Long-term Care (LTC) facility and care unit Layout: a rapid literature review (revised)

William (Bill) Benbow

Several trends are impacting Long-term care nursing home facility design.

Firstly, demographics are driving demand upwards as baby boomers approach 85 years of age, which is the age when people experience the most extreme effects of normal aging and are at the highest risk of developing dementia. World wide the scale of people with dementia is projected to triple from 50 million currently to 152 million in 2050.[1]

Secondly, there is a dramatic change in the profile of LTC facility residents. Over the past couple of decades, internationally, the proportion of LTC facility residents with dementia or cognitive decline has increased to nearly 70% of the average LTC facility's census.[2] This means that building design needs to shift from largely focusing on the frail elderly to accommodating the needs of the majority of residents having serious cognitive issues.

Thirdly, the culture change and small group living movements have led to many facilities applying lessons learned from dementia specific resources to overall facility design. In particular, there is an ongoing shift from traditional type facilities with care units generally greater than 30 residents (>30) to facilities divided into smaller care units of less than 30 residents (<30).[3] Marquardt et al.[4] found that small-scale environments for residents with dementia result in positive outcomes including improved social abilities, behaviour, and well being.

Fourthly, the COVID pandemic has highlighted the vulnerability of elderly residents in shared accommodation. A study of all LTC homes in Ontario, found that the odds of a COVID-19 outbreak were associated with older design standards that have ward-style or shared accommodation.[5] This reinforces the shift to all private accommodation.

Fifthly, the growing focus on dementia issues, particularly wayfinding, is driving an emphasis on layout in LTC facilities.[6,7] This focus on layout of LTC facilities is a topic of importance to health leaders who direct and influence the design of upgraded and new LTC facilities.

"To become completely lost is perhaps rare. But let the mishap of disorientation once occur, and the sense of anxiety and even terror that accompanies it reveals how closely it is linked to wellbeing. It carries overtones of utter disaster. A good environmental image is the obverse of the fear that comes with disorientation. Indeed, a distinctive and legible environment not only offers security but heightens the potential depth and intensity of human experience ".[8]

Marquardt[9] found that spatial disorientation was a prime reason for institutionalization and that people with dementia require a compensating environment, which means that spatial layout research findings need to be considered when designing a LTC building.

Layout in Long-term care facilities can be defined as the floor plan design and circulation typology, including the arrangement of spaces, adjacencies, affordances, anchor points, and accessibility (physical and visual).

There are three levels of layout of facility physical space that can be considered:

1. Macro: the layout of the whole building or floor,
2. Meso: the layout of the care unit,
3. Micro: the layout of individual rooms.[10]

Cutler et al.[11] developed three environmental checklists, at the room, unit and facility levels. The authors concluded that still little was known about the trade-offs made between the nested features of the physical environment: i.e. room features – the near space, and unit features – the intermediate space, and overall building features – the distant space. Their checklists did not adjust for size of units or facilities, and at the time of data collection, 1999 - 2000, many units were still quite large: i.e. 40 – 50 residents: so further research is needed so that the checklists can evolve. Small LTC facilities with few units may hope to use facility-level amenities in lieu of unit spaces, but there may be serious wayfinding issues for the growing proportion of dementia residents.

This article will focus on the macro and meso levels, whole building and care unit configuration. As LTC facilities have evolved over the last three decades with the increasing proportion of dementia residents, the 'living space' for most residents has shrunk to the unit level. LTC residents spend the majority of their time in the care unit, with most residents leaving the unit less than once per week.[12] Residents may encounter barriers to activity participation outside of their living units when building circulation is confusing and staff or volunteers are unavailable to assist.[13,14]

This trend is no doubt related to the cognitive difficulties of the majority of residents in terms of wayfinding issues. Whole building layout is critical to addressing these challenges. And wayfinding continues to be challenging at the care unit level relative to the stage of dementia or cognitive loss and the size of the unit. Compensating design features are needed at both levels.

There is some inconsistency in the literature with regard to care unit terminology as small house models have evolved. Some refer to clusters, others to households or pods or living units or neighbourhoods. A care unit is defined as a geographic area within a Long-term care facility (LTC) with a specific number of residents, cared for by specific staff.[15] Care units in newer facilities tend to be self-sufficient in amenities such as lounges, dining and activity areas. Many include a functioning kitchen accessible to some degree for residents.

There is a hybrid type of LTC facility design that evolved as large facilities subdivided into more manageable subunit groupings. In this interim configuration resident rooms are grouped in smaller clusters or wings but are not geographically self-sufficient: clusters share some common amenities such as lounge and dining spaces with other subunits, usually in a central core on the same floor. Another version is the courtyard or racetrack type where two or more clusters of resident rooms and common areas are located surrounding the main circulation corridor. In this article, in terms of comparison and analysis, it is clearer to define groups as 'care units' only if they are self-sufficient in dining.

Method

The research question is what are the evidence-based recommendations regarding LTC facility layouts, both for whole building and care unit levels, particularly for residents with cognitive decline issues as they make up the majority of LTC residents.

