UNIVERSIDAD POLITÉCNICA DE MADRID

Escuela Técnica Superior de Arquitectura de Madrid

# Evaluation of Functional & Environmental Factors in Spanish Acute-care Hospital Design

*Evaluación de los factores funcionales y ambientales en el diseño de hospitales de agudos españoles*

Ph.D. Dissertation (RD 99/2011)

**Laura Cambra Rufino** · Architect · 2021

Departamento de Construcción y Tecnología Arquitectónicas
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Supervisors:

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2021

POLITÉCNICA

Tribunal nombrado por el Sr. Rector Magfco. de la Universidad Politécnica de Madrid,

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EL SECRETARIO

## English abstract

The aim of this doctoral thesis is to explore the evaluation of functional and environmental factors in acute-care hospital design that might have an impact on healthcare outcomes.

Despite the progress of the evidence-based design process in North-European and North American countries, in Spain it still has not been fully developed. The purpose of this design process is to establish a link between design variables and health-related outcomes. Acute-care hospitals are buildings in constant change to cope with the evolving demands of clinical progress and the social context. Thus, acknowledging the functional and environmental factors that impact on the care process and evaluating them in existing acute-care hospitals becomes of paramount importance.

This dissertation follows a mixed-method methodology based on four perspectives: 1) the field, with an ethnographic study during a three-month placement in an acute-care hospital; 2) the theory, with literature analysis; 3) the future, with an ethnographic study of sixteen acute-care hospital visits considered as best practice, and 4) the present, with the evaluation of four acute-care hospitals in Spain.

The primary result of this work is the tool CURARQ. The purpose of this tool is, on the one hand to provide a first diagnostic of the functional and environmental quality of the studied unit, and on the other hand to guide in the design decision process of a new development. This tool has been created for seven units in the acute-care hospital and has been tested in four acute-care hospitals in "Comunidad Valenciana". Secondary results include: 1) feedback and scripts from users during the acute-care hospital placement; 2) evaluation through architectural layouts and photographs of the acute-care hospital visits; and 3) evaluation of CURARQ scores of the four evaluated acute-care hospitals.

This document provides a current overview of functional and environmental factors in acute-care hospitals, which evidence: 1) the need for refurbishment to promote clinical innovation; 2) the need to update national standards, 3) the usefulness of CURARQ tool to identify priority buildings to intervene, and 4) the usefulness of CURARQ tool to generate synergies between healthcare staff, patients, researchers, and architects to promote the potential of the evidence-based design process in Spain.

***Keywords**: acute-care hospital, evidence-based design, healing architecture, healthcare architecture, evaluation tool, Spain*

## Spanish abstract

El objetivo de esta tesis doctoral es explorar la evaluación de los factores funcionales y ambientales en el diseño de los hospitales de agudos, que puedan afectar a los resultados sanitarios.

A pesar del progreso del proceso de diseño basado en evidencias en países del norte de Europa y de Norteamérica, en España todavía está poco desarrollado. La finalidad de este proceso de diseño es establecer vínculos entre variables de diseño y resultados sanitarios. El hospital de agudos es un edificio en constante evolución para responder a las demandas del desarrollo clínico y su contexto social. Por este motivo, es vital identificar los factores funcionales y ambientales que impactan en el proceso de los cuidados y evaluarlos en hospitales de agudos existentes.

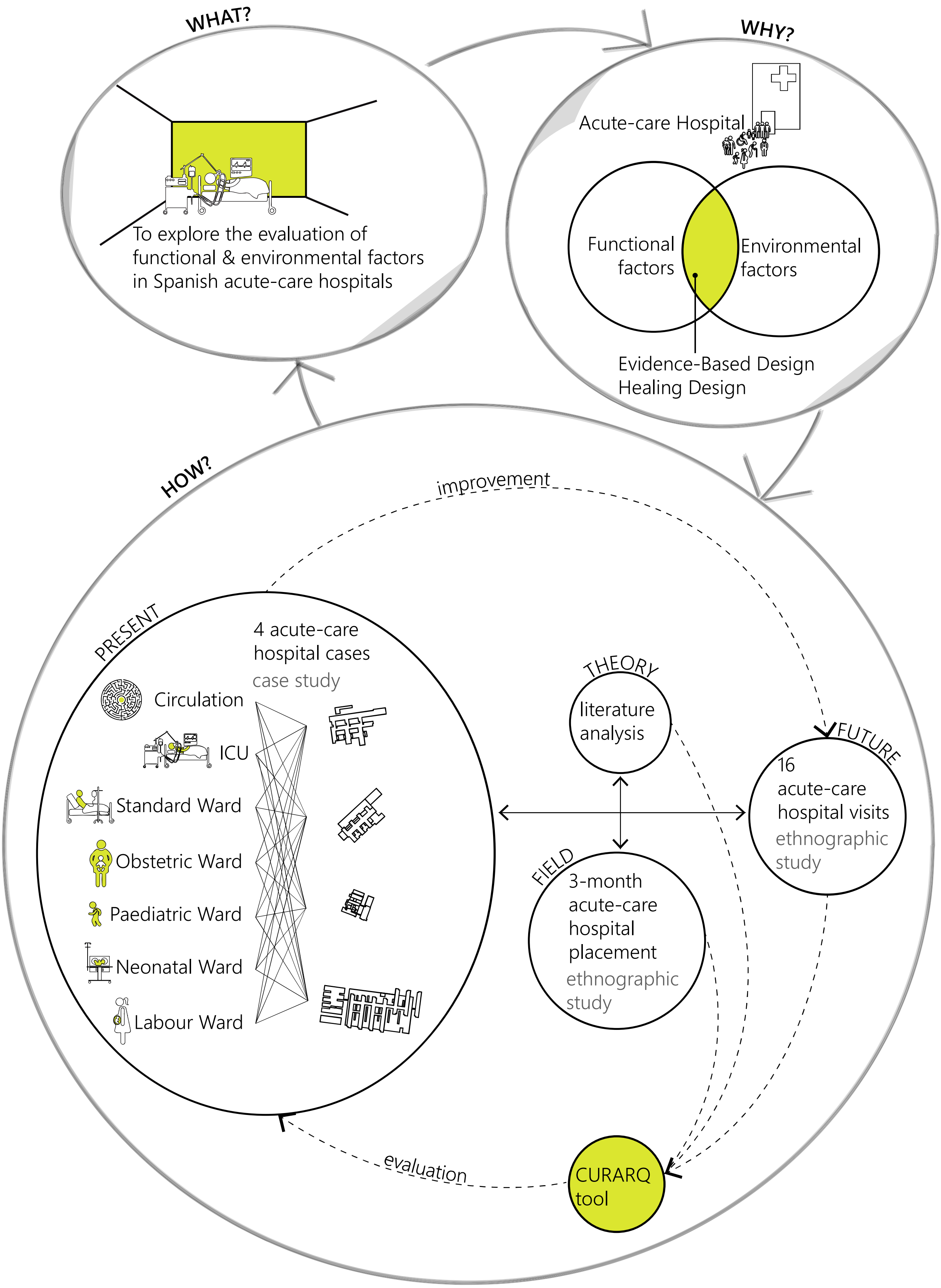
La metodología de esta tesis se basa en los métodos mixtos desde cuatro perspectivas distintas: 1) la práctica, con estudio etnográfico durante una estancia de tres meses en un hospital de agudos; 2) la teoría, con el análisis de la literatura; 3) el futuro, con estudio etnográfico de dieciséis hospitales de agudos considerados como buenas prácticas; y 4) el presente, con la evaluación de cuatro hospitales de agudos en España.

