# Dying, Death, and the Afterlife in Human-Computer Interaction. A Scoping Review.

RUBEN ALBERS, University of Siegen, Germany
SHADAN SADEGHIAN, University of Siegen, Germany
MATTHIAS LASCHKE, University of Siegen, Germany
MARC HASSENZAHL, University of Siegen, Germany

Dying is a universal experience that entails uncertainty, loss, and termination. Often, people face death unprepared and miss out on opportunities to shape their final stage of life as well as their afterlife. To better understand how thanato-technology can support the dying and the bereaved, we performed a scoping review on the current state-of-art in Human Computer Interaction. Following the PRISMA-ScR procedure, we gathered and analyzed 107 relevant papers. We categorized theoretical and conceptual contributions into three overarching themes: digital remains, remembrance, and coping. We further highlight 18 practices, such as curation, honoring and letting go. We show that technology can help to capture the identity of the deceased, to validate the life lived, and to come to terms with death. However, available approaches focus more on the bereaved than on the dying. In addition, potentially important aspects of dying (e.g., balancing involvement and autonomy, spiritual meaning-making) remain largely unexplored.

CCS Concepts: • **Human-centered computing → HCI theory, concepts and models**.

Additional Key Words and Phrases: death, dying, thanatosensitivity, end of life, scoping review

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## 1 INTRODUCTION

Dying is challenging. It is associated with negative experiences (e.g., uncertainty, loss, termination) for the individuals affected as well as their loved ones. It is deeply human to fear death. In the past decades increasing secularization and "medicalized" dying affected people's relationship to death [32], especially in western societies. As a result, people tend to avoid death as a topic in conversations, and it has become less common to think about one's own death, let alone prepare for it.

The experience of mortality, death, and bereavement are already subject to various research disciplines (e.g., anthropology, psychology, or sociology). Findings from these disciplines suggest that there are better and worse ways of death and, consequently, approaches to improve the experience of dying [80]. For example, dying at a familiar place (e.g., at home) is a widespread ideal of a better death, even though it can be impractical [125]. So far, the end of life has mostly been subject to dedicated death studies [41, 60, 61]. However, death is an integral part of life and to live a good


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life should include its final stage. Yet, researchers who strive to facilitate the good life often fail to acknowledge the importance of a "good death". [18].

With progressing digitalization, practices around death and dying become more and more mediated by technology [59]. Consequently, designing for death and dying received some attention in the Human-Computer Interaction (HCI) community. For example, the term "*thanatosensitivity*" refers to technology design that addresses experiences of people who are dying or have lost someone [76]. While death and loss are of course perceived as mostly negative life experiences, technology could play an important role in shaping practices to better deal with death. Yet, there seems to be no shared understanding of the role technology should or could play at the end of life. To this end, we conducted a scoping review to synthesize the available work on designing technology for dying, death, and the afterlife. We address the following research question: Can technology shape more positive experiences of dealing with death?

Following the idea that technology can incorporate knowledge about "successful dying" (i.e., achieving a preferable death [80]) , we contrast available theories and concepts in HCI research. Specifically, we investigate how current "thanato-technologies" make use of the existing knowledge about dying well and identify so far unused potential. Further, we explore the needs around death and which new propositions for positive experiences and practices have surfaced. In summary, our scoping review provides a categorized overview of proposed concepts, practices and theoretical considerations to guide the future design of thanato-technology in HCI. Based on this, we point out gaps and underexplored potential.

In the following, we first discuss why death and dying remains a relevant challenge for wellbeing and the groundwork that has been established around it. We then summarizes our procedure for searching and selecting works in HCI, which deals with thanato-technologies, and our findings. Finally, we discuss how current research on digital remains, remembrance and coping aligns with theoretical perspectives on the end of life.

## 2 GOOD DEATH AND HEALTHY GRIEF

Experiences around death are part of the human lifespan and affect living, dying, dead and bereaved people alike [78]. For every living person, the eventual death is certain. While this poses existential questions the eventual death has different implications than imminent death. The prospect of dying brings about drastic changes in the lifeworld of a person [81]. Death is a challenging experience of loss and transition for the dying and their loved ones alike. Efforts to "die well" (i.e., good death) summarize the conscious shaping of the time around death in ways that make it more meaningful and bearable. For the dying person this entails coming to terms with the end of life, while the bereaved need to accept the permanent absence of a loved one in their future life.

### 2.1 The Better or Worse Death

There are better and worse ways to die. Some circumstances make death tragic, as in the case of accidents, suicide, or homicide. Other circumstances appear less tragic, for example, dying in old age after a fulfilled life. There are further elements in end-of-life care which make death better, such as having time to prepare for death, not dying alone, or not dying in pain [80, 125]. Apart from this, the *good* death often refers to deaths that are well managed [54]. This foregrounds awareness and preparations in accordance with personally held values and wider social expectations [41]. Thus, a good death is not limited to the circumstances but also entails active efforts to face and cope with death. Notably, this puts emphasis on preparations to reach an individually preferred death, but not necessarily excludes the choice to deny death or refuse to take action. [99].

Various models exist to describe the circumstances and preparations that facilitate a good death. Stage models offer a rather stereotypical and passive perspective on dying since they approximate emotional states. For example, the five stages of dying [60] suggest a standard journey through emotional phases of denial, anger, bargaining, depression and acceptance. In comparison, task models attempt to empower dying people to make an active effort towards reaching an individually preferred death [25, 29].

From a design perspective, the latter are more actionable, since they offer activities conducive to a good death. Specifically, we look at dying through the lens of a holistic task-based model, which provides activities pertaining to four areas: physical, spiritual, psychological, and social wellbeing [25] (see Table 1).

Table 1. The tasks of dying [25]

| Wellbeing | Areas of task work |
|---|---|
| Physical | Meet bodily needs<br>Minimize physical distress |
| Spiritual | Develop, or reaffirm sources of spiritual energy<br>Foster hope |
| Psychological | Maximize security<br>Maximize autonomy<br>Maximize richness in life |
| Social | Sustain and enhance interpersonal attachment<br>Address the social implications of dying |

The reason why engaging in some activities turns death into a better experience is the opportunity to satisfy psychological needs and the consequential improvement of wellbeing. For example, the presence of caring people contributes to a sense of security and thus facilitates psychological wellbeing [25]. In contrast, a death can be worse when it deprives people of awareness and removes their opportunity to exercise control and preparation [54]. For example, a premature and sudden death thwarts life completion and often leaves the family unprepared. Overall, the tasks of dying provide a useful framework to understand actions that are conducive to a better death.

While a better death is a worthwhile goal, different cultures pursue it in very different ways. Socialization play a major role in what is perceived as a good death and how it is pursued [1]. Nowadays, people are exposed to a diverse range of cultural worldviews and values. Consequently, each person internalizes diverse beliefs that help to further understand how people approach dying. [18, 91]. For example, dignity serves as an umbrella term, which refers to the ability to be the person one wants to be in the eyes of others. For Chinese rural elders, dying in dignity is linked to protecting the family from humiliation and dishonor [65]. The German model of dying in dignity, contains the two widely shared needs and values of autonomy and serenity [81]. Autonomy is the capacity to decide what the dying wants before and after death, while serenity implies composure and acceptance in the face of death. Autonomy can be exercised through actions and (non)actions that reflect personal choices in line with core life values. Serenity can be achieved through various coping strategies, such as spirituality, autobiographical memory, resolving conflicts or saying farewell to relatives [81].