PRISMA methodology was followed to guide and track the selection of journal articles and record the inclusion and exclusion critieria. Please see figure 1 for a PRISMA based graphic. Key words and search

strings were Long-term care, nursing home, memory care, dementia, layout, configuration, floor plan, space syntax, spatial, built environment. Data bases searched were PubMed, CINAHL, Web of Science, and Google Scholar. References and forward citations were hand-searched. Inclusion criteria were that the articles were in English, in peer reviewed journals, within the years 2000 to 2024. The critical exclusion criteria were that the article had to focus on layout or configuration of LTC facilities or care units, had to include or be applicable to dementia residents, and have sufficient detail such as floor plans, adjacencies, affordances and accessibility features such as visibility and physical distances. In addition, clarity and simplicity were critical as the intent of this study is to provide practical design guidance for health leaders such as health authorities, architects, developers and owners of LTC facilities.

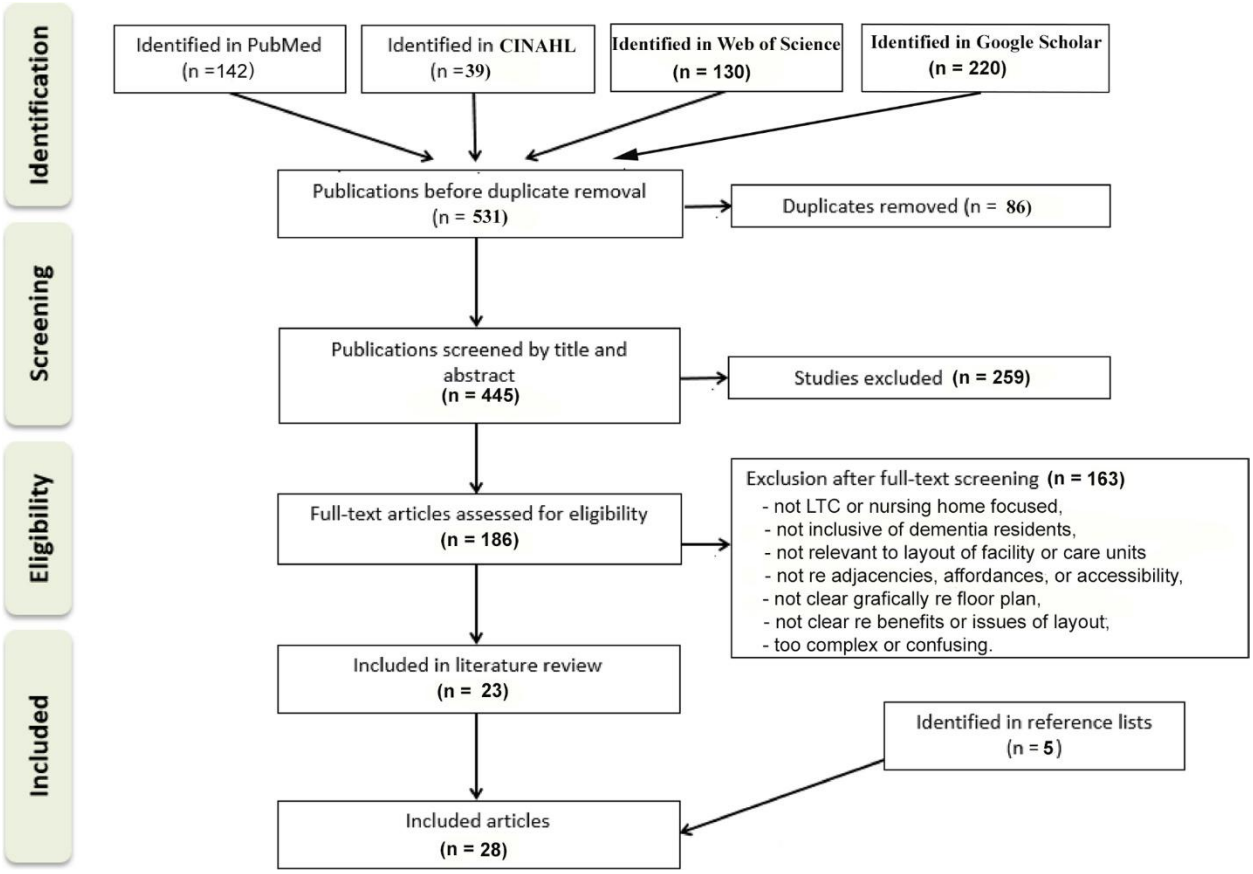


Figure 1: PRISMA diagram of study selections

Results

Findings of the 28 studies reviewed are summarized in Tables 1 and 2. Table 1 groups the 14 of the studies that focus on the Macro or whole building layout. Table 2 displays details regarding the 14 studies that focus on the Meso or Care Unit level of layout.

Articles researching LTC layout are basically studies of the physical environment's features that influence residents' well-being, and studies that develop tools to measure and analyse these features.[16] In this article we follow this thematic grouping in two sections: the macro whole building configuration and the meso care unit layout. Please see table 1 for macro whole building layout.