El principal resultado de este trabajo es la herramienta CURARQ. La finalidad de esta herramienta es por un lado obtener un primer diagnóstico de la calidad funcional y ambiental de la unidad estudiada, y por otro guiar la toma de decisiones para futuros diseños. Esta herramienta se ha creado para siete unidades del hospital de agudos y se ha aplicado en cuatro casos de la Comunidad Valenciana. Los resultados secundarios incluyen: 1) evaluación y rutinas según las personas usuarias de la estancia en el hospital de agudos; 2) evaluación mediante el estudio de las distribuciones en planta y fotografías de las visitas a hospitales de agudos; y 3) evaluación de las puntuaciones obtenidas con la herramienta CURARQ en los cuatro hospitales de agudos evaluados.

Esta tesis ofrece una visión general de la situación de los factores funcionales y ambientales en los hospitales de agudos, lo que evidencia: 1) la necesidad de renovar los edificios para promover la innovación clínica, 2) la necesidad de actualizar los estándares nacionales, 3) la utilidad de la herramienta CURARQ para identificar los edificios donde es necesario intervenir con prioridad y 4) la utilidad de la herramienta CURARQ para generar sinergias entre el personal sanitario, pacientes, investigadores/as y arquitectos/as que permitan explotar el potencial del proceso de diseño basado en evidencias en España.

***Palabras clave:*** *hospital de agudos, diseño basado en evidencias, arquitectura sanadora, arquitectura sanitaria, herramienta de evaluación, España*

## Visual Abstract



## Preface

My initial interest in architecture came up one day at primary school while observing an anthill. Almost without realizing it, I was convinced to become an architect. I studied at "Universitat Politècnica de València" and one academic year at "Universidad Politécnica de Madrid" (UPM). For my master's thesis, my fascination for people circulation started by designing a transportation centre.

After finishing my master's degree in 2012, I moved to London to work for Ove Arup & Partners Ltd in their vertical transportation department. Julian Olley introduced me to the global market of the multidisciplinary consulting firms. I worked in Julian's team for two and a half years taken up by the enchantment of their high professionalism and wisdom. Moreover, I had the opportunity to be involved in teams with highly experienced people and worked in almost all building typologies, being the acute-care hospital, one of the most difficult in terms of user flows. While in London, I received a hand-written letter by Alfonso del Águila García (UPM) encouraging me to carry out a doctoral dissertation. His invitation came at a perfect time because by then I was considering moving closer to my relatives.

Therefore, I came back to Spain and settled down in Madrid. From my overseas experience I became aware of the importance of the built environment impact on people's health. Particularly relevant was the death by pancreatic cancer of my uncle and godfather José Luís Cambra Mataix in 2012. He made me ask myself what architects could do to facilitate the acute-care hospital experience and take sensitive care of people. With this idea in mind, I talked with José Fariña Tojo (UPM), who kindly put me in contact with José León Paniagua Caparrós. Simultaneously, I got a residency at "Hospital de Dénia" (funded by "Factoría Cultural and DKV Seguros"). As if by magic, José León Paniagua Caparrós happened to be co-author of "Hospital de Dénia" design, extensively knowledgeable in acute-care hospital architecture and willing to become my doctoral dissertation director.

Another matter was the search for funding. After the first doctoral course (2015/2016) with no funds and exhausting application processes for scholarships, I started my second course (2016/2017) with a predoctoral contract thanks to César Bedoya Frutos (UPM) and the "Ayudas para la Formación de Doctores del Programa Nacional de Formación de Profesorado Universitario del Ministerio de Educación, Cultura y Deporte" (FPU15/02660). In the following courses, I was involved in teaching support activities for several subjects at "Departamento de Construcción y Tecnología Arquitectónicas". In 2018 I spent three months in the Centre for Healthcare Architecture at "Chalmers Tekniska Högskola" as a visiting Ph.D. student thanks to "Fundación Margit y Folke Pehrzon" scholarship.

Significant life milestones interrupted my dedication to this work such as the birth of my son Bruno (May 2017), my daughter Maika (December 2019), the death of my father-in-law Agustín (October 2020) and the whole coronavirus pandemic.

Balancing motherhood with caring of dependents, constant readjustment to social measures, and telework has become my most complex challenge so far. However, it has reinforced my conviction on placing care at the centre of the focus, also in acute-care hospital architecture, which precisely is the intention of this doctoral dissertation.

## Acknowledgements

Estoy convencida de que trabajando en equipo se obtienen mejores resultados. El doctorado es un proceso muy largo y solitario, pero en casi todo momento me he sentido acompañada por una red de personas bonitas que han hecho posible este arduo trabajo.

En primer lugar, mis directores de tesis. A César le agradezco su disponibilidad para orientarme por todos los trámites burocráticos y académicos imprescindibles para todo doctorando. A mi maestro José León, le admiro por su infinita generosidad, su conocimiento exquisito y su gran humildad. Por regalarme su tiempo cuando le abordé con una ingenuidad infantil y por saber reconocer que en esa ingenuidad estaba el germen de todo aprendizaje. *"Solo se aprende aquello que se ama"* y José León me ha hecho enamorarme de los hospitales hasta la médula.

En segundo lugar, quería agradecer el trato que he recibido en todos los hospitales, por un personal tan vocacional y terrenal que me han hecho sentir como en casa en un lugar que muchísimas personas no quieren pisar.

En tercer lugar, están mis amigos y amigas. Gracias a Carlitos, Maria y Arancha por nuestras conversaciones terapéuticas. Ha sido un gusto compartir conexión a internet, tuppers y cafés con Elena, Marlix, Miguel, Marta, Inês, Helena, Camila y Carmen. También más tarde con Elisa, con quien he gozado discutiendo intereses tan afines.

Por último, quería resaltar el tremendo esfuerzo que ha recaído sobre mi familia. A mis padres les agradezco su dedicación, apoyo y cuidado, tanto para mi como para mis hijos. A mi hermana, sus consejos y ayuda técnica. A mis tías, que me acompañaran hasta en Suecia. A mi hijo BRUNO, que ya reconoce su nombre en mayúsculas, le debo el haberme enseñado a ver la vida con sus ojos curiosos, a relativizar, a ser flexible y a vivir a demanda de las personas que quieres. Gracias a mi hija Maika he practicado la perseverancia, el cuidado incondicional y la intensidad de las emociones. A Antonio le quiero por ayudarme a reconectar con la vida cuando me he obsesionado y sobre todo porque incluso cuando el camino se ha vuelto insoportable, hemos decidido recorrerlo juntos.

*"El camino es siempre mejor que la posada"*

Al record del meu padrí José Luís,

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# 1. Introduction

# 1.1 Healthcare Context

## 1.1.1 Healthcare System

According to the World Health Organization (WHO), Health Systems Strengthening Glossary, the health system is defined as:

> *"(i) all the activities whose primary purpose is to promote, restore and/or maintain health [1]; (ii) the people, institutions and resources, arranged together in accordance with established polices, to improve the health of the population they serve, while responding to people's legitimate expectations and protecting them against the cost of ill-health through a variety of activities whose primary intent is to improve health." [2]*

Delving on health systems topics within the World Health Organization, the institution states that:

> *"A well-functioning health system working in harmony is built on having trained and motivated health workers, a well-maintained infrastructure, and a reliable supply of medicines and technologies, backed by adequate funding, strong health plans and evidence-based policies."[3]*

While traditional disciplines such as medicine or nursing have played a major role in delivering care, there is the necessity of a wider perspective to understand the healthcare path and propose evidence-based polices [4]. Thus, healthcare policy-makers are in need of multidisciplinary experts in order to distribute healthcare facilities more efficiently, as these facilities might in turn impact on the healthcare delivered [4, 5].

