Acta Biomed 2023; Vol. 94, Supplement 3: e2023213 DOI: 10.23750/abm.v94iS3.14557

Original article

Bridging therapeutic landscapes to architecture. International experience-based design strategies for healthcare infrastructures

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Abstract. *Background and aim:* in Italy, many cases studies of therapeutic green spaces are built into healthcare infrastructures, but only some of these follow the principles of healing gardens. Scientific literature and international case studies offer many contributions of evidence relating to how therapeutic green spaces can support traditional treatments. The paper analyze the relationship between indoor and outdoor spaces and healing gardens' features; the main research questions were: *"Can we synthetize experience-based design strategies for therapeutic green spaces and healing gardens? How can we prioritize the most relevant ones for the healthcare infrastructures?" Methods:* Research Method is divided into three different steps: 1st case studies' selection; 2nd case studies' analysis, and 3rd quali-quantitative comparative matrix. *Results:* ten case studies were identified-four of them have the therapeutic green space on the ground floor,despite of the other six having the healing garden on the rooftop.The best experience-based design strategies for the therapeutic green spaces or healing gardens development were identified from the previous comparison matrix, and divided into A.Safety, Security and Privacy; B.Accessibility; C.Physical and Emotional Comfort; D.Positive distraction; E.Engagement with Nature; F.Maintenance and Aesthetics; and G.Sustainability. *Conclusions:* The results obtained from the comparative matrix are qualitative and quantitative design elements in terms of type of element / space, percentage, perimeter, area, number, materiality, shape, color, among others. The quali-quantitative matrix is a useful and practical tool that allows the designer to have a base of design guidelines that can be later applied to the proposal of new therapeutic gardens. (www.actabiomedica.it)

Key words: Therapeutic landscape design, healing gardens, healthcare facilities, experience-based design strategies, healing architectures

Theoretical scenario

Healthcare facilities are some of the most difficult places for people to be. These are almost always environments in which people face a high degree of stress. Patients may experience physical or emotional condition; visitors, are worried and, healthcare providers - like doctors and nurses - are under strong pressure facing life and death daily. According to several decades of research that show that people can heal with less pain and faster when they are in contact with nature (1-4), hospitals and healthcare facilities are reinventing themselves (5,6) and incorporating healing gardens with specific therapeutic purpose (7,8). These health promoting landscapes are often referred to as "Healing Gardens", which are defined as natural spaces

within a healthcare facilities (9), specifically designed to promote and improve the health and well-being of patients, family, and staff.

Therapeutic Gardens can be classified (10) according to two criteria which determine their organization and the necessary design elements (11). The first criteria refer to the location and the physical features (shape, dimension, etc.) of the garden. Types of gardens according to the location and form are extensive landscaped ground, borrowed landscape, entry garden, backyard garden, courtyard, plaza, roof garden, roof terrace, peripheral garden, indoor garden, viewing garden, among others. The second criteria classify gardens according to the users: in this case it is important to consider that different patients have different needs, some have extreme restrictions, temporary complications or gradual deterioration. Furthermore, when designing therapeutic gardens, it is important to contemplate not only the patients, but all users, including medical staff, patients' families, and the community. Referring to this second criteria, the therapeutic gardens can be gardens for children's hospitals, gardens for cancer patients, rehabilitation gardens, to mention a few.

Various attempts have been made around the world to identify design principles for Therapeutic Gardens. The present study relies on the *"Guidelines for Design and Construction of Therapeutic Landscapes in Healthcare Facilities"*, because their work is focused on a comprehensive research based on the analysis and evaluation of evidence-based design approaches (12-17) such as: biophilia, stress-reduction theory, sense of control, access to privacy, positive distraction through contact with nature, and emotional conjunction theory, all of them theories that show scientific evidence about the benefits that people can obtain from the contact with nature. From all these considerations, the authors proposed the minimum requirements for the design of therapeutic gardens in new or renovated healthcare facilities and provided guidelines for the design of the different elements and spaces (18-20).

On this basis, Cooper Marcus & Sachs (21) divide the general design guidelines in *"Overarching Design Considerations" and "Specific physical design guidelines for all therapeutic gardens"*. The "Overarching Design Considerations" refer to general design concepts that are based on the evidence-based design theories and should be applied to all therapeutic gardens, they include concepts such as: Safety, security and privacy; Accessibility; Physical and emotional comfort; Positive distraction and Engagement with Nature (Biophilia). The *"Specific physical design guidelines for all therapeutic gardens"* provide a series of recommendations about design elements such as: Garden Enclosure, Hospital Building and Accessibility, Physical / Functional Layout, Pathways, Seating and Shade Structures, Planting Design, Water features, Lighting, Green Therapies, and other garden elements.

Starting from this assumption, the research questions were: *"Can we synthetize experience-based design strategies for therapeutic green spaces and healing gardens? How can we prioritize the most relevant ones for the healthcare infrastructures?"*

Research method

The Research Method is divided into three different steps: 1st case studies' selection; 2nd case studies' analysis and 3rd quali-quantitative comparative matrix.

About 1st case studies' selection international case studies (22) were selected with the aim of learning about different experiences on design of healing green spaces around the World. The selection of the Case Studies was done according to three different criteria (23): first, "Exemplary Case Studies that apply the principles of therapeutic gardens and evidence-based design"; second, "Cases that present similar location of the therapeutic gardens inside the healthcare facilities"; and third, "Cases that present similar sanitary function and users".

Starting from the first, it means that the selected cases studies are internationally well-known cause of the EBD practices (24) capable to provide scientific evidence about aspects such as: privacy and safety, accessibility, garden layout, pathways, seating, planting, green activities, lighting, use of water features, utilities, sustainable practices, among others (25-27). The second and third criteria are important because the design of the garden is strictly related to these two factors.

Referring to the second criteria, the design guidelines applied to the garden (28) depend on the sanitary

functions located near to the green areas and the specific users that are going to serve; the study is interested in hospitals with functions such as: acute care, rehabilitation, maternity, child-birth, children, oncology and spaces for staff only. Finally, regarding the third criteria, the study is interested specially in extensive landscaped ground, backyard gardens, courtyards, roof gardens and roof terraces.

Based on these three criteria, ten case studies were chosen, which are internationally recognized; correspond to the typologies: extensive landscaped ground, backyard gardens, courtyards or roof gardens; and present sanitary functions such as: rehabilitation for adults and children, gardens for cancer patients and spaces for staff only (29-30).

About 2nd case studies' analysis, the method used for the analysis of each Case Study is based on the *"General Design Guidelines for Healthcare Facilities"* (21) previously explained. Following this theoretical base, it was possible to create a base of Case Studies where each one of them was analyzed considering the *"Overarching Design Considerations"* or concepts related to evidence-based design theories (left column of the Figure 1), which encompass *"Specific physical design guidelines for all therapeutic gardens"* or elements of design (middle column of the Figure 1), which in turn have qualitative and quantitative characteristics (right column of the Figure 1) that were graphically represented through a series of diagrams.

Finally, after analyzing the ten case studies, the 3rd step was reached: a quali-quantitative comparative matrix was defined, which the aim of determine the best design practices through the comparison of the qualitative and quantitative features of the design elements identified in the different cases.