Table 1: Macro layout level: whole building environment

CITATION	LOCATION	METHOD	EXPERIMENTAL GROUP SIZE	VARIABLES	RESULTS	DISCUSSION and Recommendations
Alam, S., & Kim, D. (2023)	USA	Survey and Interviews 2022	Two LTC dementia facilities with minimum 30 res.	Wayfinding design elements	Complex bldg. layouts are most challenging; Symmetrical layout can be confusing.	Open floor plan better than corridors, Central activity/core, Visual connection best.
Burke, R. & Veliz-Reyes, A. (2023)	UK	Interviews and observations with field sketches re spatial characteristics. 2020	Two dementia care homes: 40 bed SCU and 30 bed traditional.	Liminalities, Affordances, Enablement.	Large floor plan of long corridor resident wings leading to centralized core amenities can be confusing, distant and alienating.	Long corridor design is not functionally supportive. Need for greater understanding of supportive environment.
Cao, W., & Dewancker, B. (2023)	Japan	Spatial syntax[1] used to analyse layout, circulation paths and typologies. 2021	168 nursing home floor plans	Number of corridors and connections	Four spatial layouts, single corridor, 2 corridors (T or L), 3 corridors (H or C), and 4 corridors (ring).	Fewer corridors make wayfinding easier. Best to minimize corridors while keeping distances short.
Carta et al. (2020)	Canada	Self-organizing genetic algorithm used to increase floor plan efficiency.	Irene Baron Eden Centre, Winnipeg, Manitoba	4 criteria: units <13 res, inhouse kitchen, dining room, multiple lounges/activity areas. And minimize distances within and between clusters.	New plan reduced walking distances with shorter corridors but scrambled care units to facilitate whole building circulation. Conflict between optimizing whole building layout vs. unit layout.	New plan broke up clusters, privacy zones, and visual connections. And lacked reference points and wayfinding supports. Algorithm needs more work.
Davis, R. & Calkins, M. (2023)	USA	Two connected studies: 1.Case study to compare and contrast three Configuration Measures in terms of wayfinding, 2019 2.Applied tools to 12 LTC buildings	1.Three story LTC bldg. with 90 residents; 2. twelve LTC facilities	Space Syntax (SS), Benbow Wayfinding Checklist (WC), Tool to Assess Wayfinding Complexity (TAWC)	SS measured difficulty of wayfinding based on floor plan complexity, WC measured wayfinding supportive visible elements and cues, TAWC measured individual route difficulty in terms of decision points and visual field.	1.These 3 tools are complementary and useful in guiding design. 2.Important to assess both building structure (hallway, length, turns), and visual elements: signs, landmarks, cues.
Faith et al. (2015)	Northern Ireland	Observation of 3 walks by residents: 1st walk led by researcher, 2nd and 3rd by resident.	Four LTC homes; Early and middle stage dementia	Four floor plan typologies: Y, H, Linear, and Circuit.	Central hub plans can be too symmetrical; T junctions can be confusing, avoid long narrow corridors, views inside and out can be helpful. Need good access to garden.	Early-stage dementia residents can retain some information. Simple, compact plans with distinct places are best. Avoid repetitive.

CITATION	LOCATION	METHOD	EXPERIMENTAL GROUP SIZE	VARIABLES	RESULTS	DISCUSSION and Recommendations
Hanson, J., & Zako, R. (2005)	UK	Space syntax analysis of SCEAM[2] data re whole Building layout	Two studies 1998 -2003 of 38 LTC facilities	Syntactic variables of whole building form and circulation space	Global and local spatial integration was positive for residents' engagement and activity: i.e. Quality of Life.	Access from resident rooms to day rooms is best with only 1 or 2 changes of direction.
Lee, J.et al. (2017)	USA, Australia and South Korea	Space syntax visibility graph analysis of six aged care facilities from three countries	4 whole building floor plans of cluster[3] type with wings and corridors; and 1 smaller group home; and 1 racetrack[4] type.	Connectivity and visual integration of movement paths and spaces	The corridor plans had a more complex layout from the residents' perspective, while the group home and circular approaches had a simpler more integrated layout with fewer decision points.	Traditional designs have a spatial hierarchy favouring visitors and staff. Self-sufficient small group designs have better visibility and connectivity for residents.
Lee, J. & Lee, H. (2020)	Korea	Space syntax visibility and accessibility analysis	Whole building Floor plan analysis of 2 cluster type (wings) and 2 racetrack type, 70 – 100 beds per floor	Measurement of Spatial and social attributes: focus on how layouts encourage inflows to common spaces	Centrality of amenities increases accessibility. Corridors leading to central core also provide opportunities for social contact. Both layouts have size and visibility issues.	Spaces with higher visual connectivity increase social interaction. Cluster wings and racetrack corners can decrease visibility to and from common areas. Need to sub-divide into smaller units for better visibility.
Miola et al. (2023)	Italy	Develop a tool to assess layout navigability	523 participants: residents, family and staff from 13 LTC facilities	Layout complexity, visual differentiation and signage	The Residential Care Home Navigability scale (RCHN): 18 items. (Item 16 needs math reversal)	RCHN is a reliable tool to identify strengths and weaknesses of layout navigability.
Parker et al. (2004)	UK	Test the SCEAM tool Re building design and Quality of Life	38 homes: Three building sizes in terms of number of residents: 11 Small <30, 14 Medium 31 – 40, 13 Large >41	11 domains including support for physical and cognitive frailty, choice and control, safety and health, and privacy.	Medium size buildings had highest Quality of Life, but were mostly residential care homes with less dependent residents. Small and medium size buildings were more domestic: large buildings had long corridors.	Type of building: Residential care vs Nursing care, degree of dementia, and size of care unit were not considered. Support for cognitive frailties and wayfinding most critical.