All in all, dying can be managed well under the right circumstances (e.g., pain-free) and the pursuit and realization of important needs and values, such as autonomy or serenity.

### 2.2 Coping and Healthy Grief

The circumstances of death also impact the grief of the bereaved. Grief is considered to be bad when it has long-term negative impact on the life of the bereaved, for example, by keeping them from resuming their life, such as finding a new partner. There are types of grief, such as prolonged grief disorder, which is even a clinically relevant condition. Grief is considered to be better when it results in revitalization or even in a sense of growth [30].

Phase models describe healthy grief as a process. For example, the five phases of grief [61] are denial, anger, bargaining, depression and acceptance. These models assume that most people go through these phases in a typical order. Similarly to models of good death, more recent models, though, highlight the individuality of the grief and promote an active role of grievers and therapeutic interventions. To place emphasis on activities that lead to better coping, we consider grief as well through the lens of a task-based model [122]. The tasks to achieve are to accept the reality of death, to work through the pain of grief, to adjust to an environment without the deceased, and to find an enduring connection with the deceased in the midst of embarking on a new life.

Further, the dual process model of grief highlights the oscillation between loss-oriented coping (e.g., thinking about grief, missing your old life) and restoration-oriented coping (e.g., figuring out a new life role). Both is needed for "good" grief: maintaining the bond with the deceased as well as self-transformation. For example, the Continuing Bonds Theory by Klass et al. [58] highlights the importance to remember the person, who has died, and to allow her or him to further influence the present. The purpose is to negotiate the meaning of loss and integrate it into a new identity through a transformed but continuing relationship. While Continuing Bonds can facilitate coping, it does not prescribe detachment, but rather endorses objects and memories that help to negotiate the meaning of loss. All in all, grieving can be experienced as meaningful when people are able to cope, move on and integrate the loss into a new life.

In sum, dying people should be empowered to find meaning and feel good at the end of life, whereas the bereaved should be empowered to cope with their emotions integrate the loss and continue their life. The dying get closer to their goal by satisfying their physical, spiritual, social and psychological needs and values [25]. The bereaved have to accept and move on into a new life, while finding an enduring connection with the deceased [122]. in the following, we present our scoping literature review on the background of the discussed understanding of good death and healthy grief.

## 3 LITERATURE REVIEW APPROACH

For our scoping literature review we applied the approach known as PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses [83]). In doing so, we follow the PRISMA extension for scoping reviews [109].

### 3.1 Source Databases

We chose to scope the design of thanato-technologies in HCI. We are aware that death is a topic in many other domains (e.g., books, movies, art) and also other scientific disciplines. However, since our focus was on how technology can improve the experience of death and grief, we chose the ACM Digital Library as a database that includes conference and journal proceedings from the special interest group for human-computer interaction (SIGCHI) but also other technology-relevant disciplines. Consequently, ACM DL was the starting point to search publications at the intersection of death, technology and design. We searched for studies published between 1990 and 2022 to cover a relevant and appropriate time span. We conducted our last search on the 2nd of August 2022.

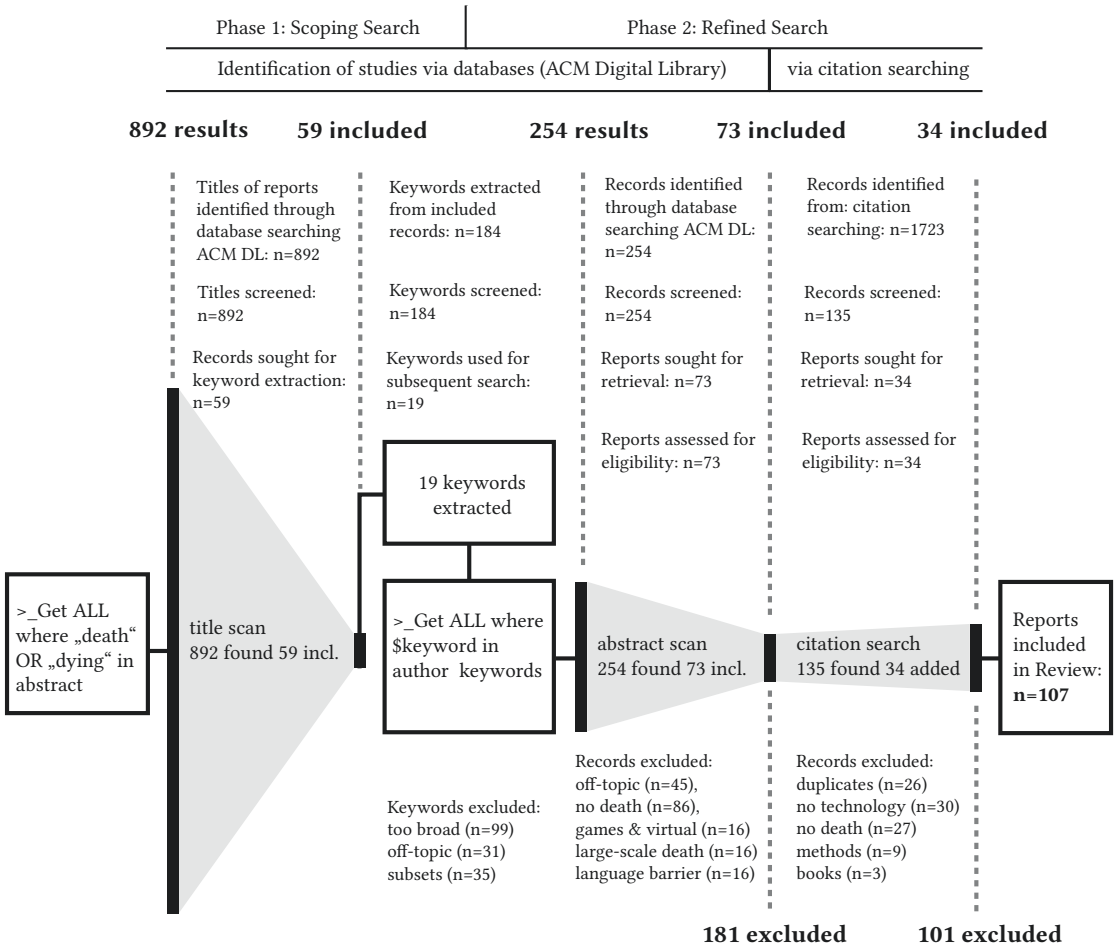


Fig. 1. Flow diagram of our two-fold search strategy consisting of scoping search (i.e., keyword extraction) and refined search (i.e., keyword search with subsequent citation search. Reporting scheme adapted from PRISMA-ScR [109])

### 3.2 Search strategy and query

We performed an initial scoping search to get a first idea of the amount of literature available. We searched for all records where "death" or "dying" appears in the abstract.

```
Abstract:("death" OR "dying")
```

The search yielded **892 results**.