Research findings

The Research Findings are followings the three steps of the Research Method.

About 1st case studies' selection, ten case studies were identified worldwide (Figure 2) according the three selection criteria previously mentioned (Figure 3);

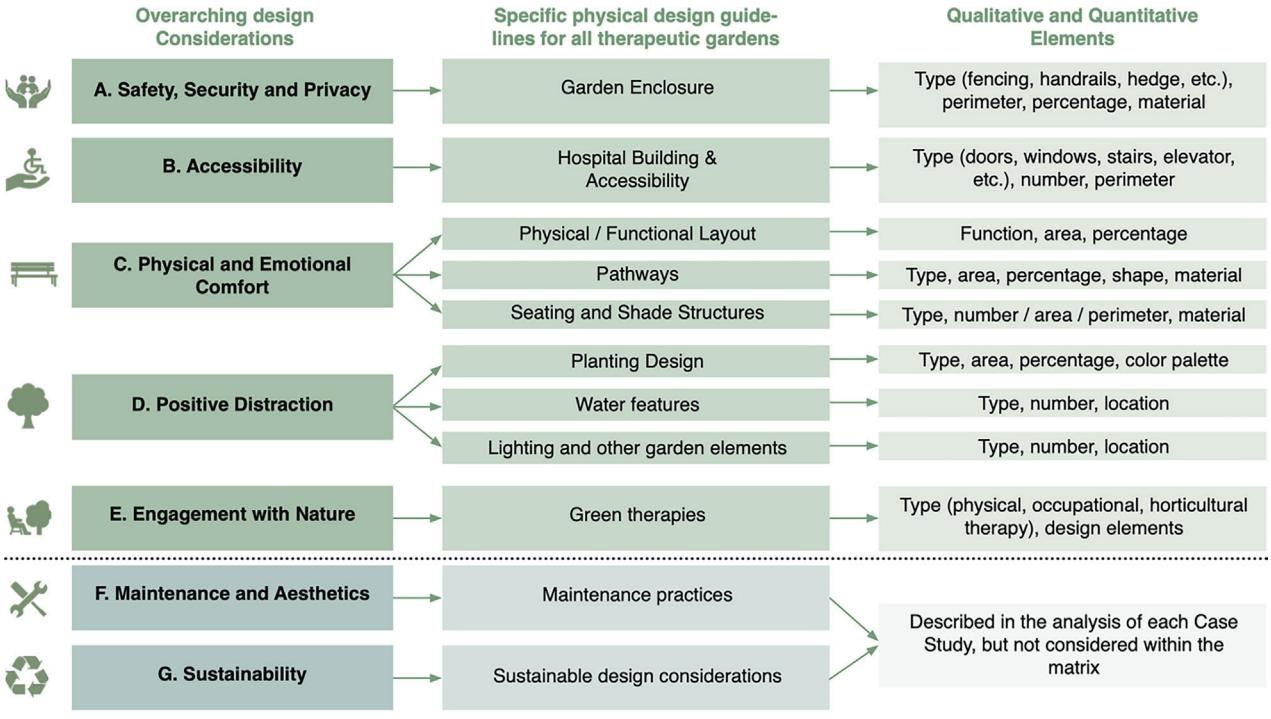

Figure 1. Case studies' comparison method analyzing the "Overarching Design Considerations" (left column), which encompass "Specific physical design guidelines for all therapeutic gardens" (middle column), which in turn have qualitative and quantitative characteristics (right column). Source(s): Authors' own work.

Figure 2. Ten case studies' location, that were identified according the three selection criteria previously mentioned. Source(s): Authors' own work.

	CASE STUDIES	LOCATION	YEAR	AREA (sqm)	HOSPITAL FUNCTION / GARDEN FUNCTION	GARDEN LOCATION
1	**Vienna North Hospital**	Vienna, Austria	2018	46.000	General Hospital / Therapeutic Gardens, Rehabilitation Garden, Gardens for children	Extensive Landscaped Ground, Courtyards
2	**Nelson Mandela Children's Hospital**	Parktown, Johannesburg, South Africa	2016	9.300	Children's Hospital / Therapeutic Gardens, Gardens for children, Therapy Gardens, Horticultural Therapy	Extensive Landscaped Ground, Backyard Garden, Courtyard
3	**Spaulding Rehabilitation Hospital**	Boston, Massachusetts, U.S.A.	2016	4.000	Rehabilitation Hospital / Therapeutic Gardens, Rehabilitation Garden	Backyard Garden, Entry garden
4	**Fiona Stanley Hospital**	Perth, Western Australia	2014	3.250	Advanced diagnostic, surgical and rehabilitation services, 24-hour emergency and acute care / Therapeutic Gardens, Rehabilitation Garden	Courtyard
5	**Ramathibodi Hospital**	Ratchathewi, Bangkok, Thailand	2018	1.500	General Hospital/ Therapeutic Gardens, Rehabilitation garden, Horticultural Therapy	Roof Garden
6	**Mercy Medical Center - Mary Catherine Bunting Center**	Baltimore, Maryland, U.S.A.	2010	1.625	General Hospital, Maternity and Neonatal Intensive Care Unit, Newborn nursery / Therapeutic Gardens	Roof Garden
7	**Victorian Comprehensive Cancer Center (VCCC)**	Melbourne, Vic, Australia	2016	1.455	Oncology Hospital / Gardens for people with cancer, Garden for staff	Roof Garden
8	**Legacy Emanuel Medical Center - Family Birth Center**	Portland, Oregon, U.S.A.	2014	605	General Hospital, Maternity and Neonatology unit, UCI cardiology / Therapeutic Gardens	Roof Terrace
9	**Yawkey Outpatient Cancer Center**	Boston, Massachusetts, U.S.A.	2005	604	General Hospital, Oncology Unit / Gardens for people with cancer	Roof Garden
10	**Great Ormond Street Hospital**	London, United Kingdom	2008	476	Children's Hospital / Garden for staff	Roof Terrace

Figure 3. Case studies' identification according to the three selection criteria previously mentioned. Source(s): Authors' own work.