Table 1: Continued

CITATION	LOCATION	METHOD	EXPERIMENTAL GROUP SIZE	VARIABLES	RESULTS	DISCUSSION and Recommendations
Passini et al. (2000)	Canada	Interviews and staff and 4 routes for residents 2 that included their own floor and 2 the use of elevators	10 staff and 6 residents with severe dementia	Architectural features that effect mobility, such as visual access and distinctiveness on circulation routes.	Finding and locating own room and wing most difficult. Decisions are made on what is visible and legible. Simple but distinctive circulation and residential scale is best. Though recall may fail, some small-scale recognition remains. Most residents require staff assistance to leave living quarters.	Repetitive elements increase wayfinding difficulty. Axe symmetry and long corridors. Residents need distinctive reference points and places. Residential floors must be autonomous. Getting lost, disoriented results in panic.
Quesada-Garcia et al. (2024)	Spain	Develop a definition of a new type of LTC building through a review of LTC building architectural typology, with historical evolution of supportive design for persons with dementia.	30 dementia care homes in various parts of the world	Cognitive support: small scale, spatial orientation, sensory stimulation, social interaction. Continuum from public to semi-private to private spaces.	Early examples: Corinne Dolan, Woodside Place, Hogewey. Defines a New Architectural typology of 8 features such as access to gardens, building size, universal design, cells of residential scale, supportive orientation, personalization, lighting, technological aids.	Shows buildings can be large; i.e. 80 – 120 residents and maintain small group living units or households of 8 – 12. Could be clearer on spatial orientation, wayfinding features and open design in defining building characteristics.
Tao et al. (2018)	Hong Kong	Survey of resident satisfaction, and Space Syntax analysis of floor plans' integration to measure legibility for wayfinding	181 older people in 9 care homes	Space syntax integration of overall building layout: Corridor links and intersections	4 circulation patterns: straight line, cross, grid and ring. Increasing complexity of floor plans negatively affect wayfinding ability. Vertical circulation can be confusing.	Linear pattern is best to connect centralized amenities with personal spaces. Use visual access. Minimize turns. Group rooms according to function.

Table 1 continued

1. Space syntax: an architectural method to measure layout complexity and connections, such as walking routes and access to spaces,
2. SCEAM: Sheffield Care Assessment Matrix,
3. Cluster type: resident rooms grouped in subunits or wings, but share centralized common amenities,
4. Racetrack type: resident rooms and common areas surround the main circulation corridor.

Supportive features (whole building)

Residents with cognitive decline face anxiety at every turn. The most difficult task they face is finding and locating their own room. Wayfinding themes were selected from the reviewed articles with this in mind. A Canadian study twenty-five years ago highlighted the main features of a building's layout that help or hinder wayfinding: namely, visibility, legibility, distinctive reference points and ease of access are supportive while too many decision points, lack of distinctiveness, symmetry, and long corridors are barriers.[17] In terms of buildings, elevators are particularly challenging. Floors should be autonomous and self-sufficient. Tao et al.[18] add that vertical circulation is confusing and should be avoided. Most residents with wayfinding challenges will need staff assistance to navigate between floors.

Passini et al.[17] emphasized that some memory and spatial understanding remains, but is often based on recognition rather than recall. They recommend enhancing recognition by personalizing rooms and reference points. And designing the environment so that it speaks a language that the resident with cognitive challenges understands.

Faith et al.[8] support this point: residents, particularly in the early stages of dementia, can retain some information. They recommend keeping plans compact, simple, and distinctive: i.e. avoid long symmetrical corridors and T junctions. Several studies focus on the detriment of long corridors and indistinguishable symmetrical wings.[19,20]

Most authors in this study echo these points. Several stress that circulation should be simple rather than complex: with only one or two changes of direction.[21] Many favour the open/perimeter type of layout which provides the resident with immediate visibility of amenities as they leave their own room.[22,23]

Visibility is critical: Lee & Lee[24] emphasize that spaces with higher visual connectivity increase social interaction. They recommend subdividing large groupings such as cluster wings and racetrack layouts into smaller residential scale units where visible access prevails.

Tool Development (whole building)

For this article we are focusing on tools that particularly emphasize layout issues for LTC facilities. These tools are usually checklists that analyse essential features of the physical environment, and rate them in terms of compliance and degree. As the proportion of residents with dementia has grown, so has the need for enhanced tools that analyse and evaluate features that support residents with dementia. Four of the studies reviewed relate to these tool developments, while a fifth study attempts to develop an algorithm to guide LTC layout design.