However, the use of the term "death" and "dying" was heterogeneous in the resulting corpus. Often, death was more a figure of speech (e.g., are textbooks dying?) than related to the human experience of death. We scanned the titles of all records and identified 59 records that deal with death-related topics. We used these initial results to refine our

search strategy. We collected all author keywords from the 59 records, 184 altogether. We then excluded those that were too broad (e.g., social media, design, ethics) as well as those that were not central to the topic of our investigation (e.g., homelessness, breakup, depression). This left us with 52 keywords, 19 of which produced exclusive search results (records that were not already returned by another keyword).

```
Keyword:("death" OR "mortality" OR "digital legacy" OR "grief" OR "suicide" OR "end of life" OR
     "post-mortem" OR "memorial" OR "dying" OR "bereavement" OR "memorialization" OR "
    remembrance" OR "thanatosensitivity" OR "immortality" OR "mourning" OR "palliative care" OR
     "grieving" OR "memorials" OR "life review")
```

This refined search for publications with any of the extracted keywords in the specified author keywords yielded **254 results**. This became the initial corpus for further study selection.

### 3.3 Study Selection

The first and second author of the paper read the title and abstracts of 254 papers to select studies likely to contribute to the knowledge around death and dying in HCI. We collected all records as sticky notes on a collaborative whiteboard and marked them for inclusion or exclusion. Further, we grouped the excluded papers by the applied exclusion criteria. In doing so, we used the abstracts to determine if the content is relevant to our research question. Further, we used short summaries generated by Semantic Scholar (SciTLDR) to double check the decision. To decide between inclusion and exclusion, we used the criteria listed in Table 2.

Table 2. Our inclusion and exclusion Criteria

| Code | Inclusion criteria |
|---|---|
| IC1 | The study is related to death, dying or the end of life |
| IC2 | The study talks about the use or role of technology at the end of life |
| IC3 | The study is related to experiencing the end of life with technology |
| IC4 | The study is of an academic nature and reports on theoretical findings or conceptual work. |
| **Code** | **Exclusion criteria** |
| EC1 | The study is not related to actual human death (i.e., figure of speech) |
| EC2 | The study deals with virtual death as a game mechanic |
| EC3 | The study deals with death on a large scale (e.g., heritage, celebrity death, catastrophes) |
| EC4 | The study only makes a methodological contribution |
| EC5 | We do not speak the language in which the study is written |

Based on these criteria, we included 73 papers and excluded 181 papers. A majority of the excluded papers either not addressed death or addressed aspects of death as a computational challenge, such as the assessment of suicide risk [64] or the processing of death certificates [3]. We excluded them because they do not address how people experience the end of life. Other papers are about the experience of death but only discuss it within virtual narratives such as game mechanics (e.g., [21]). Even though one could certainly argue that this influences attitudes towards death we did not see a direct connection or potential to improve the end of life. In addition, people encounter deaths that do not directly affect them (e.g., celebrity death, catastrophes, heritage). For example, there are papers that discuss the communal awareness of road accidents [67] or suicides [97]). We excluded those studies because we were interested in

the individual experience and meaning of death and grief. In the end, we were also limited by languages and excluded 16 papers due to language barriers since those papers were published in Portuguese (e.g., memoriais digitais na web social sob a perspectiva dos usuários). Based on the English abstract and keywords, we assume that these papers cover social networks, digital immortality, legacy-making and digital memorials (e.g., [26, 39]).

After the exclusion of 174 papers we continued with the remaining 73 papers for a citation search. Specifically, we retrieved all publications (n=1723) that have been referenced by the 73 papers and sorted them by the amount of citations. For retrieval and sorting, we use Python and the Semantic Scholar Academic Graph (S2AG). Subsequently, we reviewed all records with three or more citations. We chose the threshold of three to limit our search to the work has been relevant to multiple included studies. From 135 papers we added 34 to the corpus of 73, a total of 107 papers.

We excluded the other 101 records out of which 25 records were duplicates (i.e., already included), 37 records dealt with other topics than death (e.g., techno-spirituality, reminiscing), 27 covered death and grief without technology and 9 referred to HCI methods (e.g., research through design, thematic analysis, probes). Further, we did not consider three books that had been written on the subject of death and dying in HCI. Limiting the search to research articles made it easier for us to see the theoretical and conceptual contributions of individual studies. Notably, the added reports also contain articles from journals that are not inside ACM Digital Library (e.g., OMEGA, Death Studies).

### 3.4 Overview of the corpus

For a complete overview, we included all contributions (e.g., extended abstracts, workshop summaries) and not exclusively full papers. Thus, our corpus of 107 publications consisted of 65 full papers with an additional 28 journal articles from references, and 14 workshop summaries, extended abstracts or posters.

Among the most frequent venues for publications from our corpus were conferences, such as the Conference on Human Factors in Computing Systems (CHI), Computer Supported Cooperative Work (CSCW), Designing Interactive Systems (DIS), as well as the International Conference on Human-Computer Interaction (HCI), and the Nordic Conference on Human-Computer Interaction (NordiCHI). Further publications were from journals, such as Death Studies or the OMEGA journal of death and dying. The papers in the corpus were mostly (93%) published after the year 2010.

We further distinguished publications with a conceptual contribution from those with a theoretical contribution. A conceptual contribution can be a design proposal that the authors devised (e.g., speculative, research prototypes, sketches). A theoretical contribution can be empirical research, theoretical models or frameworks with design implications for technological systems in the context of death and dying.

In 33 publications with a conceptual contribution, we have found 47 concepts of which 23 were research prototypes, 10 design probes, and 14 feature descriptions. Notably, 12 conceptual designs were purposefully speculative (i.e., not bound by established or acceptable behaviors). The remaining 74 publications made theoretical contributions. Overall, the research is qualitative and explorative, which is also reflected in the methods used (e.g., grounded theory or research through design).

### 3.5 Data Analysis Approach

We first characterize the current state of research on death and dying in HCI by categorizing the existing concepts. For this, the first author went through all conceptual contributions and extracted concept descriptions and images if available. Further, he extracted frameworks, study description and key takeaways from papers with a theoretical contribution. We visualized the findings on an online collaborative whiteboard for further discussion. A description and overview of the concepts that we found is in the supplementary material. We distinguish whether concepts are

intended to benefit the bereaved or the dying. We use the term dying people to refer to those who are aware of their eventual death and act upon it (e.g., people approaching the end of life). With bereaved people, we mean those who have lost someone who was important to them regardless of their grieving.