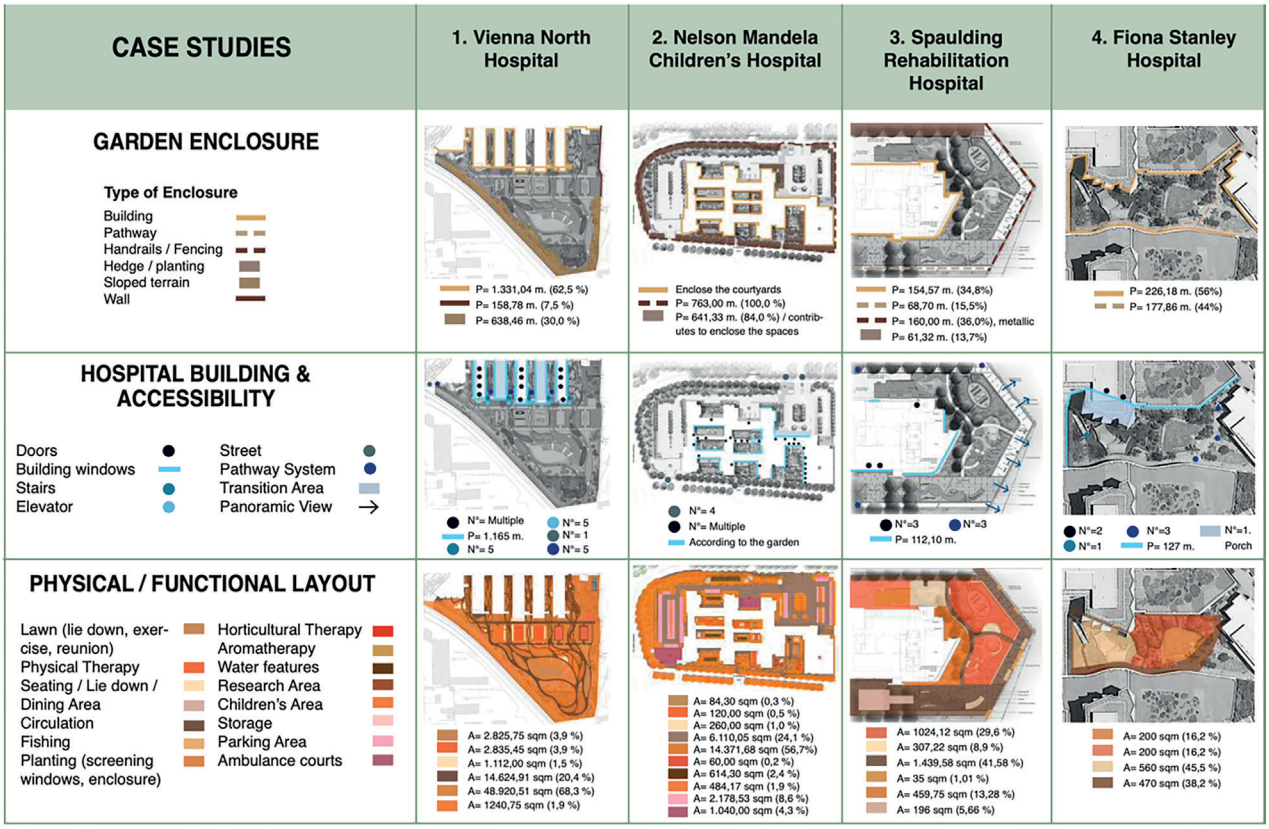

Figure 4. Comparison matrix part 1.1 analyzing the Garden enclosure, hospital building & accessibility, and physical functional layout for the four case studies having the therapeutic green space on the ground floor. Source(s): Authors' own work.

four of them have the therapeutic green space on the ground floor (and of bigger dimension), despite of the other six having the healing garden on the rooftop (and dimension between 500 and 1500 sqm).

About 3rd quali-quantitative comparative matrix, all the ten case studies were carefully analyzed, and the collected data are visible in the following charts.

Garden enclosure, hospital building & accessibility, and physical functional layout for the four case studies having the therapeutic green space on the ground floor (Figure 4), and six having the healing garden on the rooftop (Figure 5).

Pathways, Seating & shade structures, and planting design for the four case studies having the therapeutic green space on the ground floor (Figure 6), and six having the healing garden on the rooftop (Figure 7).

Water features, lighting & other garden elements, and green therapies for the four case studies having the therapeutic green space on the ground floor (Figure 8), and six having the healing garden on the rooftop (Figure 9).

Findings' discussion

The best experience-based design strategies for the therapeutic green spaces or healing gardens development were identified from the previous comparison matrix; the following strategies work as a guide and inspiration that can be applicable in new projects.

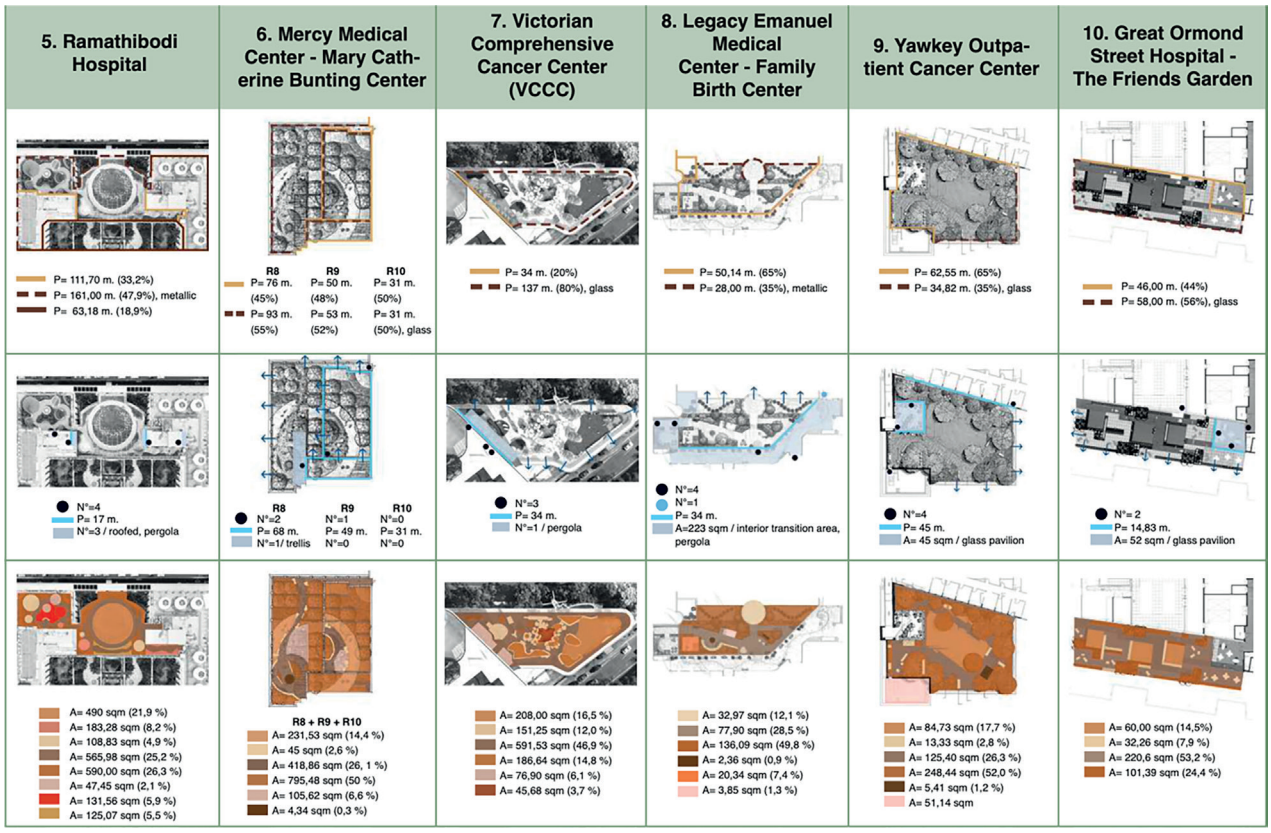

Figure 5. Comparison matrix part 1.2 analyzing the Garden enclosure, hospital building & accessibility, and physical functional layout for the six having the healing garden on the rooftop. Source(s): Authors' own work.