In awareness of their ethical responsibility with society, architects in different nations such as Canada, USA, Sweden, or UK, are becoming more and more involved in the healthcare system. Examples of these collaborations are the research centres and teaching programs available in each country (Tab.1).

Particularly in Sweden, there is the "Centrum för vårdens arkitektur" (CVA) or Centre for Healthcare Architecture at the School of Architecture, "Chalmers Tekniska Högskola" in Göteborg. This centre offers a national platform for the interaction between academics and professionals in the healthcare sector. Architects, nurses, environmental psychologists and occupational therapists conduct research and training for the exchange and dissemination of knowledge about healthcare architecture. Thus, government decisions on healthcare facilities are founded on research-based knowledge which improves the long-term social investments.

Dolum venimosam rerum fugiam endit laborion cus ut la vollita turiae pratisqui vendiorerum quiam volupides autempore pration con cumende liciunt porpore prenimus, a volupidelit

| | North America | | North Europe | | South Europe | |
|---|---|---|---|---|---|---|
| | USA | Canada | Sweden | UK | Italy | Spain |
| Population (2018, persons) | 327 167 434 | 37 058 856 | 10 175 214 | 66 435 550 | 60 421 797 | 46 733 038 |
| Life expectancy at birth (2018, years) ♀ | 81.2 | 84.1 | 84.3 | 83.1 | 85.6 | 86.3 |
| ♂ | 76.2 | 79.9 | 80.9 | 79.5 | 81.2 | 80.7 |
| Health expenditure and financing (all functions 2019) US Dollar (Per capita, current prices, current Purchasing Power Parity PPPs) and share (%) of gross domestic product (GDP) | 11 071.7<br>17<br>(E) | 5 418.4<br>10.8<br>(P) | 5 782.3<br>10.9<br>(P) | 4 653.1<br>10.3<br>(E) | 3 649.2<br>8.7<br>(P) | 3 616.5<br>9<br>(E) |
| Acute hospital beds per 1000 population (2016) | 2.77 | 2.6 | 2.34 | 2.57 | 3.17 | 2.97 |
| Average length of stay in days (in-patient care, hospital aggregates 2017) | 6.1 | n.a. | 5.8 | 6.9 | 7.8 | 7.3 |
| Centres of collaboration | The Center for Health Design; American College of Healthcare Architects | Centre for Design + Health Innovation | Centre for Healthcare Architecture | Architects for Health | "Centro Nazionale per l'Edilizia e la Tecnica Ospedaliera" (C.N.E.T.O.) | Null! |

*Tab. 1 Organisation for Economic Co-operation and Development. Source: https://stats.oecd.org/. Data extracted on 19th October 2020. (E) for estimated value and (P) for provisional value.*

### 1.1.2 Spanish Health System

Spain has a decentralised national health system or "Sistema Nacional de Salud" (SNS) which is funded by taxes. This public system is based on the principles of "universality, free access, equity and fairness of financing" [6]. The SNS is organised independently by the 17 regions and two autonomous cities with a national institution responsible for the overall coordination and monitoring of its performance (Fig. 1). Each region of the country is subdivided in "Áreas de Salud" or healthcare areas that consist of territorial demarcations that act as basic pieces of healthcare services. The concept of healthcare area has been modified through time, as each region has developed its own way for healthcare delivery and administration in its area of influence [7]. As an example, the region "Comunidad Valenciana" had 23 healthcare areas in 1986, 20 in 1993, in 2003 the term changed to "Departamentos de Salud" or healthcare departments, in 2005 there were 22 of them and from 2010 on, there are 24 in total [7] (Fig. 2). Each of these healthcare departments has its own centres for primary and special care that work as a network to provide the best care possible to any given patient.

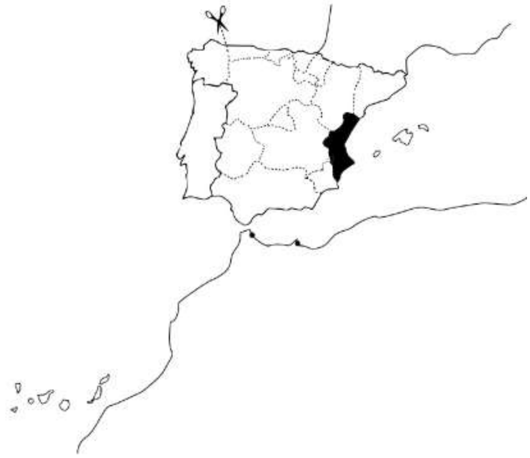

*Fig. 1 Division of the healthcare competences into regions. Location of region "Comunidad Valenciana".*


*Fig. 2 Healthcare Departments in "Comunidad Valenciana" in 2017. Figure by [8].*

Prior to the devolution of the national healthcare competences to every region of the country by a national law [9], Spain had a centralised healthcare system. Within this system there was the "Instituto Nacional de la Salud" (INSALUD) or national health institute created in 1978 and responsible for the design and maintenance of public healthcare facilities. This institution had its own architects specialised in healthcare architecture [10]. As a consequence of the decentralisation of healthcare competences, the INSALUD disappeared in 2002. Since then, there has been a lack of coordination, knowledge, and expertise in healthcare planification, functional programming and acute-care hospital architecture which has its direct impact on the conservation status of many acute-care hospital facilities nowadays.

## 1.2 Acute-care Hospital

The acute-care hospital is the place where care is offered to patients with acute diseases. The adjective acute refers "to a severe or intense degree" and is related to a *"short duration" of time [11]. Acute-care includes "the health system components (...) used to treat sudden, often unexpected, urgent or emergent episodes of injury and illness that can lead to death or disability without rapid intervention. The term acute care encompasses a range of clinical healthcare functions, including emergency medicine, trauma care, pre-hospital emergency care, acute care surgery, critical care, urgent care and short term inpatient stabilization."* [12].

In the past, the global trend was to classify acute-care hospitals according to their number of beds (less than 250 beds, from 250 to 800 and about 1000) and it was assumed that the higher the number, the better the medical care [13]. However, nowadays acute-care hospitals are identified by the complexity and diversity of the healthcare services they provide which might be tailored to a specific group of patients, ages, or pathologies [14].

In addition to the many definitions of the acute-care hospital as a functional typology by the WHO [15], national laws [9] and other official documents [16], an acute-care hospital can be defined as the public or private institution that develops three main purposes: healthcare, education and research. Each one of these functions consist of:

1. Healthcare function: medical assistance, diagnostic and treatment procedures required by acute patients (such as surgical interventions, laboratory tests, radiology, rehabilitation, pharmacology, or pathological anatomy).
2. Educational function: additional activities, besides healthcare, that involve teaching and learning about healthcare practices for undergraduate students (medicine, nursery, radiology, laboratory technicians and others), postgraduate students (such as resident doctor, resident biologist or resident psychologist), and acute-care hospital staff (for the continuous learning process of both clinical and non-clinical staff).
3. Research function: depending on the complexity level of the acute-care hospital, research can be carried out in the acute-care hospital wards or in designated research departments such as laboratories.