In a first step, we used an online collaborative whiteboard to group concepts and theoretical papers that address a similar technology-mediated activity. To find categories, the first and second author looked at all concepts and discussed underlying needs, situatedness in the process of dying and grief, as well as theoretical backgrounds. To give an example, we observed that social media is used to disclose the pain of grief, but also to talk about the deceased. We chose to distinguish self-disclosure from sharing stories about the deceased because we understand the former as reaching out to peers (who not necessarily mourn the same death), whereas the latter constitutes a form of shared remembrance. In the end, we find overarching practices (e.g., commemoration, social support) which describe the technology-mediated activity that dying or bereaved people engage in to improve their experience of death.

In a second step, we grouped the identified practices into three main themes that describe research on death and dying in HCI. For this, we considered the emotional or practical purpose for which the dying and bereaved engage in a practice. The resulting themes apply to the dying and bereaved alike, even though the challenges per group are unique.

## 4 RESULTS

Table 3. Our three main themes and the associated technology-mediated practices

| | **Theme 1. Digital Remains** | **Theme 2. Remembrance** | **Theme 3. Coping** |
|---|---|---|---|
| | *Leaving Behind* | *Looking Back* | *Facing Death* |
| **Dying** | Preparation [23, 50, 66, 70, 82, 92, 94, 105] , Curation [7, 23, 44–46, 48, 51, 93, 95, 108] , Tidying up [47] , Delegation [12–14, 27, 37, 38, 69, 71] | Retrospection [62, 101, 103] | Enjoying life [35, 72, 107], Sensemaking [52, 53, 126] , Decision making [36] |
| | *Inheriting* | *Remembering* | *Coping with Grief* |
| **Bereaved** | Archiving [22, 56, 57, 88–90, 104] , Feeling close [10, 34, 124] , Talking to the dead [2, 19, 23, 103] | Integration [48, 68, 77, 118, 119] , Honoring [49, 111, 112, 114] , Storytelling [75, 85] , Commemoration [15, 16, 28, 33, 42, 43, 63, 73, 79, 85–87, 89, 96, 106, 110, 120] | Letting go [55, 84, 100, 102, 113, 115], Sensemaking [31, 98, 106], Social support [4–6, 8, 11, 17, 20, 40, 74, 75, 77, 103, 104, 106, 116, 117, 123] |

We grouped concepts for dying people into 8 practices and the concepts for bereaved people into another 10 practices (see table 3). We then linked all practices to three main themes: **digital remains**, **remembrance**, and **coping**.

Some concepts touch upon more than one theme and some theoretical contributions address multiple practices. Clearly, there is some interrelation between what dying people leave behind and how they are remembered by the bereaved. Similarly, curating a legacy also requires some retrospection. Yet, all practices fulfill a particular emotional or practical purpose. All in all, the three themes address distinct challenges of dealing with death in a digital world.

In the following, we briefly outline the three main themes and describe the associated practices. For each theme we highlight its importance for dying and bereaved people.

### 4.1 Theme 1. Digital Remains

Over a lifetime, people accumulate vast amounts of data, stored on multiple devices (i.e., digital estate). This data increasingly reflects their lives. Like with material possessions, dying people care about what happens with their digital estate and how digital remains continue to represent a part of their identity beyond death. Consequently, digital remains can be an influential record of lived life for the dying and bereaved alike. For example, the disembodied self-presentation of a person on social media can sustain a sense of presence to the extent that social death never occurs (i.e., the dead remain socially included). Consequently, digital remains manifest a continuing bond between the dying and bereaved and also shape how people prepare for their death. On the one hand, digital remains capture who the dying person was and their relationship with the bereaved. On the other hand, digital possessions (e.g., photos, posts, location data) evoke personal memories for both of them. In addition, there are practicalities and instrumental tasks to prepare digital possessions for an eventual death.

*4.1.1 Leaving Behind.* Leaving Behind embraces the general theme of digital remains from the perspective of the dying person and subsumes preparation, curation, tidying up and delegation as conscious efforts to leave a meaningful legacy. The underlying practices determine what is passed down to loved ones after death. In this context, tidying up and preparation are instrumental tasks of legacy-making, whereas curation focuses on the emotional value that is attached to it. Further, dying people can delegate responsibility (e.g., over social media profiles) to ensure that digital remains reflects their intentions after death. All in all, the challenges of leaving a legacy are to select, prepare and convey meaning through digital remains.

**Preparation** refers to the instrumental practice of pre-arranging things before death. Specifically, we use this category to describe practicalities, such as drafting a digital will, which people consider as necessary precautions rather than having high experiential value. This ensures that systems deal gracefully with digital remains (e.g., close a dating profile or arrange the transfer of an e-mail account [50]). Often the eventual death of a user is not considered by systems, which leaves unexploited potential to automate burdensome tasks, have sensible defaults, and provide anticipatory support [50, 76, 94].

The benefit of being prepared is the opportunity to identify meaningful digital possessions, handle sensitive content gracefully and arrange a safe transfer of data [66, 82, 92]. Empirical research suggests that religious and spiritual beliefs influence the preparations that people make [105]. For example, people who do not belief in an afterlife are more likely to block chats on messengers after death [70]. Overall, preparing is perceived as a chore which is for example reflected by the concept *Preparedness Badge*[23]. The concept turns preparation into a social media challenge and awards people with a badge for fulfilling their duty (i.e., preparing for death).

**Tidying up** is a practice that refers to the disposal of digital possessions either for pragmatic reasons (e.g., it is not useful anymore) or the liberating feeling (i.e., refocusing on what is truly important). A large and heterogeneous amount

of digital remains can be overwhelming at the end of life and not everything is suitable or preferable for passing on. For the practice of tidying up, the nature of digital possessions is hindering because they are spaceless and persistent.

There are concepts that counteract the persistence by letting digital photos decay or by storing them in an irretrievable format that provides information about the stored file (i.e., how long it has been stored), but not the file itself [47]. The authors who explored these concepts found that decay goes against the reasons why people use digital technologies. Preservation was the preferred course of action.

**Delegation** is a practice where loved ones take on the responsibility to look after a digital possession following the death of its owner. A representative example are social media profiles which are typically not passed down to family or friends, but rather managed by them [14]. For this, social networking sites can provide features that allow account holders to nominate a steward [13].

The functionalities and design of such features are pivotal to make sure that accounts and their contents are handled in a way that benefits the dying and bereaved (e.g., volitional upkeep, desirable self-representation, opportunities for commemoration [27, 69]). Further, researchers who explored existing means of delegation highlight that it is important to trust stewards [37]. Beyond the efficient nomination of a legacy contact, systems could be improved if they support a thoughtful setup, involve both parties and provide anticipatory support, for instance by illustrating how the system functions after death [27, 38].

**Curation** is the purposeful selection and composition of memories, objects, stories with the intent to pass them on to loved ones or future generations. Compared to other practices the digital possessions of a dying person are not managed but used as a resource to create something meaningful (e.g., convey important aspects of one's life [45]). Further, it can be done out of the intention to do good for the family and loved ones (e.g., pass on lessons to future generations) [44]. There are two processes that are supported by technology: finding meaning in digital collections and conveying it through inheritance.

