP)converts vague advice ("watch your baby") into a repeatable routine with three phases:

5.1.1 Phase 1: Pre-Bath Staging (Eliminate Retrieval Incentive)

Before water is turned on, stage all supplies within arm's reach:

- towel(s), washcloth, soap/shampoo
- diaper, clothing, cream, wet bag/trash
- phone silenced/away; distractions minimized

This targets the "retrieve towel/clothes" lapse trigger observed in bathtub submersion scenarios. [6]

5.1.2 Phase 2: Continuous Contact Supervision

While the child is in the tub, maintain continuous physical contact or a physically controlling hand position that provides immediate tactile feedback if posture slips.

5.1.3 Phase 3: Interruption Drill — *Extract–Secure–Resolve*

If an interruption occurs (door, phone, sibling), default to a drill:

1. **Extract:** remove the infant from water immediately.
2. **Secure:** stabilize the infant against the caregiver (towel wrap and hold; Rapid Extraction Apron (REA)only *after* extraction).
3. **Resolve:** address the interruption only after the infant is secure.

5.2 Component B: Rapid Extraction Apron (REA)(Rapid Securing Concept)

The Rapid Extraction Apron (REA)is proposed as a rapid securing aid to reduce slip/handling risk during the post-extraction transition when the infant is wet and the caregiver's attention is divided.

5.2.1 Functional requirements (design intent)

- One-handed or low-fine-motor securement in seconds.
- High-friction infant contact surfaces (wet handling).
- Moisture management to prevent caregiver saturation and grip loss.

5.2.2 Compliance considerations

If the Rapid Extraction Apron (REA)functions as a soft infant/toddler carrier, it must be designed and tested per 16 CFR Part 1226 and incorporated ASTM F2236 requirements, and supported by appropriate compliance documentation. [7, 8] If components could detach and become small parts (including magnets), designs must comply with applicable small parts regulations and relevant CPSC guidance. [9, 10]

6 Theory of Change (Logic Model)

The Continuous-Contact Bath Safety System (CCBSS)is designed to modify bath-time behavior at high-risk moments (interruptions) by pre-committing the caregiver to a drill and removing common triggers (missing supplies).

Table 2: Logic model (theory of change) for Continuous-Contact Bath Safety System (CCBSS)deployment.

Inputs	**Activities**	**Outputs**	**Outcomes (short → long)**
Protocol card; staff training; community partners; (optional) compliant wearable	Teach Stage/Touch/Drill; integrate into discharge/home visits; reinforce at follow-ups	Caregivers stage supplies; adopt Extract–Secure–Resolve drill; improved supervision practices	Fewer "step-away" lapses; faster interruption response; reduced bathtub submersion incidents; reduced morbidity/mortality

7 FMEA-Lite (Failure Modes and Effects)

Table 3 summarizes key failure modes targeted by the Continuous-Contact Bath Safety System (CCBSS)and practical mitigations.

Table 3: FMEA-lite for bath-time submersion prevention (qualitative).

Failure mode	**Likely effect**	**Detection/Signal**	**Mitigation in Continuous-Contact Bath Safety System (CCBSS)**
Missing towel/diaper triggers "quick retrieval"	Child left unattended even briefly	No immediate alarm; event can be silent	Phase 1 staging; supplies within arm's reach
Sibling / household interruption	Attention diverted; caregiver steps away	Competing cues; urgency bias	Phase 3 drill: Extract before Resolve; secure infant first
Phone distraction / multitasking	Reduced engagement while "present"	Inattentional blindness / delayed response	Remove distractions; define engagement standard; drill

Failure mode	Likely effect	Detection/Signal	Mitigation in Continuous-Contact Bath Safety System (CCBSS)
Wet handling slip risk during extraction	Dropped infant or re-submersion risk	Loss of grip; unstable posture	Secure-by-default after extraction; towel wrap; (optional) Rapid Extraction Apron (REA)concept post-extraction
False sense of security from wearable	Increased risk-taking behavior	Caregiver assumes device substitutes supervision	Explicit disclaimers; training emphasis: no in-water use; supervision remains mandatory