# 1.3 Functional & Environmental Factors

Any acute-care hospital reflects a specific combination of design decisions defined by its financial, social and cultural context. In addition to its background, there are determinant variables that define its final design and which can be classified as functional and environmental factors. While functional factors are driven by the precise functionality of the building to perform properly, environmental factors deal with the additional qualities needed for creating an optimal atmosphere [17, 18].

## 1.3.1 Functional Factors

Several phases have to be followed for the inauguration of a new or renovated acute-care hospital which consist of planning, functional programme, project tender, design, works tender, construction and occupancy. Of all of them, the functional programme is the stage where the functional factors are defined. These factors are key for the performance of the acute-care hospital and include spatial logistics, organization and healthcare processes, which need to be tackled in an integral manner so that there is a correlation between programme and design [4].

In the functional programme phase, both the acute-care hospital model as well as the quantitative dimensioning of it are defined [19]. The acute-care hospital model comprises the main characteristics that define the healthcare organization, teaching and research that the future acute-care hospital will deliver. For the definition of the acute-care hospital model, a careful evaluation of the current and future variables must be made [19]:

1. Socio-demographic trends: including variations in the morbidity pattern, cultural changes and population expectations of the reference area.
2. National and regional healthcare system: health care organization and care modalities.
3. Biomedical technologies.
4. Information and communication technologies.
5. Organizational culture of current acute-care hospitals to facilitate the change.
6. Changes in the organization of the general services and the infrastructure services.

When these organizational and functional configurations are clearly defined, comes the quantitative dimensioning of the acute-care hospital. For doing so, the functional programme becomes an instrument that identifies the activities of the acute-care hospital and the rooms required for each activity [20]. However, the functional programme has its own limitations as it usually expresses functional and practical requirements, but it does not deal with many other sensitive aspects like the site, the landscape, orientation, views and, even more importantly, the psychological expectations of different users of the building [20]. Acute-care hospital design does not come directly from the functional programme but from a clear understanding of not only the functional but also the environmental factors needed for its optimal performance.

### 1.3.2 Environmental Factors

Traditionally, environmental factors have focused on providing comfort to people. According to the dictionary [21], the first meaning of the word "comfort" relates to a physical state in which we have "*a feeling of being physically relaxed and satisfied, so that nothing is hurting you, making you feel too hot or cold*". The second, has to do with an emotional state "*if someone or something gives you comfort, they make you feel calmer, happier, or more hopeful after you have been worried or unhappy*".

In a similar way, architectural and engineering fields have traditionally focused on the physical aspects to achieve a comfortable design (hygrothermal, acoustics, lighting and olfactory parameters) [22]. On the contrary, the psychology field has more to do with the emotional level, starting with its interest in persons processes, later interactions between persons and for about the last 50 years, in the person-environment relation [23]. Environmental psychology studies the "transactions between individuals and their physical settings" [23] which include the natural environment (issues related to climate change, energy shortages or pollution) as well as the built environment (making buildings more humane). According to environmental psychology "individuals change the environment, and their behaviour and experiences are changed by the environment" [23]. Until the end of the 20thc., it was thought that the loss of neurons in adult humans was irreversible. It was not until the late 90s that neurogenesis was proven and linked to the environment [24]. This scientific milestone proved that changes in our environment could modify the brain, thus conditioning our behaviour. Since 2003, the "Academy of Neuroscience for Architecture" in California has aimed at exploring the architectural environments from a neuroscientific perspective [25].

These dualities between the physics and the psychics, and the natural and built environments have all merged in the field of healthcare architecture. Sustainable thinking translated to healthcare architecture is based on protecting health at all levels, focusing both on the ecological impact of the building as well as its influence on its user's life quality [26]. These two views are classified as eco-effective design and evidence-based design [27]. The first is aimed at environmental global issues while the second cares about the building's influence on relatives, patients and staff health and wellbeing. This thesis focuses on the second one and its ability to create healing environments.

*"Well is the new green"* [28]

# 1.4 Evidence-Based Design Process

Back in the 19thc., a highly educated English nurse called Florence Nightingale published a book [29] which gathered the first data that linked her observations on acute-care hospital design strategies with the patients' recovery process [30]. Her manuscript proved the importance of layout distribution, hygiene, lighting and silence and its impact on saving lives in military hospitals. Her contribution made the foundations of what nowadays is known as Evidence-Based Design (EBD).

The term "Evidence-Based Design" was printed for the first time back in 2000 [31] even though its origins stem from three key factors that happened several years before. The first one was the evidence-based medicine movement that emerged at the beginning of the 70s in Canada, whose goal was to determine the best medical evidence for treating patients [32]. The second factor happened at the end of the same decade, in the USA and consisted of the patient-centred care movement [33]. The third and determinant factor was in the 80s, again in the USA, when the environmental psychologist Roger S. Ulrich, published a scientific paper that linked a design variable (the views in the acute-care hospital patient bedroom) with medical outcomes (average length of stay and analgesics usage, among others) [34]. This empirical relation between design and healthcare outcomes brought to light not only the potential of architectural design on the recuperation process of patients, but also the financial benefits for the healthcare facilities. EBD is defined as "the process of basing decisions about the built environment on credible research to achieve the best possible outcomes" [5]. Its differentiating value consists of using research both to inform and to evaluate design strategies. The EBD process has derived from other evidence-based practices like medicine or nursing, and it is intimately linked to the research process. It can be applied to any stage of the design process, but its best potential is achieved when implemented from the beginning. The process consists of eight steps as shown in Fig. 3.

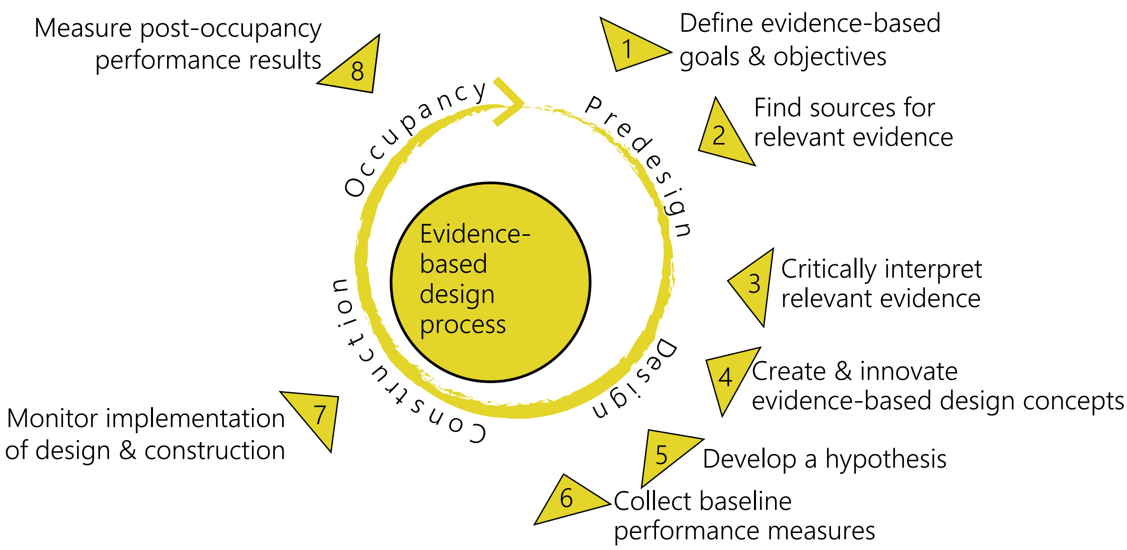


*Fig. 3 EBD process, figure adapted from The Centre for Health Design [5].*

The goal of the EBD process is to generate rigorous evidence that establishes a direct link between design variables and health-related outcomes, though it is also connected to organizational performance and healthcare facility management [35]. Despite its recent history, an increasing number of papers [36-38] from a wide range of fields (environmental psychology, architecture, nursing or medicine among others) are studying the relationships between design strategies and clinical outcomes, economic performance, customer satisfaction, productivity or cultural measures in healthcare facilities (Tab. 2).