To find meaning, technologies can automatically process large collections of digital information (e.g., lifelogs) and contextualize the findings [45]. For example, software agents could reckon that unusual e-mails are meaningful or combine location data and twitter posts to deduce places of interest [48]. The researchers who explored automated reasoning suggest to expose system interpretations, utilize metadata (specifically time) and consider multi-generational links. In addition, systems can structure large collections (e.g., semantically or episodically [95]) and enable users to sift through a lifetime of memories [46]. For example, *MemorySwipe* facilitates a handpicked selection by allowing loved ones to vote on digital possessions that are worth keeping [23]. Notably, the researchers found that owners of digital data dislike to give away control over curation because the perceived value of possessions might be different for loved ones.

To convey meaning, technologies act as a data carrier and presentation format for memories (e.g., photos, stories, multimedia content). Available concepts include a multi-generational cloud storage, a multimedia life story scrapbook, or posthumous messages [7, 23]. Researchers who investigated posthumous messaging (i.e., photos or messages that are delivered after death) highlight potential distress and its impacts on grieving [51]. Because there is not much one can do with an intangible inheritance, some researchers argue to blend physical and digital interactions [93]. In line with this thinking, there are concepts to augment material inheritance with digital information (e.g., through QR-Codes [108]) or to turn digital data (e.g., songs, location-data) into a box with physical artifacts (e.g., vinyl record, postcards) [23].

*4.1.2 Inheriting Digital Remains.* The category focuses on digital remains from the perspective of the bereaved and subsumes archiving, feeling close, and talking to the dead.

Memories are often preserved and revisited to honor the relationship with the deceased. However, the bereaved are also confronted with the challenge to form a new identity in their ongoing life without the deceased. Essentially, digital remains that are inherited are either archived or used to remember the deceased. However, they can also be used therapeutically, such as in the practice of letting go.

**Archiving** is a practice that suggests to keep and preserve digital remains. Field research shows many reasons for people to engage in archiving practice in the home, such as to connect with others, to define the self and the family, to fulfill obligations, and to safely forget [57]. In line with the wish to keep digital mementos, designers created three technology heirlooms that aim at preserving and revisiting memories [88]. All three show that technology can shape the act of storing and revisiting memories through embodiment, placement and interaction [9, 90]. For example, a digital slide viewer features family photos in cartridges and provides a dedicated device to revisit them [88]. PenseiveBox [22] is another device that automatically retrieves information about a deceased person on social media. The box would then display those memories on a screen and send ambient reminders on special occasions (e.g., birthday).

**Talking to the dead** is a practice where the bereaved interact with an embodied representation of the deceased. Technology makes the interaction possible by relying on patterns that can be found in past interactions between the bereaved and dead person (e.g., chat records). Further, it shapes the experience through the embodiment of the deceased (e.g., through an encounter in virtual reality). While it allows the bereaved to relive interactions with the deceased it can keep them from adjusting to their new life. From a theoretical perspective, interacting and conversing with simulations of the deceased is a hotly debated topic in terms of expected interactions, the effects on grief and ethical implications [2, 19]. BlastFromThePast [23] and XSphere [103] are both speculative concepts that build on the premise of simulating conversations with the deceased either in virtual reality, or through chatbots and conversational agents.

**Feeling close** highlights a more intimate connection between the deceased and loved ones. In some cases, it can be comforting for the bereaved to experience closeness to the deceased. Technology, which supports such experiences evokes bodily sensations that draw on intimacy. For example, *HeartBeats* [34] and *ReMember* [124] both play back a recording of the heartbeat to provide comfort and elicit strong emotions. HeartBeats uses the squeezing of a pillow as an interaction that conveys physical closeness. A different form of physical closeness can be experienced through *BodilyHeirlooms* [10] which are handcrafted heirlooms that are reminiscent of the body (e.g., bones, guts, flesh). The authors of this paper speculate whether and how the body can be passed on to future generations.

### 4.2 Theme 2. Remembrance

The past plays an important role for the dying and bereaved alike. Because lives are increasingly mediated by digital technologies, online activities and digital possessions become a reflection of present and past selves. At the end of life this can influence whether people look back at a time well spent or regret their past decisions. For people who have lost someone it can be a constant reminder of what was and never will be again. The theme remembrance describes how the dying and bereaved engage with their past. Dying people look back on their life narratives when they approach death. For the bereaved, memories of the past celebrate the relationship and bond with the deceased. Practices and rituals around this are either directed to the deceased to honor their existence or to the bereaved to reflect on the past relationship.

*4.2.1 Looking Back.* This category relates to the overall theme of remembrance and covers it from the perspective of the dying. We found only a few examples of concepts that support a holistic reflection of the life lived before death.

**Retrospection** is a practice that dying people engage in to evaluate the life lived and to find closure. Theoretical research suggests that life reviews can help dying patients in palliative care to confirm their values and to find what matters to them in the end [101]. Digital remains (e.g., photos, facebook profile etc.) are sometimes used to facilitate retrospection and guide life reviews. However, there is a lack of technological tools that can support the recall and organization of life events beyond non-linear visualizations [101]. A further study explored the use of games to facilitate inter-generational life reviews [62] The only conceptual work in our body of literature was speculative. The fictional *CharonX* robot in palliative care presents a conversational opportunity to reflect on the personal life journey and to remember it fondly [103].

*4.2.2 Remembering.* For those who lost someone memories of the deceased are closely linked to grief and digital remains. Beyond memories that are evoked by objects or digital remains the construction of memory can also be subject to rituals and communal practice. Some authors in the HCI community refer to Continuing Bonds Theory [58] to explain the role of the deceased person in the ongoing life of the bereaved. The theoretical construct of *ongoingness* builds on the idea of continuing bonds and emphasizes a continued yet altered relationship with the deceased.

**Integration** is a practice where the bereaved include the dead into everyday life to negotiate the meaning of loss and make them a part o their ongoing life. It is related to other practices, such as honoring or commemoration, but differs in the sense that it facilitates continuous meaning-making. The aim is not only to remember the relationship with the deceased as it was prior to death, but also to give it a new role in the future. Technology can mediate this negotiation by enabling a continued interaction with the deceased [119]. For example, *Calendara* [48] integrates calendar entries of a deceased person into the monthly view to stimulate regular reflection. ReFind [118] is a smart photo viewer that uses tagged meaning and a curated photo archive of the deceased to responds to new pictures made by the bereaved. Thus, the deceased remain a part in the ongoing life of the deceased, however the relationship changes.

**Honoring** is a ritualistic practice where the bereaved perform a certain gesture for the deceased. For example, lighting a candle for the deceased can be a routine interaction to situate the deceased in daily life. This can be perceived as fulfilling a perceived obligation to the deceased (e.g., not forgetting them). The interaction with technology then invites a certain performance and enhances the experience. For example, the interactive family altar *Fenestra* [111] uses a lit candle as an activator for the image sequence on a picture frame and thus invites rituals of remembrance. Designated places, such as graveyards or shrines also shape the encounter with the deceased. *Matsaba* [114] is a household shrine for daily use where families look at the lifespan of their ancestors and even compare themselves at the same age through pictures. Gravestone displays follow a similar purpose by augmenting gravesites with additional information about the deceased (e.g.,family tree, photographs) [49].