1. A recent study combined three tools: a checklist of wayfinding domains developed by Benbow[25] for small house unit analysis modified to apply to whole building layouts; a Space syntax analysis to assess spatial configuration and connectiveness; and a new tool for route analysis: the Tool to Assess Wayfinding Complexity (TAWC). The authors believe the combined three tools can be used as design support tools. [26]

2. Miola et al.[27] developed a tool to analyse layout navigability, the Residential Care Home Navigability Scale. It is whole building based but does require some minor mathematical adjustment to one item which rewards long corridors rather than penalizing them. The main factors are visual differentiation, signage and layout. Under layout are ease of finding your way,

shape of circulation, location of rooms, length of corridors, visibility of outdoors, and assess to common areas.

3. A test of the Sheffield Care Environment Assessment Matrix (SCEAM) tool re building design and Quality of Life differentiates between building sizes in terms of number of residents: small <30, medium 31 – 40, and large >41. It found that support for cognitive frailties such as ease of way-finding was associated with positive emotion. These features were more prevalent in small residential homes that specialise in dementia care than in larger buildings with long featureless corridors.[28]

4. A recent Spanish study has developed a definition of a new type of LTC building based on 8 architectural features including universal design and care unit cells of residential size and supportive orientation. This newer type of building favours an open design with short paths and clear visuals. Large buildings of 80 to 120 residents are still possible, but achieve a residential scale by subdividing into small group living units of 8 to 12 residents. This could lay the groundwork for future research.[29]

5. Future AI research is foreshadowed in a Canadian study that attempted to develop an algorithm to aid layout design and floor plan efficiency by minimizing distances within and between clusters. Unfortunately, the result was unsatisfactory and did not resolve the conflict between optimizing whole building layout while maintaining care unit integrity.[30] More research is needed to make this approach useful.

Meso: care unit layout

Table 2 follows with the 14 studies that focus on the Care Units that are subdivisions of the LTC building. Similar to the whole building layout, the principles of care unit layout focus on wayfinding issues.

Table 2: Meso layout level (Care Unit or living unit layout articles)

CITATION	LOCATION	METHOD	GROUP SIZE	VARIABLES	RESULTS	DISCUSSION
Bai, L., and Nasu, S. (2018)	Japan	Space syntax analysis of nursing home floor plans to determine most integrated spaces. Review of transition from large-scale corridor based care to unit care with private rooms around living space amenities.	62 nursing homes: 40 large-scale and 22 unit- care type. Large-scale typically with long corridor; unit care more perimeter type[1].	Large-scale nursing homes compared to unit care nursing homes in terms of 4 main common spaces: community (living), care service station, dining, and physical activity.	Common spaces in large scale nursing homes have least spatial integration. Transition in 2000s from large-scale to unit care resulted in common spaces becoming more centralized in each care unit and more accessible to residents.	Unit care type has increased spatial consolidation of shared amenity spaces: i.e. better integration which facilitates resident use and social interaction. Private accommodation has replaced shared.
Brodsky, D. and Shepley, M. (2020**)**	USA	Questionnaire and Behavioral observation of LTC brain injury residents, in two different floor plan layout typologies	Two settings, one corridor[2] type (15 res) and one perimeter type (16 res)	Comparison of Corridor type and Perimeter type of care unit layout re social interaction	Residents in perimeter/open layout showed more emoting interest, interaction with staff, and received more assistance from staff than residents in corridor type layout.	Building layout is an important factor for social interaction. Gathering spaces adjacent to resident rooms preferred.
Chau, H. et al., (2018)	Australia	Space syntax analysis, field observation and design evaluation	Residents in 3 dementia units, All with sub-group wings: A – 13 (6 and 7), B – 34 (17 & 17) C – 17 (8 and 9).,	Layout simplicity, Small Unit size, Small sitting area, Short Corridors, Small dining group, Access to privacy, and outdoors.	Unit B has low connectivity with 34 residents in 4 wings, all sharing common centre: over stimulating. Wings in unit A are too small to facilitate social interaction: under stimulating. Unit C has poor sight lines.	Clear sight lines and short distances from resident rooms to amenities enhance spatial orientation, navigation and social interaction.
Isaksson, U., et al. (2008)	Sweden	The Multi-Dimensional Dementia Assessment Scale.	450 residents in 33 wards in 10 nursing homes	Wards with a high violent behaviour score vs wards with a low score.	Wards with high violence scores were larger in size: i.e. had more residents; and had larger and longer corridors.	This study confirms advantages of smaller care units and shorter corridors.
Ma, C., et al, (2024)	Netherlands	Case study of small-scale care unit using observation of behaviour	10 participants from 32 bed facility: 16 residents per care unit (floor)	L shaped layout with central living and dining rooms, and two activity rooms at ends of corridor.	Wandering was most observed behaviour, usually in corridors and central amenities. L shaped layout made space centripetal: residents preferred central amenities rather than end of corridor activity areas.	Floor plan layout impacts residents' activity ranges. Best to increase visibility of amenities by collocating and centralizing location and avoiding amenities at end of corridors.