| **Design Strategies or Environmental Interventions** | Single-bed rooms | Access to daylight | Appropriate lighting | Views of nature | Family zone in patient rooms | Carpeting | Noise-reduced finishes | Ceiling lifts | Nursing floor layout | Decentralized supplies | Acuity-adaptable rooms |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Healthcare Outcomes** | | | | | | | | | | | |
| Reduced hospital-acquired infections | ** | | | | | | | | | | |
| Reduced medical errors | * | | * | | | | * | | | | * |
| Reduced patient falls | * | | * | | * | * | | | * | | * |
| Reduced pain | | * | * | ** | | | * | | | | |
| Improved patient sleep | ** | * | * | | | | * | | | | |
| Reduced patient stress | * | * | * | ** | * | | ** | | | | |
| Reduced depression | | ** | ** | * | * | | | | | | |
| Reduced length of stay | | * | * | * | | | | | | | * |
| Improved patient privacy and confidentiality | ** | | | | * | | * | | | | |
| Improved communication with patients & family members | ** | | | | * | | * | | | | |
| Improved social support | * | | | | * | * | | | | | |
| Increased patient satisfaction | ** | * | * | * | * | * | * | | | | |
| Decreased staff injuries | | | | | | | | ** | | | * |
| Decreased staff stress | * | * | * | * | | | * | | | | |
| Increased staff effectiveness | * | | * | | | | * | | * | * | * |
| Increased staff satisfaction | * | * | * | * | | | * | | | | |

*Tab. 2 Adaptation of table "Summary of the relationships between design factors and healthcare outcomes" in paper [36]. * Indicates that the relationship was indicated, directly or indirectly by empirical studies and ** indicates that there is especially strong evidence for the relationship based on multiple rigorous studies.*

In order to increase the chance of success of such an ambitious target, the traditional design team (made up of architect, owner, planners, contractors, and engineers) needs to be enlarged. The transdisciplinary team includes (Fig.4): 1) academics and researchers (professional or internal, academic, student and staff support); 2) practitioners (architects, interior designers, project manager, landscape architects, medical planner, engineers, operations expert, , construction manager, wayfinding and art experts, philanthropy manager, LEED consultant, Lean consultant, vendors and manufacturers); and 3) users consisting of the owner's representatives (board members, chief executive officer, chief of staff, chief financial officer, medical director, chief nursing officer, facilities, key manager, foundation, marketing, operation), plus the final users (caregivers, family members, patients, physicians, clinicians, nurses, community, infection control, quality improvement managers, medical records managers, information systems managers, facility managers) [39].

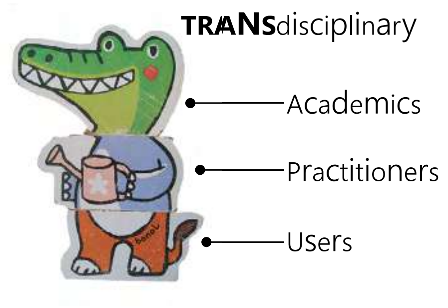


*Fig. 4 Composition of the transdisciplinary team.*

Managing collaboration, responsibilities, expectations and communication is fundamental for the performance of such a numerous team of people (Fig. 5) with different backgrounds and skills. In order to increase user engagement and the formulation of goals and needs from the early phase of the design process, participatory methodologies can be used. The design dialogues methodology [40] facilitates the collaborative production of design artefacts, with the aid of design games and scenarios (Fig. 6), that might enhance innovative thinking and improve the architectural design process.

*Fig. 5 Workshop "LOKALER FÖR PSYKIATRI" at Chalmers University of Technology, Gothenburg 13/04/2018.*

*Fig. 6 Design dialogues workshop material at Chalmers University of Technology, Gothenburg.*

Another key issue for creating a dialogue between team members is communication (Fig. 7). Architects have traditionally communicated visually but their role in a participatory design process depends on whether they achieve a common understanding of the graphical language that produces meaningful and productive design dialogues between all the team members [41].

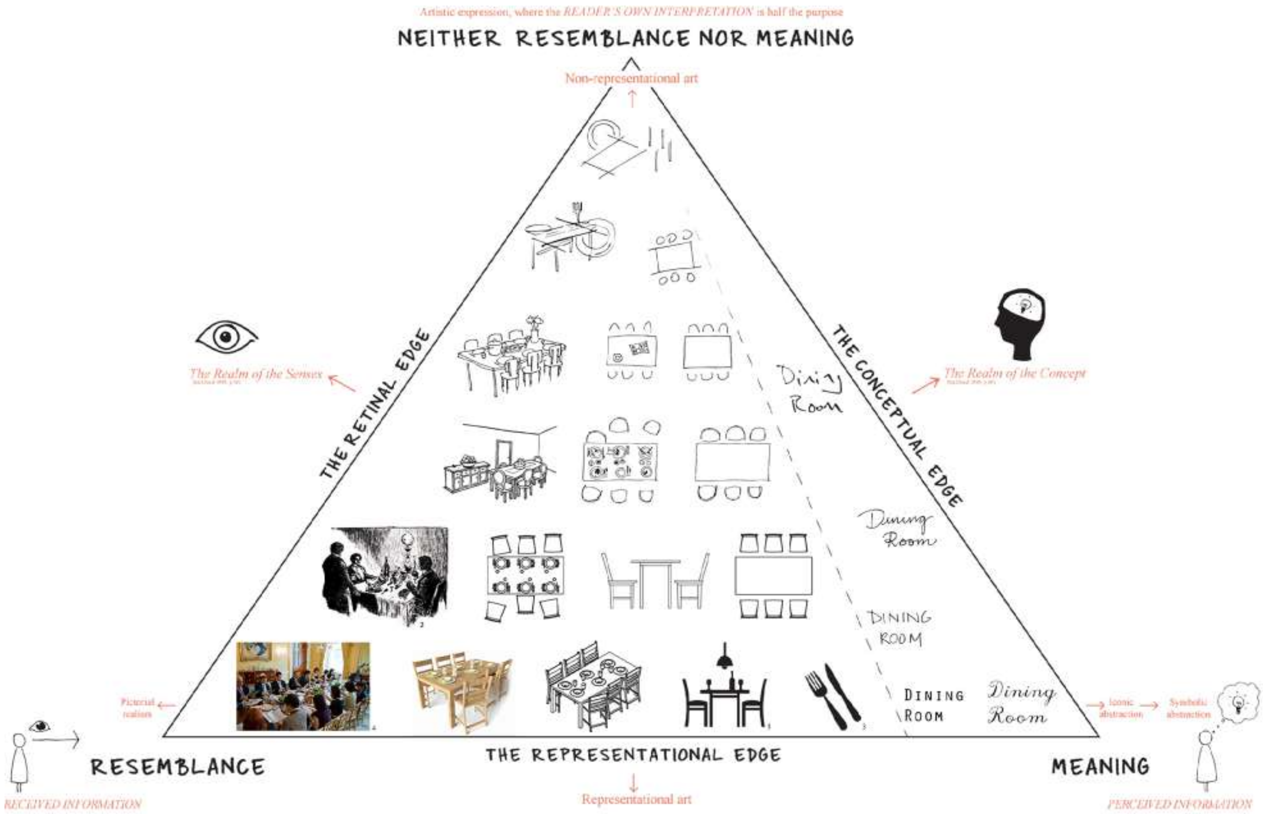


*Fig. 7 Triangular model for architectural representation by Irmeli Magnusson [41].*