8 Arkansas Implementation Strategy (Program-Level)

ICDR emphasizes supervision as a contributing factor in drowning deaths reviewed and documents common drowning risk contexts (open water, barriers). [1] An Arkansas-aligned implementation approach for the Continuous-Contact Bath Safety System (CCBSS)prioritizes low-burden integration into existing touchpoints:

8.1 Primary delivery channels

1. **Postpartum discharge education:** brief protocol training alongside safe-sleep and injury prevention.
2. **Home visiting programs:** reinforcement during newborn and early-infant visits.
3. **Pediatric practices/community health centers:** protocol card distribution and quick coaching.

8.2 Training format

- One-page protocol card + 90-second demonstration.
- Emphasis on the non-negotiable interruption drill: Extract–Secure–Resolve.
- Reinforcement: short reminder at 2 weeks and 2 months (SMS, flyer, or visit note).

9 Evaluation Plan (Evidence-Building Roadmap)

Evaluation should be staged to minimize risk while building evidence:

9.1 Stage 1: Protocol feasibility

Outcomes: caregiver recall, adherence, perceived burden, and near-miss reporting (anonymous, optional).

9.2 Stage 2: Wearable safety and usability (if developed)

Bench testing and compliance evaluation per applicable carrier standards and CPSC guidance, plus usability testing using simulated workflows. [7, 8]

9.3 Stage 3: Program impact

Longer-horizon monitoring using ICDR reporting and (if feasible) state-level injury surveillance to observe trends and inform targeted prevention campaigns. [1]

10 Governance and Accessibility (Seraph Safety Mission)

Seraph Safety Missionintends to operate as a public-benefit organization focused on reducing preventable pediatric drowning. This includes:

- Broad access to protocol education (low-cost, printable, and distributable).
- Ethical separation between charitable programming and any commercial manufacturing activity, with independent oversight and fair-market terms.
- Transparent documentation of program materials and evidence updates.

11 Limitations

- **Arkansas bathtub-only quantification:** ICDR reports pool-or-bathtub as a combined category in at least one table; bathtub-only counts require additional coding-level analysis and may be limited by small-number suppression. [1]
- **Generalizability:** bathtub registry findings used for interruption triggers are not Arkansas-specific. [6]
- **Attribution:** demonstrating causal reduction in drownings from a protocol requires careful evaluation and adequate sample sizes.

12 Conclusion

Arkansas ICDR reporting documents 12 unintentional drowning deaths among infants and children in 2023, with a measurable pool-or-bathtub fraction and explicit supervision findings in the 1–4 age group cases reviewed. [1] National CDC, NCHS, and CPSC sources support the relevance of bathtub-focused prevention for infants and in-home settings. [2, 4, 3] The Continuous-Contact Bath Safety System (CCBSS)offers an Arkansas-ready prevention framework built around a standardized bath-time checklist and a clear interruption drill, with a cautiously framed wearable concept that must be validated and certified before any deployment. Future work should prioritize protocol feasibility in Arkansas partners, then expand evidence with staged evaluation.

References

[1] Arkansas Infant and Child Death Review Program. *Arkansas Infant and Child Death Review Annual Report: 2025 Report Reviewing Deaths from 2023*. Arkansas Children's Injury Prevention Center / Arkansas Department of Health, 2025. URL: https://archildrens.azureedge.net/-/media/Files/injury-prevention-center/ICDR-Annual-Report-FY26-121125.pdf?hash=A1368F413FCE340D430786C7377DDDE6&rev=ea60d0729bfc4dbabc13fd3794967210 (visited on 02/04/2026).

[2] Centers for Disease Control and Prevention. *Drowning Facts*. Jan. 2026. URL: https://www.cdc.gov/drowning/data-research/facts/index.html (visited on 02/04/2026).