A. Safety, security and privacy

A.1 Garden Enclosure: the types of elements used to provide enclosure to the therapeutic garden were identified, such as the hospital building, pathways, handrails, fencing, tree hedges, or walls. These elements were described according to the perimeter they occupy, area, proportion, and materiality. The type and perimeter of the Garden Enclosure is directly related to the type or location of the therapeutic garden inside the hospital facility, the relationship that the design wants to establish with the surroundings, and the topography and characteristics of the own garden or landscaped areas.

Referring to the gardens at the ground level (case studies from 1 to 4): in some gardens there are topographic characteristics that contribute to isolate them and to provide privacy to the users. This characteristic is helped by elements such as retaining walls and fencing. In most of the cases the privacy to the garden and at the same time to the building indoors is provided by tree hedges or planting elements located as a second barrier next to the fencing elements, next to the hospital windows, or surrounding a garden and establishing semi-private spaces.

Regarding the rooftop gardens (case studies from 5 to 10): in all the rooftop gardens the perimeter of the garden that is not com- posed by the building correspond to handrails, which provide safety and at the same time allow panoramic views of the context. Regarding materiality, most of the gardens use glass handrails to allow visual accessibility of the surroundings.

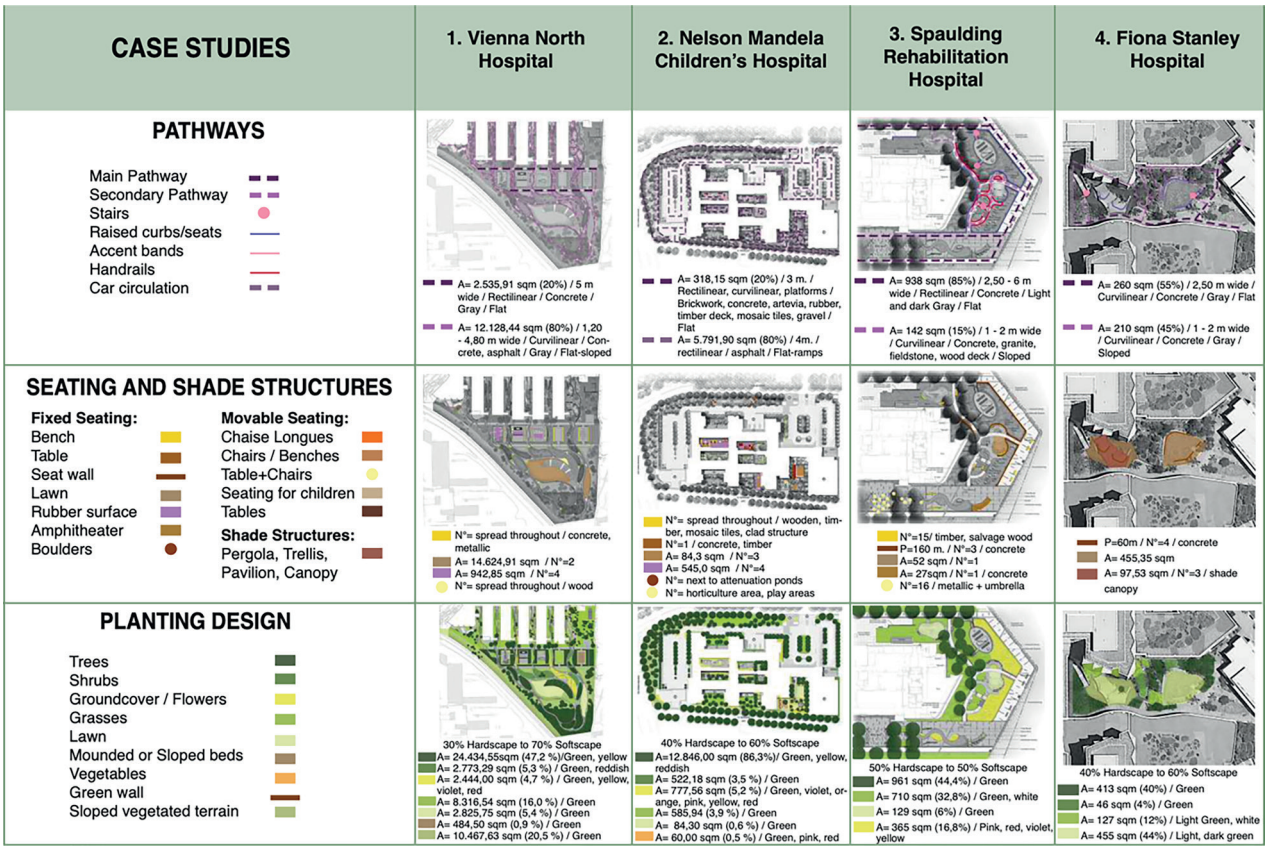

Figure 6. Comparison matrix part 2.1 analyzing Pathways, Seating & shade structures, and planting design for the four case studies having the therapeutic green space on the ground floor. Source(s): Authors' own work.

In other cases, small walls or metallic handrails are used to enclose the garden.

B. Accessibility

B.1 Hospital Building & Accessibility: the elements that allow visual and physical accessibility were identified, such as doors, windows, stairs, elevators, access from the street, access from a road system, transition area between exterior and interior, and panoramic views towards the context. These elements were identified in terms of location, quantity, perimeter, area, and materiality.

Referring to the gardens at the ground level (case studies from 1 to 4): the number of doors or entrances to the garden depends on the hospital design and the garden location. If the garden is large presents more entrances from the building. At least a main entrance and a secondary entrance were observed in all the cases. The perimeters of the windows that allow the visual accessibility of the garden depend also on the building design. Contemporary hospitals include continuous tall windows that allow full visual accessibility of the garden. The transition area between the inside and the outside is mainly composed by porched spaces or pergolas. And in other cases, there is a direct connection of the landscaped areas with interior gardens.

Regarding the rooftop gardens (case studies from 5 to 10): in most cases, there is a main entrance and a secondary entrance to the rooftop gardens. The perimeter of windows depend on which floor is located the garden and on the building design; however, in most of the contemporary cases there are continuous tall