CITATION	LOCATION	METHOD	GROUP SIZE	VARIABLES	RESULTS	DISCUSSION
Marquardt, G. and Schmieg, P. (2009)	Germany	Floor plan analysis, and ratings of residents using 5 routes within living unit	450 dementia residents in 30 nursing homes	Three circulation layout types: 1. Straight, 2. 1 shift in direction (L shape), 3. Continuous path around a courtyard. And Straight corridor with Intermediate Element.	Best layout was straight without shift in direction. Residents' orientation is affected by: Stage of dementia, Size of unit and number of residents in living unit, Size and shape of corridors, Visibility of whole corridor, Number of decision points. Garden access should be central to amenity area.	Minimize shifts in direction. Meaningful decision points are critical to wayfinding. Spatial anchor points are supportive such as the kitchen/dining area. Intermediate elements are helpful in long straight corridors. Rooms need to be legible.
Moore, K. and Ferdous, F. 2013	USA	Space syntax analysis and behaviour mapping[6] of social spaces	3 LTC units: one small mixed[3] type with open plan amenities; a mid-sized courtyard layout with a circular corridor; and a large floor layout of wings with a shared amenity core.	Proximity and visibility in dining and living rooms; with regard to frequency and level of social interaction	The smaller mixed type unit with more open amenities was the most connected and visually integrated social space. It had more frequent social interactions. However, the larger units which had less integrated amenities had fewer but more high-level or intimate social interactions.	This study focused on visibility and proximity within the amenity spaces and not on the wayfinding issue of distances and visibility from resident rooms. Residents indicated a preference for privacy and control: such as 2 or 3 chairs clustered within social spaces or laybys.
Nishino et al. (2024)	Japan	Scoping review of transition to private resident rooms and unit care system over past twenty years in Japan.	43 articles	Small care unit or living unit composed of 10 – 15 private rooms and core common space.	Private rooms facilitate family visits, prevent infections, help with terminal care, and increase resident well-being. Most common small care unit layouts were enclosed types with 3-way or L shaped perimeter configurations, and straight corridor with an intermediate common space or a combined wide corridor and common area.	Making units smaller brought staff closer to residents. Residents tend to live completely within the unit. Standard size of care unit has risen from 10 to 15 due to staffing issues and economics. Unit care and private rooms provide more humane care.

Table 2 continued

CITATION	LOCATION	METHOD	EXPERIMENTAL GROUP SIZE	VARIABLES	RESULTS	DISCUSSION and Recommendations
Quirke, M. et al., (2021)	Australia	Develop a design assessment tool, Plan-EAT[7], for LTC unit layout planning by applying the tool to published floor plans.	34 care unit layout types from 28 facilities with a median size of unit of 15 residents	Ten Dementia Design Principles (DDPs): 1. Safety, 2. Size and scale, 3. Visual access, 4. Low stimulus 5. useful stimuli 6. movement 7. Familiarity 8. Privacy 9. Community links 10. Domestic activity	Identified several high scoring layouts likely to support wellbeing of dementia residents. Top scoring layouts were: 1. A 9 bed corridor layout with open plan amenities at one end; and 2. Five 15 bed corridor layouts with core amenities at an intermediate point. Both provided secondary communal spaces for more private seating.	The majority of layouts were corridor based so lacked good visual access. The only perimeter type was oversized at 40 beds so though it had good visibility it lacked residential scale, small intimate seating spaces and outdoor access. The tool can aid planning by architects and designers.
Roberts, E. (2015)	Canada	Small-house model case study: interviews and observations.	50 residents in four perimeter type care units of 11 – 14 private beds. Two units per floor, and lower-level community centre.	Resident socialization and participation within care unit and community.	Residents have difficulty getting from their care unit to the community centre on their own, particularly from upper floor. Within the unit residents can choose whether to stay in the privacy of their own room or socialize in the amenity areas.	Good visibility and direct access to in-house amenity area in this perimeter type layout, with multiple levels of privacy or interaction. Some residents prefer to stay in their own rooms other than at mealtimes.
Rom, Y. et al., 2022	Israel	Develop a tool to analyse LTC units' layout: using Space Syntax and direct CAD measurement: The Psycho-Spatial Evaluation Tool.	Twenty floor plans of LTC units. L shaped plans used to illustrate tool.	Five elements of Layout support for physical well-being (PWB) and social well-being (SWB: 1. comfort: PWB, 2. Stimulation: PWB, 3. Status: SWB, 4. Behavioural: SWB, 5. Affection: SWB.	Four typologies: 1.Low PWB / High SWB, 2. High PWB / High SWB, 3. Low PWB / Low SWB, 4. High PWB / Low SWB. Relative distances and visibility are affected by arrangement of rooms: in a row or around a central semi-public core, (corridor vs perimeter styles).	Main positive factors are short distances and enhanced visibility from strategic functions or spaces. All of the units analysed were large: i.e. minimum 25 residents. Subsequent use of this tool suggested large size was an issue.