[3] U.S. Consumer Product Safety Commission. *In-Home Drowning Safety Information Center*. n.d. URL: https://www.cpsc.gov/Safety-Education/Safety-Education-Centers/In-Home-Drowning-Safety-Information-Center (visited on 02/04/2026).

[4] National Center for Health Statistics. *Unintentional Drowning Deaths Among Children Aged 0–17 Years: United States, 1999–2019 (Data Brief No. 413)*. July 2021. URL: https://www.cdc.gov/nchs/data/databriefs/db413-H.pdf (visited on 02/04/2026).

[5] Centers for Disease Control and Prevention. *Drowning Data*. Jan. 2026. URL: https://www.cdc.gov/drowning/data-research/index.html (visited on 02/04/2026).

[6] Ryan M. Johnson et al. "Pediatric hospital visits for unintentional drowning in bathtubs in Central Texas, USA". In: *Injury Epidemiology* (July 2025). DOI: 10.1186/s40621-025-00597-7. URL: https://link.springer.com/article/10.1186/s40621-025-00597-7 (visited on 02/04/2026).

[7] Electronic Code of Federal Regulations. *16 CFR Part 1226 — Safety Standard for Soft Infant and Toddler Carriers*. n.d. URL: https://www.ecfr.gov/current/title-16/chapter-II/subchapter-B/part-1226 (visited on 02/04/2026).

[8] U.S. Consumer Product Safety Commission. *Soft Infant and Toddler Carriers — Business Guidance*. n.d. URL: https://www.cpsc.gov/Business--Manufacturing/Business-Education/Business-Guidance/Soft-Infant-and-Toddler-Carriers (visited on 02/04/2026).

[9] U.S. Consumer Product Safety Commission. *Small Parts Ban and Choking Hazard Labeling*. n.d. URL: https://www.cpsc.gov/Business--Manufacturing/Business-Education/Business-Guidance/Small-Parts-for-Toys-and-Childrens-Products (visited on 02/04/2026).

[10] U.S. Consumer Product Safety Commission. *Safety Standard for Magnets — Business Guidance*. n.d. URL: https://www.cpsc.gov/Business--Manufacturing/Business-Education/Business-Guidance/Safety-Standard-for-Magnets (visited on 02/04/2026).

[11] Centers for Disease Control and Prevention. *Drowning Facts (CDC Stacks PDF)*. 2024. URL: https://stacks.cdc.gov/view/cdc/130749/cdc_130749_DS1.pdf (visited on 02/04/2026).

[12] Centers for Disease Control and Prevention. *Drowning Increases in the U.S. (Vital Signs)*. May 2024. URL: https://www.cdc.gov/vitalsigns/drowning/index.html (visited on 02/04/2026).

[13] Centers for Disease Control and Prevention. *Drowning Deaths Rise in the United States (Media Statement)*. May 2024. URL: https://www.cdc.gov/media/releases/2024/s0514-vs-drowning.html (visited on 02/04/2026).

A Appendix A: Touch-First Bath Protocol (TFBP)One-Page Checklist (Draft)

1. **Stage:** towel, diaper, clothes, soap within arm's reach. Phone away.
2. **Touch:** continuous contact while baby is in water.
3. **Interruptions:** *Extract–Secure–Resolve.* Always remove baby from water first.

B Appendix B: Source Materials Provided (Internal Draft Lineage)

This LaTeX whitepaper was derived and tightened from internal draft materials provided by the team, including:

- `Seraph_Safety_Mission_Whitepaper.docx`
- `Closing_the_Towel_Gap_Pitch_Deck.docx`
- `Seraph_Safety_Mission_Website.html`
- `Meeting_Quick_Reference.html`

These internal drafts informed framing and messaging; empirical claims in this LaTeX version are anchored to the cited external sources noted in the bibliography.