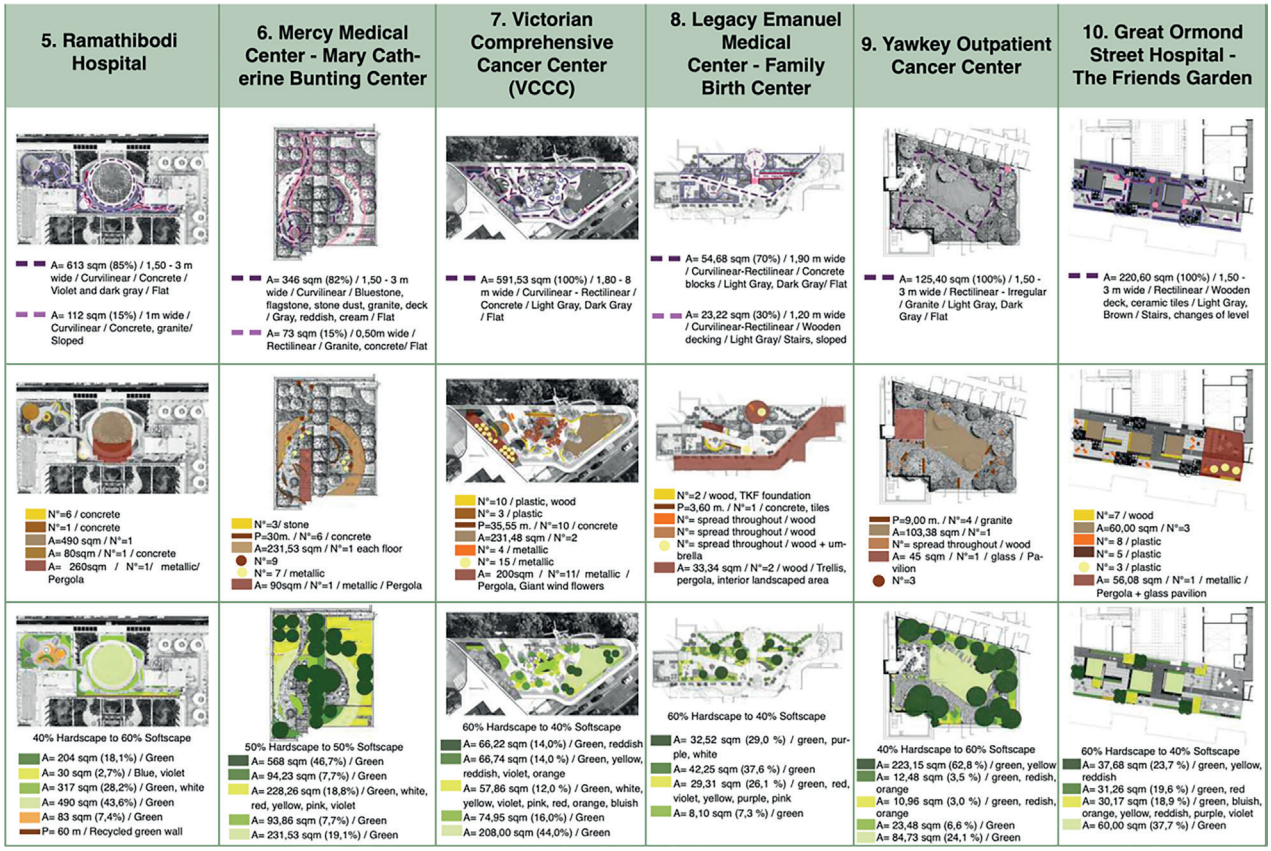

Figure 7. Comparison matrix part 2.2 analyzing Pathways, Seating & shade structures, and planting design for the six having the healing garden on the rooftop. Source(s): Authors' own work.

windows. The transition area present glass pavilions or internal landscaped areas visible from outside, which provide a green anteroom to the garden. Most of the gardens allow a panoramic view of the surroundings.

C. *Physical and emotional comfort*

C.1 Physical/Functional Layout: this design factor depends largely on the users that the garden has and the area it occupies within the healthcare facility. Some of the spaces that were identified are planting, circulation, multifunctional lawn, seating areas, dining areas, water features, playgrounds, areas for physical therapy, areas for horticultural therapy, parking areas, among others. All the spaces were analyzed in terms of surface and proportion they occupy within the therapeutic garden.

Referring to the gardens at the ground level (case studies from 1 to 4): planting or vegetation occupy the largest area in most of the gardens, with a percentage of 60-70% of the garden layout. Regarding circulation, it occupies among the 20-40 % of the gar- den layout. All the cases present a curvilinear and rectilinear garden layout, according to the needs. All the gardens include a lawn which are multifunctional spaces where users can exercise, do therapy, or just sit and lie down. The lawn areas are usually present in a proportion of 1-20 % of the total garden area. The seating spaces occupy a smaller proportion in comparison to the other garden elements, among the 1-10%. In all the cases these elements are located next to the rehabilitation areas or playgrounds, spread along the main pathways, and, looking towards planting, water features, sculptures, or panoramic views. The dining areas are related to the seating spaces. The horticultural

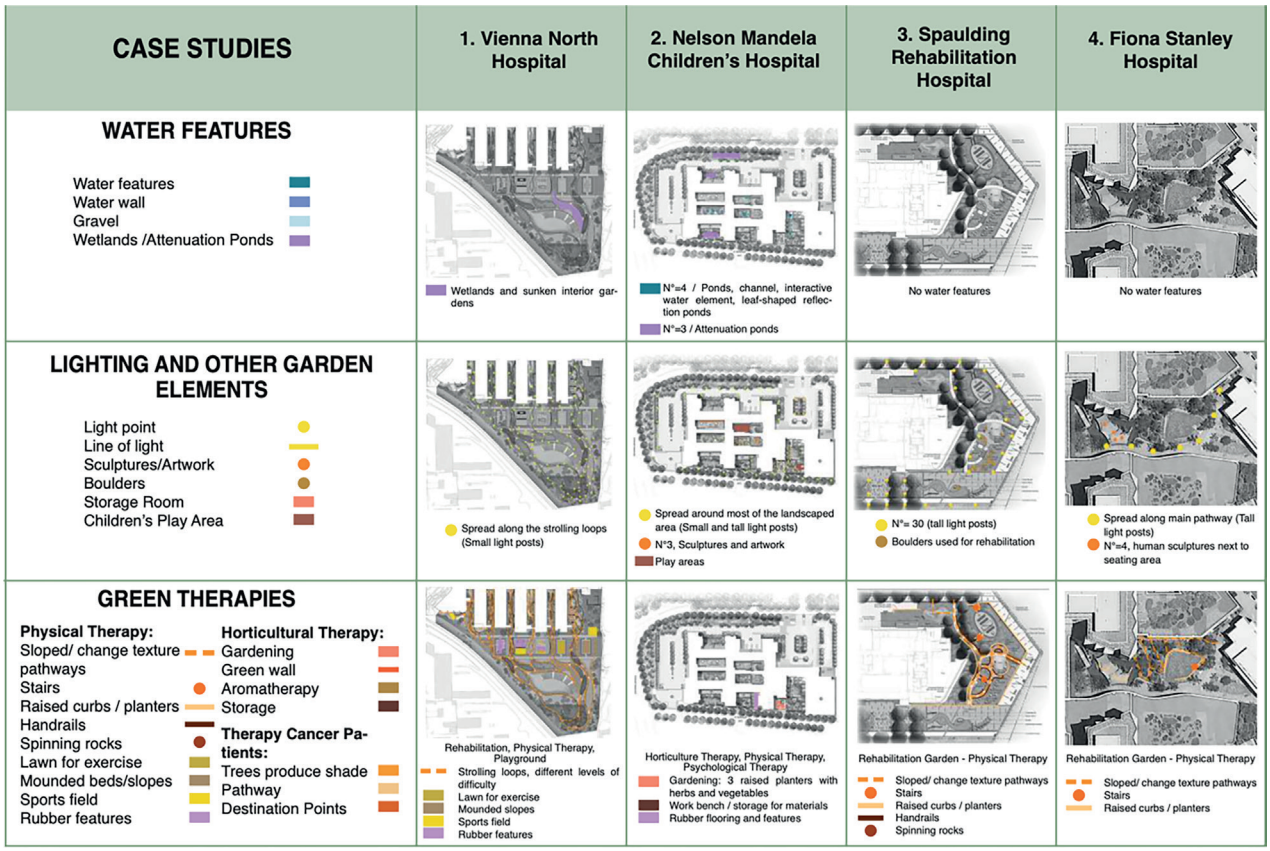

Figure 8. Comparison matrix part 3.1 analyzing Water features, lighting & other garden elements, and green therapies for the four case studies having the therapeutic green space on the ground floor. Source(s): Authors' own work.

therapy, aromatherapy, and storage areas, occupy a relatively small area within the garden layout. Finally, the water features occupy approximately the 3% of the total garden area in just one case.