Table 2: Continued

CITATION	LOCATION	METHOD	EXPERIMENTAL GROUP SIZE	VARIABLES	RESULTS	DISCUSSION and Recommendations
Schwarz, B. et al., 2004	USA	Case study of a LTC renovation using Behavioural mapping, focus groups, and PEAP[5]	Two dementia care units on two floors: each unit a cluster of 10 - 12 residents	Reduced size of units, private rooms to replace doubles, and perimeter type layout with resident rooms surrounding common area to replace long hallways and difficult to reach amenities.	Switch from 20 – 30 residents using lower floor lounge and dining room to decentralized units with direct physical and visual access to small lounges and adjacent dining areas resulted in reduced disruptive behaviour and improved social interaction.	More residential scale and homelike attributes changed patterns of space usage and improved resident well-being. But staff resistance and limited activities complicated transition.
Van Buuren, L. & Mohammadi, M. (2021)	Netherlands	Floor plan analysis of group living units	14 floor plans of units with 6-16 residents	14 design criteria to support wayfinding: Sequence of spaces, Visual access, Length of route, Decision points, Corridor elements, Doors, Daylight.	Five layout types: 1. linear, 2. linear with corners, 3. circular corridor, 4. two corridors (L shape), 5. special (perimeter). Majority of units were linear.	Linear and Perimeter were highest ranked. Best to reduce number of decision points, keep corridors short, locate amenities to be clearly visible and accessible, reduce number of doors.
Van Haitsma et al., (2004)		Behaviour mapping, TESS[4], PEAP, floor plans, interviews.	6 dementia care units defined by number of residents who dine together: 3 units each for Small: $\leq$29 and Large: $\geq$30.	3 distinct LTC configurations for each of the unit sizes: 1. Hallway based, 2. Open-plan, and 3. Mixed design. And Functional Social Density.	Residents in Open (perimeter) layouts had less anxiety and increased levels of interest. Residents in Mixed layouts had greater well-being, less depression and less restraint use.	Excellent typology for study of layout, but small sample size: only one for each configuration by size. Future research is needed to disentangle effects of size from configuration.

Table 2 continued

1. perimeter/open-plan type: at least 2/3 of resident rooms surround a common space and open more directly onto amenity space;
2. corridor/hallway type: at least 2/3 of resident rooms open onto corridors,
3. mixed type: more than 1/3 or rooms open directly onto amenities; more than 1/3 of resident rooms are on corridors (Van Haitsma et al. (2004)
4. TESS: Therapeutic Environment Screening Scale;
5. PEAP: Professional Environmental Assessment Protocol;
6. Behaviour Mapping (BM): observation method of recording resident behaviour.
7. Plan-Eat: based on Environmental Audit Tool.

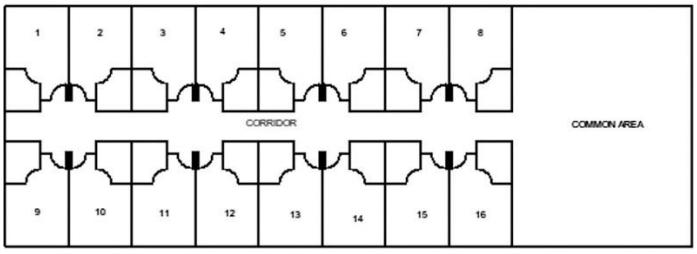
Supportive features: care unit

Much of the literature related to LTC facility layout has focused on developing and defining typologies. This can be quite confusing, with a variety of shapes and sizes suggested including linear, L shaped, circular, or courtyard, other letter shapes, number of corridors, shifts in direction and location of amenities. The most favoured type of layout for care units appears to be the open perimeter configuration or the mixed type rather than complex corridor-based designs. Van Haitsma et al.[31] introduced this three-part typology to better define layout types. They studied this typology on both the Macro level of large units equal to or greater than 30 residents and to the Meso level of units less than 30 residents. They found that the open perimeter design resulted in residents having less anxiety and increased levels of interest.

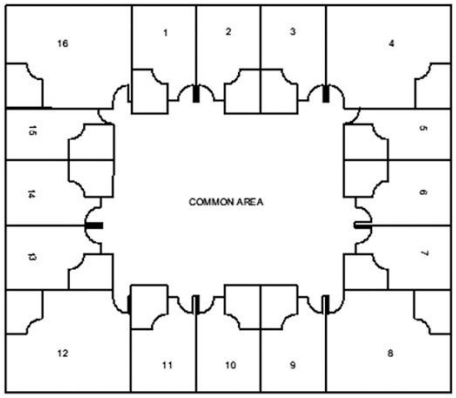
In this simplified typology there are 3 basic types of layout:

1. hallway-based (corridor), meaning that at least 2/3rds of the resident rooms open onto a single or double-loaded corridor;
2. open-plan (perimeter), meaning at least 2/3rds of resident rooms open on to some shared social spaces, and
3. mixed, meaning more than 1/3rd of resident rooms open on to hallways or corridors, and more than 1/3rd open on to shared social spaces.

Brodsky and Shepley[32] found that residents in open perimeter layouts showed more emoting and interaction. They clearly preferred gathering spaces close to their rooms. Please see figure 2 for a simplified graphic of Perimeter type layout and a corridor-based layout.