**Commemoration** is a communal practice where the bereaved share stories about the deceased and construct a shared representation. The sympathy of others and the opportunity to express grief while maintaining memories of the deceased makes this a helpful experience for the bereaved. Networked media changed the way in which people commemorate because they make it more public and shape the way in which people express (e.g., by posting to a website). Online memorials offer a special place for remembrance. They are dedicated websites on which the bereaved share stories about the deceased. Sometimes they are created from social media profiles that the deceased left behind (e.g., memorialized facebook accounts). For example, facebook's memorial pages constitute a continuing bond between the dead and the bereaved.

Such online memorials must respect the wishes of the former account holder [79] while also becoming spaces for direct messages to the deceased, remembering and sharing stories about the deceased, and communication among

the bereaved [40]. A comparative study of grave sites and online memorials concludes that online memorials are less restrained, remain secular and constitute a living social presence of the dead [43] . Further, the content of online memorials often expresses that the deceased is missed [28, 96]. Sometimes, QR-Codes are used to link grave sites with online memorials [42]. People use memorials to write about the deceased as well as to the deceased. In this context, they are often used to exemplify continuing bonds with the deceased. Some authors highlight the breadth of design opportunities and propose a framework that groups characteristics of online memorials into actors, inputs, form and message. [86].

**Storytelling** is part of commemoration, but also helps to work through grief. For example, a recording device can encourage the bereaved person to collect stories about the deceased from family and friends [85]. Being able to tell the story and explore "what if" scenarios, such as how it would be if the deceased were still living, helps the bereaved to make sense of a death[75].

Even though there is extensive research to explore existing online memorials and services there are are virtually none conceptual design cases that propose new forms of commemoration. The only example we found is SenseVase, a concept that brings together virtual memorials and real world floral tributes [110]. By putting flowers into a sensing vase a virtual floral tribute is generated at an online memorial.

### 4.3 Theme 3. Coping

The theme of coping describes the individual experience of facing death and coping with grief. Technology supports this by connecting people and allowing them to make sense of their ending life. Dying requires people to make end of life decisions and to say goodbye, which can be complicated by a decline in capacity and a need for medical care. The bereaved have to accept that their life goes on without a loved one. Self-disclosure, social support, grief rituals and informational resources can support this.

*4.3.1 Facing Death.* This category describes the theme of coping from the perspective of dying people and according practices that help dying people to face death. Specifically, we describe how technology supports enjoying the last days, making sense of death and taking end-of-life decisions.

**Enjoying Life** refers to the actions that dying people take to find richness in life. This can be a distraction from facing death or a conscious effort to make the last days count. Researchers who explored technology use in hospice care highlight the importance of physical, emotional and spiritual support [107], especially the importance of normalcy, comfort and conversation [35]. One concept supports this by compensating for a decline in capacity through a telerobot that enables hospitalized patients to visit places remotely, to meet people and to participate in social events [72]. This leaves many opportunities to support other things that dying people find enjoyment in, such as familiar soundscapes, meaningful conversations and the presence of loved ones [35].

**Sense-Making** is important for dying people to find closure at the end of life and accept death. A negative example of sense-making would be to blame oneself for a terminal illness. Better alternatives are to be found in existential and spiritual perspectives or simply by fostering the acceptance that things cannot be changed. The existential perspective has already been taken up by a theoretical framework in HCI and highlights notions of death, identity, isolation, freedom and meaning [52, 53]. Informational and educational technologies can influence the mindset and knowledge that is used for sense-making. Further, technology can communicate and re-frame knowledge in ways that humans cannot. An example of technology that has been used to support this are SMS messages. Researchers used messengers to facilitate acceptance in cases where patients blame themselves for their illness [126]. The practice of sense-making is also related

to retrospection, already described above. In comparison, retrospection affords a more spiritual perspective, whereas sense-making is a more rational process. Overall, both is not yet fully supported by conceptual designs and existing technologies.

**Decision-making** is an important part of shaping the end of life. In the context of coping, delegation can become necessary because there is a chance that dying people become unable to make end-of-life decisions. Thus, it is the only way to secure autonomy at the end of life. Currently, technology is only used to facilitate proxy decisions by identifying shared understanding and encouraging exchange. The only conceptual design was *ThinksLikeMe* [36], a tool that triggers conversations about end-of-life choices and uses value sharing modules to visualize how far positions are apart. Notably, this is a step away from autonomy and towards relationships, specifically family units.

*4.3.2 Coping with Grief.* People who are dealing with grief can look for comfort on their own or reach out to others. The latter is usually encouraged and thought of as a healthy way of coping. Further, grief rituals can help to integrate the loss and mark a self-transformation.

**Social Support** is a practice where grieving and non-grieving people come together to help each other. The internet has enabled online social support where the bereaved connect with larger groups of people in a similar situation or others who are willing to help. Thus it became a resource for various types of social support, including informational, emotional, and instrumental support [106]. The research that we have grouped under this practice primarily focuses on bereavement support groups, chat groups, or discussion groups where bereaved people share their feelings. We distinguish social support from commemoration since it focuses on the bereaved, whereas commemoration is about the deceased. In this context, technology can become a medium, conversation starter, or surrogate companion. Thanato-technologies support social support practices by offering large social networks or facilitating intimate disclosure. For example, networked media allow the bereaved to reach peers that they would have otherwise never met. Empirical research explores how grieving people appropriate existing platforms (e.g., facebook). It suggests [4, 5] that anonymity, disclosure reciprocity and removing stigma help people to share their grief. In addition, while online bereavement support groups can not replace face-to-face support groups, they offer a complementary, optional component to the experience of grief [74]. Further, research with bereaved people indicates that they constrict communicational availability and frequency [75]. In this case, the bereaved used technology to modulate who can contact them and when they are receptive to communication. In our corpus we found four concepts that are either aimed at talking to peers or at facilitating disclosure. NotAlone [6] was designed as a dedicated platform to talk with people who have experienced a similar type of loss (in this case pregnancy loss). However, there are also concepts that encourage communication among the bereaved. For example, Tilting Frame is a concept [116] to make hidden grief visible by offering an indicator that someone has expressed their feelings in front of a picture. Similarly, Mourning Stones [116] are owned by multiple grieving people and signal when one of them is thinking about the deceased. Others have the change to respond in a symbolic way (i.e., heating up of the stone). Social platforms offer a more public space to express grief and exchange with others. Furthermore, technology can become a surrogate companion for disclosure. Huggy is a fictional humanoid robot with a warm textile surface that can provide some quasi-social comfort. As a reactive companion, it passively supports the bereaved by accompanying them throughout the day [103].

**Sense-Making** is a practice that grieving people engage in to understand how grief is affecting them. A study that looked into the use of search engines found that people often try to understand grief as a phenomenon and looked for types, stages, treatment and effects [98]. Technologies can offer educational and informational support. *Making Sense of*

*Grief* is an internet tool that provides self-paced interactive tools to help users to better understand and to normalize their grief [31].