The ultimate goal of applying the evidence-based design process is to generate relevant evidence and translate this knowledge into practice [42]. Different types of evidence have traditionally been used in the design process (geometry, engineering or mathematics to mention just a few). However, and due to the impact on healthcare and financial outcomes, the evidence used to guide acute-care hospital design should come from the most rigorous sources in order to achieve the best possible outcomes [43]. The EBD only emphasizes the need for raising the level of rigour of the evidence that guides architectural design without excluding the tacit knowledge of intuition [44]. Due to its short history (Fig. 8), the field of EBD is still facing many limitations and scepticism (such as lack of architectural training on research [45], lack of evidences or not rigorous enough studies). These facts could be overcome by extrapolating other evidence-based disciplines like biology, medicine or neuroscience [46].

In 1993, a new organization called The Center for Health Design (CHD) was established in USA. Its mission is to transform the healthcare environment into places that are safer and healthier. This consortium works as a platform to share and connect knowledge between different healthcare institutions, universities, professional associations, administrative institutions, architectural firms and any person interested in healthcare architecture. In 2007, the CHD founded the peer-reviewed journal "Health Environments Research & Design" (HERD), for the publication and dissemination of evidence-based design from an interdisciplinary perspective.

In 2009 and in order to institutionalise and standardise the evidence-based design process, the EDAC programme was launched. EDAC stands for "Evidence-based Design Accreditation and Certification" programme and identifies individuals capable of applying the evidence-based design process to healthcare design projects. Since then, more than 2500 people have been certified, whose profiles include university professors, students, interior designers, architects, clinicians, nurses and manufacturers from different countries, mainly USA and Canada , but also from Spain [47, 48].

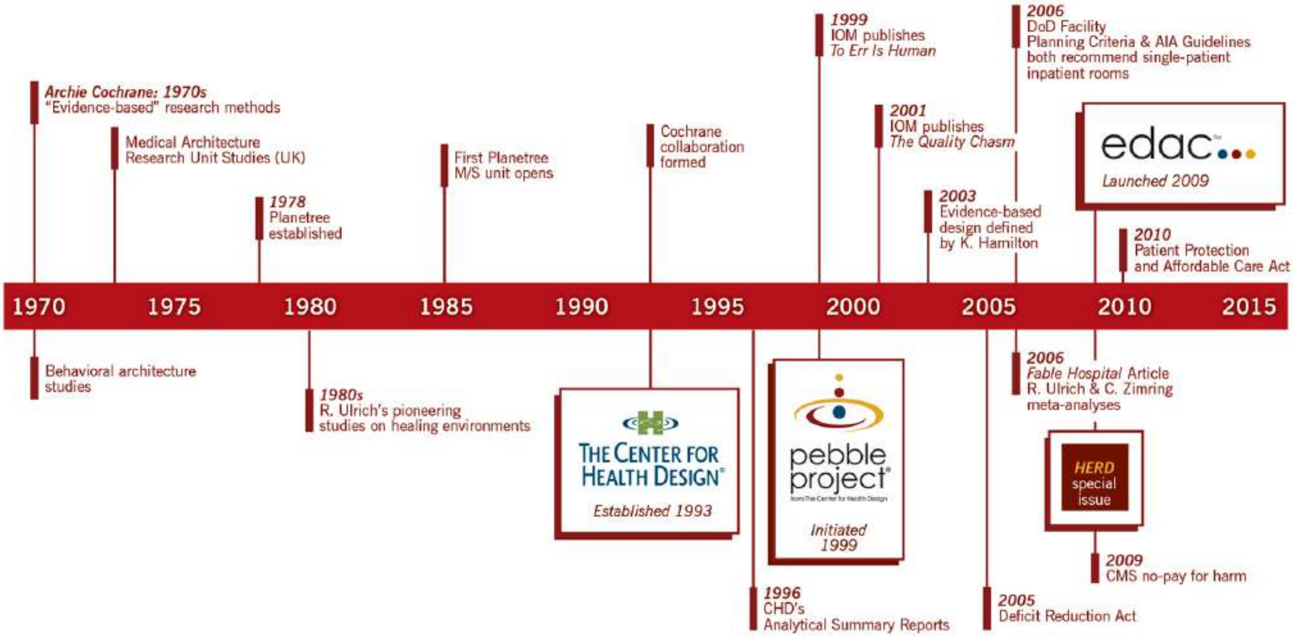


*Fig. 8 EBD timeline, figure by [49].*

# 1.5 Aim

## 1.5.1 Research Incentive

A recent survey study on Spanish healthcare design studios showed that only in 48% of the studios there were designers with specific training in healthcare design [50]. This fact was related to the inexistence of official healthcare design programmes at Spanish universities, and consequently, the lack of researchers or academics in this field. Interestingly, it was the professional practitioners who taught in the few postgraduate courses found nationally [50]. The lack of academics in healthcare architecture also has an impact on the low production of scientific publications which in terms determined the low usage of scientific papers by architects [50].

The research incentive of this doctoral dissertation relies on the presumption that, by generating original information from the existing acute-care hospitals, it will be incorporated by architects into their future designs (Fig. 9). The design evidence needs to be added to the extensive and complex inputs and variables that define a new acute-care hospital (population needs; healthcare resources; health technologies; management and logistics; clinical progress; demographic, socioeconomic, and urban analysis, etc) to improve the overall quality of the care delivered.

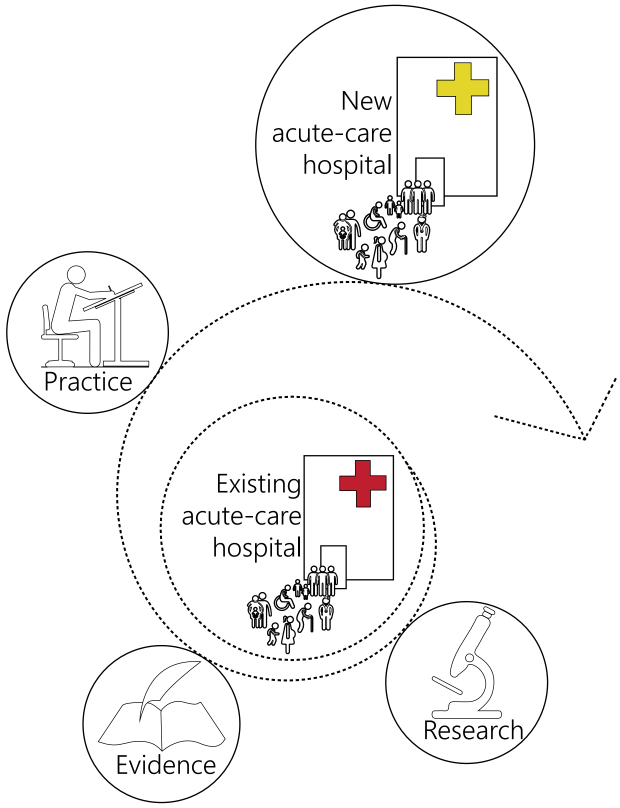

*Fig. 9 Virtuous circle for incorporating research into the design process of acute-care hospitals.*

## 1.5.2 Research Question

The research question of this dissertation is: How could we evaluate functional and environmental factors, in existing acute-care hospitals, that might have an impact on healthcare outcomes within the Spanish context?