Corridor type configuration



Open perimeter type configuration

Figure 2: Configuration types[32]

Marquardt and Schmieg[9] are pioneers in researching what works well in terms of care unit layout. They emphasize a small number of residents per living unit, straight corridors and limited shifts in direction, meaningful decision points, direct visual access, spatial proximity of legible core amenities which could be intermediate elements to shorten corridors, memorable anchor points and good garden access. Stage of dementia was critical as it becomes increasingly difficult for residents to find their own rooms as the disease progresses.

Studies support the concept of smaller care units of 10 to 15 residents.[33,34] Nishino et al.[35] suggest that the number of residents in small care units has risen from 10 to around 15 due to staffing issues and economies of scale.

Co-locating common amenities centrally in small care units is well supported. Ma et al.[36] point out that a centralized core makes the space centripetal, drawing residents into social opportunities and activities. Bai and Nasu[37] found that consolidated amenities in small care units were more accessible, better used and facilitated resident social interaction. Roberts[33] noted that residents of small care units do have difficulty leaving their own unit to reach a community centre shared between units, particularly if it is distant or on a different floor.

Short corridors and clear sight lines are well supported.[38, 39] Isaksson et al.[40] found that care units with higher violence had longer corridors. Moore and Ferdous[41] did note that some residents preferred small less visible areas with seating for 2 or 3 residents for more privacy.

Tool development (care unit)

Two studies pursued tool development for care unit layout.

Quirke et al.[42] based their floor-plan checklist, Plan-EAT (Environmental Audit Tool) on ten Dementia Design Principles. Their case studies had an average of 15 residents per unit. The high scoring layouts were straight corridor types with core amenities placed at one end or intermediate locations. They had short corridors with easy access to these main amenities and secondary communal spaces for smaller gatherings. They acknowledged that the corridor design did have the weakness of limited visual access for most of the residents. Their only perimeter case was much too large with 40 residents.

Rom et al.[16] used space syntax and direct measurements to develop their tool based on five layout elements that support well-being. They point out that spatial relationships are caused by the arrangement of resident bedrooms: either as a row of rooms along a corridor or placing the rooms around a central public space. Unfortunately, all of their case studies were large with a minimum of 25 residents. Although their main elements reward visible access and short distances, in follow up articles they acknowledge that large size is an issue. They recommend that appropriate layouts should provide a variety of social interaction places, to allow for privacy and less noisy venues.

Discussion

As sought in the research question, the articles reviewed in this study highlight a number of evidence-based supportive features for LTC buildings and care units, particularly several basic wayfinding principles as they affect residents with cognitive decline issues. Four recommendations for LTC design leaders flow from this summary.

1. Visual accessibility: a resident should be able to see their destination from their room; and when in common areas they should be able to see their room or a simple route back to their room with good signage and landmarks.

2. Physical accessibility: residents should be able to reach common areas directly from their rooms or via short well marked corridors. Short distances and a minimum of decision points facilitates wayfinding and reduces the anxiety of feeling lost.

3. Common areas should be collocated, centralized and legible for ease of wayfinding.

4. There should be a minimum of design symmetry, particularly for resident areas such as wings , rooms and resident room doors which should be individualized.

As discovered in this review, there are basically three types of layouts in LTC facility care units: rows of resident rooms along corridors, resident rooms around the perimeter opening onto a central space of amenities, and a mixture of the two. The perimeter type of layout is most suitable for small groups. More than ten or twelve rooms surrounding a core of amenities is difficult to design geometrically without the amenity area becoming oversized.[43] Whole facilities and larger care units can use the mixed type layout with short corridors, a minimum of T junctions and lots of supportive wayfinding features including signage, landmarks and reference points.

Limitations

As a rapid review this study is limited and not intended to be exhaustive. It is a sampling of articles researching the topic of layout in LTC facilities with a focus on firstly, macro or whole building layout and secondly, on meso or care unit layout. There are many related factors that affect resident and staff well-being, but this article is limited to the one factor of layout or configuration of spaces. This article is limited to evidence-based journal research articles and does not include the gray literature or health authority standards and guidelines. It is intended that the summarized themes and findings of these articles will inform the development of standards and guidelines. This article has focused on dementia related research due to the growing preponderance of residents with cognitive issues in LTC facilities. It does not encompass comorbidities but design recommendations should be useful to most LTC residents. Micro layout of individual rooms is not included but would be worth a similar review.

Conclusion

The supportive layout features and tools under development for both the Macro (whole building) and Meso (care unit) levels require ongoing validation and adjustments. The articles reviewed have shown the gradual development over the past two decades of improved whole building wayfinding and the subdivision of LTC facilities into smaller care units that are more supportive of residents with cognitive issues. Studies will continue to refine evidence-based optimal configuration principles. There is general agreement at both Macro and Meso levels that visible and physical access are paramount to support residents with cognitive decline to find their way, particularly from their room to amenities and back again. And clear distinctiveness of wings, rooms and doors in terms of legibility and lack of symmetry is critical. Healthcare leaders can use the principles uncovered in this review to guide layout design guidelines and decisions; and to encourage ongoing research in both supportive wayfinding features and tools to evaluate these elements.

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