**Letting go** is a practice where symbolic objects and actions are used to capture and process grief emotions emotionally [100]. Theoretical work on grief therapy suggests that disposal practices can help to achieve a sense of peace when grief is met with acceptance and understanding [102]. The authors refer to the experience of embodied disposal practices that can be passive, slow and hidden or active, quick and visible. In this context, interactions with technology can be design according to such attributes and mediate the experience of letting go.

For example, *BlackBox* [55] is based on the design rationale of letting go. Essentially, it mediates the act of storing away never-to-be-retrieved information and keeping the box as a memento. The finite space of *BlackBox* affords careful selection since it slowly closes with every added piece of digital. Similarly, images in the digital locket *Forget* slowly disappear and are eventually deleted after each day [119]. While the former concept uses a memento to capture the act of storing away, the latter places emphasis on the slow disappearance that can be passively experienced.

We also included funerary rites in this category because the underlying concepts highlight the act of saying farewell. For example, webcasting services enable remote mourners to say their last farewells [115]. Further, technologies can be used to personalize or enhance the ceremony [84, 113].

## 5 DISCUSSION

The present review shows that digital remains prolong the presence of the dead and influence their posthumous reputation. Digital records increasingly capture life and become tools for the dying and the bereaved alike to reflect the past and to allow it to influence the present. Further, technologies can support emotional needs when facing death or coping with grief. In the following, we contrast the identified themes with task-based approaches to dying and grieving in order to highlight issues that are already addressed as well as those that remain unexplored.

### 5.1 The Dying: Affirming Identity, Constructing Narrative and Facing Death

We highlighted technology-mediated practices that dying people engage in. Being successful in these practices can be linked to the tasks of dying [25] and the prospect of a better death. While we map out areas of already existing technological support, this does not imply that these practices are most relevant or successful in achieving a better death.

Keeping in mind that the dead remain present, people who approach the end of life wonder how they will be remembered, what stories their digital remains tell and if they would agree. Technologies support the practices of preparation, tidying up, curation and delegation within the scope of digital possessions, legacies and identities. Notably, the role of technological support is foremost limited to managing digital estate. While this gives dying people control over their self-presentation beyond death, others might favor tidying up and deleting their digital remains. Both choices could be a way to exercise control of one's afterlife.

The efforts of the dying to construct a legacy or lasting self-representation require them to refocus on core life values and use digital media (e.g., family photos) to recap and validate who they are. A better death would be when people are able to affirm and convey their identity, whereas a diminished posthumous reputation would result in a worse death. Curation constitutes a practice that allows dying people to reflect and shape their life narrative and how they will be remembered. The resulting sense of self-continuity is an integral part of dying in dignity [24]. Notably, the appreciation of a person's uniqueness is also conducive to autonomy. Further, passing down lessons to future generations supports

generativity. Thus, we would argue that the practices, we observed in the context of digital remains are conducive to the social and psychological wellbeing of a dying person.

People who die in old age have lived a long life and might view their death as a closing chapter. While only few concepts address the practice of retrospection, it is in part covered by the evocative experience of curation. For example, looking at old pictures could brings up memories of past chapters in one's life and stimulates the construction of a life narrative. For the dying person, a life narrative can be beneficial, if it provides a sense of closure or life completion. For this, it can be helpful to find continuity throughout a life story and to die in a way that seems to be a fitting ending. A better death would be when dying people are satisfied with a life's work and their death reflects a continuous narrative rather than a disruption. In this sense, we see a connection between technology-mediated life reviews, perceived integrity, and the psychological wellbeing of a person.

Eventually, a dying person has to face death. Here we saw that technology can support practices of sense-making, end-of-life decision making or help to enjoy the remaining time. The technology-mediated practices already suggested take into account the dying's declining capacities by addressing the inability to make end-of-life decision or restricted mobility. Sense-making and enjoyment make it easier to come to terms with imminent death. Facing death with less fear while maintaining joyful life moments is more accepted. Consequently the manner of facing death also affects the psychological wellbeing of a person. Specifically, serenity (i.e., composure and acceptance in the face of death) supports a death in dignity. However, the concepts that we found in this category aim rather at compensating the negative aspects of dying, such as declining capacity. Less is known about technological support for active efforts to achieve serenity.

All in all, suggested technology-mediated practices seem conducive to the psychological and social wellbeing of a dying person. They help especially in affirming one's identity, constructing a life narrative, and facing death. However, the latter two have been less explored and the dimension of spiritual wellbeing is not addressed. So far, research in HCI has focused on digital remains, legacies and post-mortem identity. While this secures dignity (i.e., dying well in the eyes of others), it does not equally satisfy other needs, such as self-exploration, transcendence, and autonomy. Current suggestions are more instrumental and seek to create a posthumous reputation, which will not be experienced by the dying person. While a digital legacy might be important to some people, others might care more about end-of-life decisions, unfinished business, or how loved ones will cope without them. It seems worth to further explore how technology can help dying people to gain control over other aspects that matter to them.

### 5.2 The Bereaved: Knowing the Deceased, Integrating Loss and Moving On

The bereaved maintain their own idea of the dead in relation to them. This is not necessarily aligned with the self-image of the deceased. A shared understanding invites delegated responsibilities, such as taking care of a post-mortem profile [38] or making end-of-life decisions when a dying person is not able to [36]. Here, technology can help to facilitate exchange and to create shared understanding.

Further, we found that evocative materials, such as family photos, are kept to remember the deceased and reconstruct a shared past. This becomes evident in three practices that make use of digital remains after a loved one has passed away: archiving, feeling close, and talking to the dead. Furthermore, there are disposal practices for the purpose of letting go.

The interaction with digital remains can facilitate the process of grieving in two different ways. This is best explained by the dual process model, which suggests that bereavement oscillates between loss-oriented and restoration-oriented experiences. Encounters with digital remains can create tension between remembrance and moving on. Current

practices with thanato-technologies support either loss-oriented experiences (e.g., archiving, talking to the deceased) or restoration-oriented experiences (e.g., letting go). What seems to be missing is a deeper understanding of the interplay between those two directions. We think that the process of integrating loss can provide further answers to understand positive ways of coping.

Some concepts and approaches contest the therapeutically informed detachment from the deceased at large [119]. They draw on the model of Continuing Bonds [58] which highlights the process of memorializing, remembering, knowing the person who has died, and allowing them to influence the present. This model relates to our theme of remembrance and its practices commemoration, honoring and integration. For example, online memorials facilitate shared representations of the deceased, which can become integrated in the relationships that bereaved people have with each other. Specifically, interaction with social network profiles of a deceased person shows that the bereaved share stories about the deceased and post messages to the deceased [33]. Similarly, the design of photographic family altars facilitates continuing bonds with ancestors as part of a cultural tradition [111]. While the model of continuing bonds can facilitate coping it does not prescribe detachment, but rather endorses technological heirlooms, keepsake and mementos that help to negotiate the meaning of loss [88, 118, 119]. Consequently, thanato-technologies help the bereaved to negotiate the meaning of loss and and to integrate it into a new identity through a continuing but transformed relationship.