## 1.5.3 Research Aim

This thesis uses an explorative approach whose purpose is to provide a general view of the topic without a predefined hypothesis. The overall aim of this thesis is to evaluate functional and environmental factors that might have an impact on healthcare outcomes from four different perspectives (theory, field, future and present). The reason behind this aim is to generate information that might provide a better understanding for both academics and practitioners and be applied to Spanish acute-care hospitals in use.

The specific aims based on the four perspectives are:

1. Field: To explore the evaluation of functional & environmental factors from the user's perspective.
2. Theory: To explore the evaluation of functional & environmental factors from the literature perspective.
3. Future: To explore the evaluation of functional & environmental factors from the analysis and documentation of best practice designs.
4. Present: To explore the evaluation of functional & environmental in current acute-care hospitals in Spain.

## 1.5.4 Delimitation

The study is focused on the Spanish context and in acute-care hospitals that are in use. As an acute-care hospital is a very complex building and the kind of users and length of their stay varies according to the unit considered, only seven units have been selected for the development of this study. The logic behind this selection criteria is based on a patient focus approach and the fact that if environmental and functional factors can affect healthcare outcomes, their impact will be higher in the areas where patients stay the longest, which are the in-patient units. To achieve a broad range of individuals with different life spans, the in-patient areas selected are the intensive care unit, the standard ward, the obstetric ward, the paediatric ward, the neonatal unit, and the labour ward (to complete the maternity process). Additionally, the circulation spaces have been considered because of their key role in determining the functionality of the whole building, as well as the care-path of patients and all the different users and services flows.

# 1.6 Dissertation Structure

This doctoral dissertation consists of five chapters, four appendixes and the website www.curarq.net. Each chapter, excluding chapter 5 conclusions, includes its own reference section with a list of the figures, tables, glossary (underlined words) and bibliography used. All this book is written in English, but more information can be accessed through the website that is written in Spanish. The structure of each chapter is as follows:

- **Chapter 1** provides an overview of the healthcare sector in Spain, an introduction to acute-care hospitals, the relevance of functional and environmental factors, and the impact of the evidence-based design process to justify the need and aim of this doctoral dissertation.
- **Chapter 2** addresses the background of this work with the historical evolution of the acute-care hospital, current research on the seven units of the study and on post-occupancy evaluation.
- **Chapter 3** explains the methodology chosen and the four perspectives of the study: acute-care hospital placement, literature analysis, acute-care hospital visits and acute-care hospital cases. There is also the basic building information of the sixteen visits and the four study cases.
- **Chapter 4** introduces the tool CURARQ, the evaluation process with this tool and its discussion. Next, there are the results and discussion of the seven units of the study (circulation spaces, intensive care unit, standard ward, obstetric ward, paediatric ward, neonatal ward, and labour ward) according to the four perspectives mentioned in chapter 3.
- **Chapter 5** includes the conclusions of this work as well as the limitations of the study, contributions, and suggestions for academic research.
- **Appendixes** consist of the curriculum vitae, documentation (financing, placement and evaluated acute-care hospital certificates), and material from the acute-care hospital placement (interviews and summary of results).

# 1.7 References

## 1.7.1 Tablas



## 1.7.2 Figures



## 1.7.3 Glossary

- Length of stay: the period of confinement of a patient to a hospital or other health facility (Online Medical Dictionary).
- Morbidity: the proportion of patients with a particular disease during a given year per given unit of population.
- Neurogenesis: formation of neurons which involves the differentiation and division of stem cells in which one or both of the daughter cells become neurons (Online Medical Dictionary).
- Psychological: related to psychology. Psychology: the science dealing with the study of mental processes and behaviour in man and animals (Online Medical Dictionary).

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# 2. Background

# 2.1 Hospital Evolution

Through history, the word hospital has been used to name institutions with very diverse forms, functions and meanings [1]. These buildings have been in constant development to cope with the evolving demands of clinical progress and social context.

In this schematic and shallow historical analysis, there is a selection of buildings in which one of its functions was related with the caring process of sick people. The timeframe established dates from the 3000 before Christ (B.C.) to the twenty-first century and is focused on a Western vision (North America and Europe). Tab. 1 summarises the basic information for each period considered.

| | | Model | Style | Funding | Treatment | Patients |
|---|---|---|---|---|---|---|
| **Ancient Age** | (3000. B.C. - 476 A.C.) | Greek (900 B.C.) | Sanctuary | Civilian | Rituals, thermal water, medicinal plants | Sick people |
| | | Roman (800 B.C.) | Consulting room | Civilian | Care, food, and accommodation | Slaves and legionnaires |
| **Middle Age** | ($1^{st}$c. – $15^{th}$c.) | Byzantine ($1^{st}$c. - $15^{th}$c.) | Hospice | Religious | Care, food, and accommodation | Poor and/or sick people |
| | | Gothic ($12^{th}$c. - $15^{th}$c.) | Monastery | Religious and civilian | Rest, heat, hygiene, diet, and asylum (pain house) | Pilgrims, poor and/or sick people |
| **Modern Age** | ($15^{th}$c. - $18^{th}$c.) | Renaissance ($15^{th}$c. - $16^{th}$c.) | Palace | Civilian | Surgery inception | Urban marginalised population |
| | | Baroque ($17^{th}$c. - $18^{th}$c.) | Monumental | Civilian | Therapeutic vocation, medicine as science | Soldiers, poor and/or sick people |
| **Contemporary Age** | ($18^{th}$c. - $20^{th}$c.) | Pavilions ($19^{th}$c. - $20^{th}$c.) | Military barracks | Civilian | Ventilation, hygiene, sunlight, and surgery | Sick people |
| | | Monoblock ($20^{th}$c.) | Compact block | Civilian (public and private) | Specialised medicine, privacy, and comfort | Sick people (with and without purchasing power) |
| | | Poliblock ($20^{th}$c.) | Autonomous blocks connected | Civilian (public and private) | Development of diagnostic and treatment areas | Sick people |
| | | Podium-tower (1950-1970) | Zoning | Civilian (public and private) | Diagnostic and treatment, in-patient wards, and general services | Sick people |

| | | |
|---|---|---|
| **Inflection point** | 20th C. | National Health Service |
| | | Megastructures |
| | | Modern Movement |
| **Present paradigm** | 21st C. | Sustainability & Evidence-Based Design |
| | | COVID-19 Pandemic |

*Tab. 1 Summary of hospital historical evolution. Based on references at each age considered.*

Next, there are tables with the correlation between the clinical and social development, and the hospital architectural model, at each considered period. The texts highlighted with the symbol ✪ describe with further detail a specific hospital that has been considered representative for that time.