Regarding the rooftop gardens (case studies from 5 to 10): in the rooftop gardens the areas with Planting (trees, shrubs, perennials) constitute around the 15-50% of the total garden layout. These areas are located mainly surrounding the garden, close to the hospital windows and defining the different spaces inside the garden. In terms of Circulation the rooftop gardens present a percentage that varies among 25-50% of the total garden area. The pathways are organic and curvilinear in half of the cases, and in the others are rectilinear and/or irregular. In all the gardens there is a lawn used as a multifunctional space. Its proportion corresponds to the 10-20% of the total garden layout. Its shape is rectangular, irregular, circular, according to the design. The seating and dining areas occupy around 2-20% of the garden layout. The spaces related to cafeteria and staff gardens present a larger seating area. Seating is available in designated areas around the garden as well as along the main walks. The spaces related to Occupational or Physical Therapies occupy around the 10% of the garden layout in one case. The areas related to Horticultural Therapy and Aromatherapy occupy approximately the 15% of the garden layout in one case.

C.2 Pathways: Regarding the pathway system, the primary and secondary pathways were identified, the area they occupy in the garden, proportion, width, shape, materiality, color, and slope. Furthermore, other elements

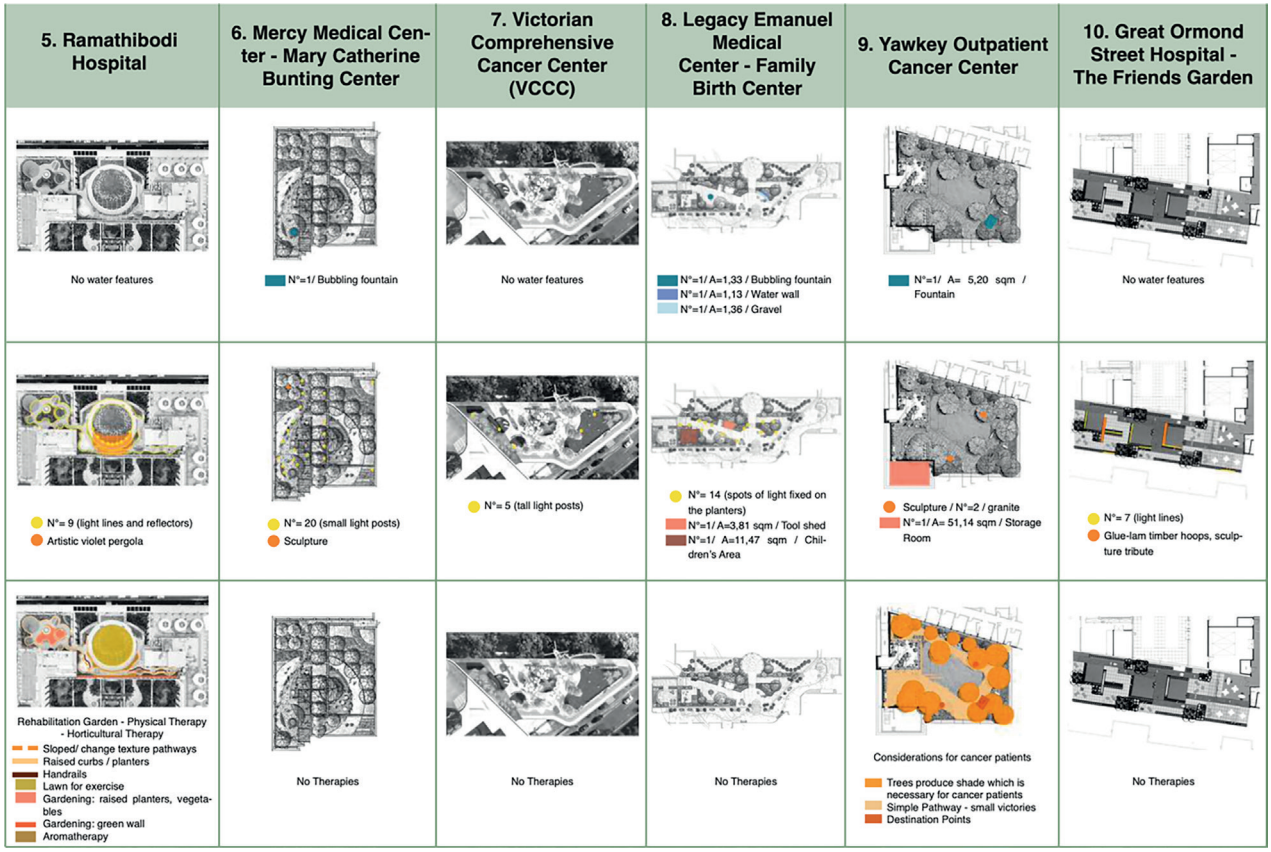

Figure 9. Comparison matrix part 3.2 analyzing Water features, lighting & other garden elements, and green therapies for the six having the healing garden on the rooftop. Source(s): Authors' own work.

were also described, such as stairs and handrails, or raised curbs and accent bands.

Referring to the gardens at the ground level (case studies from 1 to 4): the area and proportion of primary pathways varies from case to case. The width of the path ranges between 2,50 and 6 meters, depending on the needs and dimensions of the garden; for car circulation the dimensions are between 6 to 8 meters wide. The primary pathway is rectilinear in all situations, and in some circumstances, it is a combination of rectilinear and curved shapes. Concrete is mostly utilized for the main path; however, other materials such as brickwork, rubber, timber deck, and gravel are also employed. The path is flat in every case.

The proportion of secondary pathways varies from case to case. The width of the secondary paths varies from 1 to 2 meters in most situations, although in one case it reaches 5 meters. In every case, the secondary pathways are curved or meandering. Concrete is used in the majority of situations, however other materials such as asphalt, granite, fieldstone, and wood deck has been also used. In the rehabilitation gardens there are stairs (2-3 steps), handrails, raised curbs or raised planters, and sloped walkways.