Finally, we also highlighted the practices of social support and sensemaking which help the bereaved to cope with grief and embark on a new life. Thanato-technologies support these practices by offering large social networks or by facilitating intimate disclosure. For example, networked media allow the bereaved to reach peers that they would have never met otherwise. Thus, technologies provide a complementary support structure that can help the bereaved to move on.

All in all, technology-mediated practices consider existing knowledge about living with grief and address relevant challenges. Yet, there is no overall concept for technologies that help integrating loss and moving on. Arguably, individual circumstances and grief journeys make it difficult to find a solution that fits for everyone. However, there is a common understanding that grief should be actively confronted and be used to ascribe personal meaning to loss.

### 5.3 The Unused Potential of Involvement and Spirituality

Existing means of support for the bereaved and dying include systems that mediate between both of them. Digital remains are selected or curated by a dying person and passed on to loved ones after death. However, passing away creates an asymmetrical relationship with the receiver of a digital legacy, because the deceased do not live to see its reception. This can lead to situations where miscommunications or misinterpretations impose perceived obligations on the bereaved [89]. In line with this, researchers suggested to invite the receivers of digital legacies to make sense of, to interact with, or to add to them before death. Some concepts (e.g., *MemorySwipe*) already introduce ways to involve family members before death. Others consider the involvement of the deceased beyond death (e.g., *FutureStories*) [23]. However, it is often unclear how to preserve individual interests and how to negotiate the terms of involvement. For example, one could imagine a conflict where bereaved people want to have a digital legacy whereas the dying person prefers to delete all digital traces. To us, it seems that there is a missed opportunity of designing systems that allow both parties to exercise autonomy while fostering the involvement in the processes of dying and grieving. Certainly, the meaning-making process of the dying and their loved ones is not completely separate. Involvement could pave new avenues for shared meaning-making and soften the disruptive impact of death. However, it requires timely exchange and collaboration. Currently, the majority of concepts focuses either on dying or grief and simply mitigate the

negative consequences. Preceding involvement would enable loved ones to acknowledge the wishes of dying people and vice versa. For example, it would allow them to prepare a funeral together or make the dying person part of other future events that she/he cannot experience anymore. Technology then extends the agency of dying people beyond death. However, quasi-autonomous actions after death are also prone to become inappropriate in given circumstances. For example, a bereaved person who has moved on, maybe even found a new life partner, may not want to receive pre-ordered flowers from a deceased husband. Yet, it could be important for a dying husband to show that he cares and does something for his life partner [81]. In this context, technology could be used as support to secure the relational autonomy of both parties. Overall, involvement and carefully negotiated actions after death could ease the transition from life to death for both parties.

We have already shown that thanato-technologies can support practices that improve the experience of death on a social and psychological level. However, we also found no concepts to explicitly address the spiritual wellbeing of dying people. Only the practice of retrospection would allow for spiritual self-exploration to some extent. All in all, the ways to prepare for death remain rather secular, although beliefs appear to have an influence on post-mortem choices [70]. We argue that thanato-technology consequentially neglects key elements of dying such as purpose and hope [25, 99]. To our knowledge, there are no technology-mediated practices that seek to provide hope or address purpose in life. We suggest that thanato-technologies should also cater to the spiritual needs of dying people. This could include reconciling life choices, exploring beliefs about an afterlife or exploring one's lifetime contribution [121]. Further, a turn towards spirituality could enrich the ways in which legacies are created. For example, technological systems could produce life stories that are comforting for the bereaved and the dying by emphasizing integrity and purpose. It should also be noted that a majority of papers included deal with death and dying as practice in Euro-American and Japanese culture. Obviously, there are many ideas on good dying that are not explicitly dealt with, especially those associated with other religious or cultural worldviews. Considering practices in different cultures for the design of thanato-technologies could widen the understanding of a good death. For example, the Continuing Bonds theory is informed by cultures that accept the maintenance of bonds with the dead. Similarly, narratives about the afterlife, roles of the dead, and death rituals could inspire new concepts and theoretical understanding.

### 5.4 Reflections on the Research Process and Limitations

We conducted a scoping review which was based on publications in the HCI community. We may have missed thanato-technologies that are not reported in this scientific community especially those that are not inside the ACM Digital Library, such as reports published in books or scientific journals (e.g., Death Studies, OMEGA) and not included in our citation search. Notably, the citation search covers some work in journals, such as Death Studies and OMEGA, but not extensively, especially with regard to more recent publications. Nevertheless, the technology-mediated practices gathered from our scoping review in ACM Digital Library already reveal future directions and provide a good basis to design thanato-technologies for a better death. While grouping the contributions of the papers we included, we decided to make a distinction between conceptual and theoretical. We started the subsequent categorization by finding similarities between concepts rather than theories. This might have influenced our perceptions of the research landscape, but fits to our research question since conceptual designs more directly address the possible and intended benefit of using a technology. Further, it helped us to see how practices are shaped by technology. Notably, there are some simplifications we made by grouping concepts into practices. For example, we categorized a huggable robot as social support because it listens and provides comfort, although it is at best quasi-social. Thus, our practice-based approach to some extend masks the heterogeneity of the underlying concepts, especially with regard to their embodiment, aesthetics

and the technologies used. Nevertheless, the practice-oriented approach seemed best to acknowledge our interest in the activities people engage in to prepare for death or to grief the loss of a loved one, as well as the needs that those activities address. A further challenge was the heterogeneity of studies included and available information about the different concepts (e.g., research prototypes, speculative concepts, art installations). We acknowledge that other researchers may have derived different categories.

In our interpretation of the results we draw on secondary literature (e.g., task-based models) to contrast the HCI perspective on death and dying with other views of a good death. Certainly, other models or principles of a good death could have yielded different insights. It should also be noted that we are more familiar with death and dying as practice in a Western context, which in turn affects our cultural attitudes and beliefs towards designing research about death and technology.

## 6 CONCLUSION

Current thanato-technologies attempt to improve the end of life with new opportunities to capture the identity of the deceased, to validate the life lived, and to come to terms with death. Specifically, dying people curate digital remains to convey identity and continuity. The bereaved store and interact with digital remains to integrate the loss and maintain an active connection with the deceased through technological representations (e.g., digital memorials). While most thanato-technologies are primarily vessels of memories and digital possession, they are already conducive to a better death. In our review we saw that some researchers already consider knowledge about dying well and coping with grief. Overall, however, thanato-technologies do not address all aspects of a good death and seem to focus more on the bereaved. Certainly, technology cannot make death pain-free, change the place of death, or other circumstances. Nevertheless, it allows for a well-managed death by providing dying people with control over their preparations and by helping the bereaved to integrate their loss. HCI's predominant focus on digital legacies and memories seems restrictive in the sense that it fails to address other preparations that matter to dying people. We suggest to exploit this unused potential and create technologies to empower people at the end of life. Untapped opportunities lie in spiritual wellbeing and in balancing involvement and autonomy between dying people and their loved ones.

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