Regarding the rooftop gardens (case studies from 5 to 10): the primary pathway takes up about 70-85 % of the total area in all rooftop gardens, and in certain circumstances, when the garden pattern is relatively simple or it is a roof terrace, the primary pathway takes up all of the space. The width of the pathway varies between 1,5 and 3 meters in most cases

but reached 8 meters in one case. The pathways are curvilinear in half of the cases and rectilinear in the other half, depending on the space available. Concrete is used in the majority of situations, however materials such as bluestone, stone dust, granite, wooden decks, and ceramic tiles have also been used. In most cases, the primary pathway is flat.

In some cases, secondary pathways take up 15 to 30 percent of the garden, while in others, they are absent. The paths are approximately 1 meter wide. Curvilinear or rectilinear pathways are available. Concrete, granite, and wooden deck are among the materials available. Some paths are sloped or present stairs and handrails.

C.3 Seating and shade structures: In this case, the different types of fixed and movable furniture used to sit and as cover within the therapeutic gardens were determined. Benches, tables, chairs, seat walls, lawn areas, rubber surfaces, amphitheaters, boulders, chaise lounges, furniture with dimensions for children, pergolas, pavilions, etc. were identified. These elements were specified in terms of location, number, area and materiality.

Referring to the gardens at the ground level (case studies from 1 to 4): among the fixed seating all gardens include benches which materiality is mainly concrete or wood/timber, other materials are aluminum and mosaic tiles. All the gardens include lawns where people can sit or lie down, the area and number of lawns depends on the garden dimension. Two cases include also seat walls that extend along small or large perimeters according to the possible views and uses. The rubber surface was also considered since the children can sit and play on it; therefore, in the case of the two Children's hospitals the gardens include these surfaces. Some cases include amphitheaters and other boulders for seating spread around natural areas. Regarding the moveable seating most of the gardens include tables and chairs located in areas related to dining activities and inside the horticultural therapy spaces. Regarding the shade structures all the gardens use vegetation as the main source of shade; however, in two cases there are pergolas and canopies.

Regarding the rooftop gardens (case studies from 5 to 10): in the rooftop gardens the fixed seating includes mostly wooden benches; however, there are also other materials such as concrete, stone and plastic. Two cases include fixed concrete and plastic tables. Most of the cases present seat walls located next to planting or water features and looking towards interesting views. All the cases but one includes lawn areas where people can sit or lie down. One case study presents an amphitheater with some steps for groups of people. And some also include boulders to sit next to planting spaces. Regarding the moveable seating, great part of the gardens present tables and chairs especially if there is a dining area, which materials are aluminum, wood or plastic according to the case. Just one case includes seating with a children dimension. Two cases related to staff gardens present additional seating such as chaise lounges. Among shade structures, most of the cases include pergolas or trellis. In two cases there is a glass pavilion created with the aim of being a landscaped transition area; and in one case the internal space of the building is also landscaped and includes seating elements.

D. Positive distraction

D.1 Planting Design: within the Planting Design, the different types of vegetation were identified: tall trees, shrubs, groundcover and flowers, grasses, lawn areas, mounded or sloped beds, horticultural plants, and green walls. These elements were described in terms of area and proportion within the planting design. On the other hand, the ratio hardscape to softscape was specified in all the cases.

Referring to the gardens at the ground level (case studies from 1 to 4): most of the cases present a ratio of 40% hardscape and 60% softscape. In others the percentage of vegetation increases. The proportion of tall trees varies from case to case, depending on the

location of the garden. In comparison to other examples, those with an extensive landscaped ground have a greater number of trees. However, in all cases trees account for more than 40% of the total planted area. Seasonality differs from one place and one specie to another. The trees are strategically located to give shade, diminish the building's scale, provide views of nature to the upper floors, and as frame of the various areas and pathways.

Regarding the rooftop gardens (case studies from 5 to 10): most of the cases present a ratio of 60% hardscape and 40% softscape. In others the percentage of vegetation increases. Because of the weight they represent for the rooftop, tall trees have a lower proportion in the rooftop gardens and in one case study are not present. In most circumstances, the proportion varies between 15 and 30%; nevertheless, there are two cases where it reaches 40 and 60%, the first of which is likely due to a graphic reason that is not true in the reality. The percentage of tall trees and other planting, in any case, is determined by the roof structure and the loading capacity. The seasonality varies from one site to another. The trees are arranged in small groups above the garden, adjacent to building windows to offer privacy to the inside, and enclosing the garden in circumstances when privacy from the surroundings is required.

D.2 Water features, lighting design and other garden elements: additional design elements such as water features, lighting and others were also analyzed. Features such as fountains, water walls, wetlands, or attenuation ponds, high or low-rise light posts, sculptures, among others, were identified. In this case, the type of element, the location, the number, and the area, were specified.

Referring to the gardens at the ground level (case studies from 1 to 4): the gardens that correspond to extensive landscaped ground, contain wetlands, sunken interior gardens, and attenuation ponds as part of the stormwater management and as a long-term watering strategy for the landscaped areas. Just one case includes water features such as ponds and channels. These water features take up a modest percentage of the landscaped spaces (2%) and are strategically placed to provide a sensory experience for people, particularly children, such as touch, a nice view, a relaxing sound, and the opportunity to observe wildlife.

Regarding the lighting elements, all the cases include small or tall light posts spread along pathways, surrounding specific areas, or illuminating interesting spots such as water elements and pergolas. Sculptures placed in strategic locations are among the other garden components. The aim of these elements is to provide additional positive distraction to people in rehabilitation, and particularly to children through attention-getting motifs.

Regarding the rooftop gardens (case studies from 5 to 10): in case of rooftop gardens, half of them have water elements, that take up a modest percentage of around 1%. These elements include fountains and a water wall, which are in organized into specific spots of the garden to provide an additional sensorial experience.

In the case of rooftop gardens, there is variety of lighting elements such as lines of light located on the foot of the vegetation planters or under benches, small light posts spread along the pathways, tall light posts located in specific points of the garden, spots of light fixed on the planters, and one garden that does not have light elements because it is not accessible during the night. Other garden components include sculptures placed in strategic locations, an artistic huge violet pergola, large timber hoops that frame the surrounding scenery, and a children's playhouse.

E. Engagement with nature

E.1 Green therapies: In this case, the therapies carried out in each garden according to the patients it receives were specifically analyzed. The elements used for physical therapy, psychological therapy, horticultural therapy, aromatherapy, therapy for cancer patients, among others, were described.

LEGEND:

	CASE STUDIES	GARDEN ENCLOSURE	HOSPITAL BUILDING & ACCESSIBILITY	PHYSICAL FUNCTIONAL LAYOUT	PATHWAYS	SEATING & SHADE STRUCTURES	PLANTING DESIGN	WATER FEATURES	LIGHTING & OTHER GARDEN ELEMENTS	GREEN THERAPIES
1	Vienna North Hospital									
2	Nelson Mandela Children's Hospital									
3	Spaulding Rehabilitation Hospital									
4	Fiona Stanley Hospital									
5	Ramathibodi Hospital									
6	Mercy Medical Center - Mary Catherine Bunting Center									
7	Victorian Comprehensive Cancer Center (VCCC)									
8	Legacy Emanuel Medical Center - Family Birth Center									
9	Yawkey Outpatient Cancer Center									
10	Great Ormond Street Hospital									

Figure 10. Final comparison matrix, representing a qualitative evaluation for each case studies' strengths and weaknesses. Source(s): Authors' own work.

Referring to the gardens at the ground level (case studies from 1 to 4): most of the gardens present elements for Physical Therapy such as secondary pathways with a different slope or change in texture, stairs, handrails and a lawn for exercise. The gardens related to children and adolescent rehabilitation also include rubber features, sports fields, and mounded beds. Just one case includes Horticultural Therapy with elements such as raised planters, vegetables, attractive planting, and storage area.

Regarding the rooftop gardens (case studies from 5 to 10): one garden presents Physical Therapy and includes design elements such as secondary pathways with small changes in slope and texture, handrails, and a large lawn area for exercise. The same garden includes Horticultural Therapy with design elements such as raised planters, a green wall, vegetables and gardening tools. Other garden provides Therapy for cancer patients where shade, frequent seating, destination points and a simple looped path that allow patients to reach small victories, are the main design elements.

F. Maintenance and aesthetics

Only few information was found about the maintenance of the gardens, cause the observational assessment didn't permit a direct conversation with people in charge of the maintenance of the buildings analyzed. The recognized practices are automatic water irrigation, hose bibs, and staff and patients participating in the maintenance of the garden.

G. Sustainability

As well as the previous point, only few information was found about the sustainable features of the gardens, cause the observational assessment didn't permit a dept analysis in these terms. Among the sustainable practices used in the various case studies are: use of native vegetation that supports local biodiversity; vegetation is used as the main source of shade so there is no need of additional shade structures; use of wetlands, detention areas and underground infiltration tanks to contribute with the stormwater management and irrigation; practices related to waste reduction as reusing medical saline bags for planting or use of recycled furnishing materials; use of plastic furnishing for cleanliness and low maintenance; roof gardens contribute with the stormwater management absorbing and filtering rainfall, and reduce the heat of the building below; and, one case included solar panels.

Referring to all the previous consideration - argued from letter A to letter G - aimed to clarify and develop the experience-based design strategies for the therapeutic green spaces or healing gardens, one last comparison matrix (Figure 10) can represent a final picture resuming all the crucial aspects. The Figure 10 represent a qualitative evaluation, based most of the time on criteria as much as possible objective. Dark green means *excellent*; light green, *relevant*; light yellow, *average*; dark yellow, *low*; and light red, *poor/absent.*

Reading the Figure 10 by columns - that means considering features - some of them like *Physical*

Functional Layout and *Planting Design* are more developed despite of other ones, like *Garden Enclosure, Water Features* and *Garden Therapies.*

Reading the Figure 10 by lines - that means considering case studies - there's a relevant difference between the four case studies (1-4) having the therapeutic green space on the ground floor, and the six case studies (5-10) having the healing garden on the rooftop. Some features like *Garden Enclosure, Hospital Building & Accessibility, Pathways* and *Green Therapies* are more developed into those case studies having the therapeutic green space on the ground floor. Vice-versa, some features like *Seating & Shade Structures* are more common and spread into those case studies having the healing garden on the rooftop, cause the absence of trees and high vegetation suggest to find different solutions.

For sure, case studies 1.*Vienna North Hospital* and 2. *Nelson Mandela Children's Hospital* are the most interesting cause of the huge variety of best practices that they offer; but the Figure 10 shouldn't be considered like a ranking of the case studies, vice-versa a final picture representing a qualitative evaluation for each case studies' strengths and weaknesses.

Conclusions and research outlooks

At the beginning, it's important to have a theoretical basis on therapeutic gardens, their definition and principles, which allow to have an overview of what is about to be designed, considering that not all gardens are therapeutic, but they must follow some aspects that make it therapeutic (31-33). If the garden design considers the clinical diagnosis of the patients who will be its users, incorporates elements to facilitate their rehabilitation, and serves as a complement to medical treatments, then the garden is not only curative but also therapeutic.

The areas, therapies, vegetation, and design elements of a therapeutic garden (34) are determined by the location, form, and size that the garden occupies within the hospital (backyard garden, roof garden), as well as by the users that it will receive, considering that patients receiving different types of care can utilize these areas for a variety of purposes. Because of this, knowing firsthand the needs of hospital users are critical for a designer and for an optimal therapeutic garden.

It is also important to determine a theoretical frame of design standards (35) that serve as a basis for later analyzing and evaluating Case Studies. In the present study, the Design Guidelines proposed by Cooper Marcus and Sachs (2014) were chosen, because are based on the analysis and evaluation of evidence-based design theories about the benefits of the contact with nature.

For the selection of the Case Studies is necessary to establish selection criteria considering international examples that are recognized worldwide to lay a foundation that allow to determine optimal design principles that serve as inspiration for new projects. At the same time, the case studies should present similar location and users because, as mentioned above, the design of a therapeutic garden is determined by these two criteria.

To build a base of case studies, it is recommended to analyze all the gardens following a same research method, in this way it will be easier for the subsequent comparison between the case studies and definition of design guidelines.

Later, the application of the quali-quantitative comparative matrix helps to determine the best design practices through the graphic analysis of the design elements that characterize the different case studies. Aspects such as Garden Enclosure, Garden Layout, Pathways, Seating, Planting, Water Features, Lighting and other garden elements, and Maintenance and Sustainable Considerations were compared and analyzed.

The results obtained from the comparative matrix are qualitative and quantitative design elements that can serve as an inspiration and can be directly applied on the design of therapeutic gardens in terms of type of element / space, percentage, perimeter, area, number, materiality, shape, color, among others.

The quali-quantitative matrix is a useful and practical tool that allows the designer to have a base of design guidelines that can be later applied to the proposal of new therapeutic gardens.

Further studies can incorporate to the matrix the identification and analysis of the maintenance practices applied in the case studies. Much information

about the topic could not be found during this study; however, it is a very important consideration when proposing the project to the hospital administration.

Acknowledgements: technical offices and workers from the following hospitals:Vienna North Hospital (Vienna, Austria); Nelson Mandela Children's Hospital (Parktown, Johannesburg, South Africa); Spaulding Rehabilitation Hospital (Boston, Massachusetts, U.S.A.); Fiona Stanley Hospital (Perth, Western Australia); Ramathibodi Hospital (Ratchathewi, Bangkok, Thailand); Mercy Medical Center - Mary Catherine Bunting Center (Baltimore, Maryland, U.S.A.); Victorian Comprehensive Cancer Center (Melbourne, Vic, Australia); Legacy Emanuel Medical Center - Family Birth Center (Portland, Oregon, U.S.A.); Yawkey Outpatient Cancer Center (Boston, Massachusetts, U.S.A.); and Great Ormond Street Hospital (London, United Kingdom) that support the research, providing functional layouts and graphic projects to be analyzed.

Funding: none.

Ethic committee: none.

Conflict of Interest: none.

Authors Contribution: KJCA research main Author and developer; AR and MG, research co-developer; MB specific Supervisor responsible for the Healing Gardens topic; SC specific Supervisor responsible for the Healthcare Facilities topic, and overall research Supervisor.

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Received: 6 April 2023
Accepted: 29 August 2023
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