## 2.1.1 Ancient Age (3500. B.C. - 476 A.C.)

| **Greek Model** [1] | |
|---|---|
| Background: | Architectonic solution: |
| • Health associated to religious rituals such as food offerings and ritual bathing. | • Greek temples, "Asklepieion".<br>• Sanctuaries located next to thermal water fountains and medicinal plants. |
| **Roman Model** [1] | |
| Background: | Architectonic solution: |
| • Funded by city government.<br>• Offered medical care to the population. | • "Demosieuontes iatroi" or public doctors.<br>• "Iatrea" consulting rooms for some surgical procedures located in a room of the doctor's house. |
| | • "Valetudinarium" facilities of "valeduto" or health for the urgent care of slaves and legionnaires from the military camps (Fig. 1). They offered health care, food, and accommodation. |

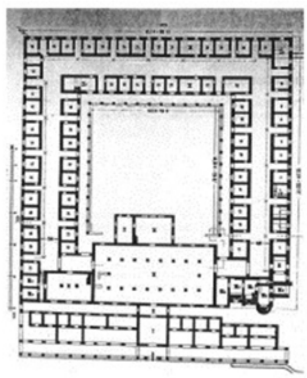


*Fig. 1 Valetudinarium, Vetera. Germany (70 A.C.). Figure by [1].*

*Tab. 2 Ancient age summary.*

# 2.1.2 Middle Age (1$^{st}$c. – 15$^{th}$c.)

**Byzantine Model** [1]

| Background: | Architectonic solution: |
|---|---|
| • Strong population growth concentrated in cities.<br>• Promoted by the church, for Christian charity, for the caring of the poor. The governments did not provide those services. | • "Xenones" originated by the byzantine Christian church. Considered as a basic equipment of the city. Combined doctors' training activities with the caring of the sick. With bathrooms and chapels for religious functions. |
| | • "Nosokomeia". "Nosos" illness + "komeo" city. Provided accommodation, food and medical care for sick people. |
| | • "Ptochotropeia" or "ptocheia". "Ptochos" poor + "tropho" feed. For the poor people. |
| | • "Xenodocheia". "Xenos" guest + "docheion" receptacle.<br>• Lodge or hospice. With doctoral staff and assistants for the care of the sick people. |

**Gothic Model** [1]

| Background: | Architectonic solution: |
|---|---|
| Common treatments:<br>• Segregation: dying people were in a separate room away from the common room.<br>• Resting: wooden beds to be shared by the patients.<br>• Heat: chimneys in the common basilican rooms.<br>• Hygiene: bathrooms.<br>• Diet. | • God's House. Building that received and treated the ones in need. It gave asylum to the poorest and hosted the pilgrims. House of charity and pain. It was part of the many buildings that formed the monastery (cathedral, bishop's palace, canons' school, monks' hospital, laymen hospital and "hospitum" for the poor people, travellers and pilgrims) (Fig. 2).<br>• Limited development of medieval surgery. The building was similar to the rest of the facilities associated with the monastery.<br>• Basilican typology.<br>• The patients were located aligned with the perimeter of the room to follow worship.<br>• Urban location next to the city accesses and rivers (supplies, laundry and waste disposal). |

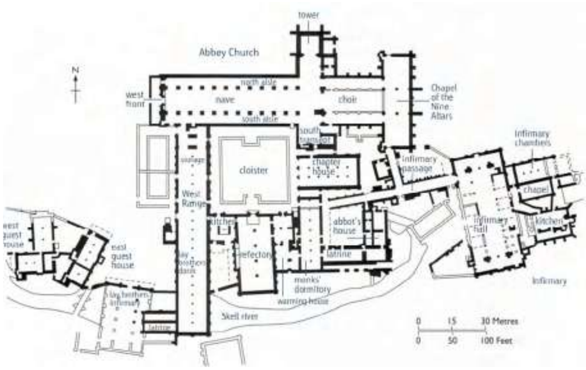


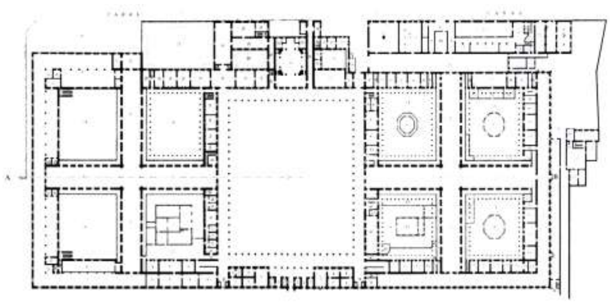

*Fig. 2 Fountains Abbey site plan. Yorkshire, England (13$^{th}$ c.). Credit: Holly Hayes. Figure by [2].*

| | |
|---|---|
| • 11$^{th}$c. growth of hospitals linked to pilgrimage roads.<br>• Increase in the number of hospitals originated by laypersons (funded by kings, lords and bourgeoisie). | • Adaptation of the "God's House" to the new city needs. |
| • Social instability at the end of the 12$^{th}$c.<br>• Bourgeoisie started to take control over hospitals to tackle poverty (linked to misery and sickness).<br>• Creation of hospitaller orders (12$^{th}$c. - 13$^{th}$c.) due to pilgrimage to Christian holy places. | • Fortified hospital model with cloistered arrangement (religious, military and hospital component). |

*Tab. 3 Middle age summary.*

## 2.1.3 Modern Age (15$^{th}$c. - 18$^{th}$c.)

**Renaissance Model** [1]

| Background: | Architectonic solution: |
|---|---|
| • Decrease of religious power and increase of civilian power.<br>• Hospitals were important for controlling urban marginal population (linked to poverty and sickness) by monarchy. | • The medieval model was still in use (it lasted until 18$^{th}$c.)<br>• Quite simple urban buildings.<br>• Palace aesthetics and renaissance geometries (Fig. 3). Only differed in their bigger dimension and scale. |
| • Moderate development of surgery. Improvement in interventions and treatment of gunshot wounds.<br>• More appropriate instrument development.<br>• Advances in obstetric and ophthalmology specialities. | • Surgical procedures were done in the same hospitalization room with other patients.<br>• Undifferentiated rooms (became converted into other functions).<br>• Hospitalization occupied 90% of the whole hospital building.<br><br>*Fig. 3 Floor plan and section. Ospedale Maggiore, Milan, Italy, Filarete 1456. Figure by [3].* |

**Baroque Model** [4]

| Background: | Architectonic solution: |
|---|---|
| • Place associated with death.<br>• Designated for the poor and sick populations.<br>• Little medicalized. | • Hospital for incurables. |
| • Large variety and dispersion of hospital facilities in use. Economic and healthcare deficit.<br>• Dispossession of religious properties by the State. Dissolution of clerical orders. Decrease in healthcare staff (mainly were nuns and priests). | • Replacement of smaller hospitals by bigger hospitals located in the main cities. |

- From a religious approach to a civilian approach, the healthcare function was more important than Christian charity.
- Hospitals managed by civilian commissions that reported back to the king.
- Socialisation of healthcare.

- Institutional monumental architecture that represented the social order.
- Architectural magnificence like other facilities such as the palace (power), the barracks (military), or the prison (neglected marginal population).

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- French revolution (1790). New age of reason, hygiene, and science.
- Human beings were no longer God's creatures but citizens.
- Several states started organising healthcare systems. Inception of control and preventive medicine to reduce hospitalization cases (doctors as civil servants).
- Hospital as a place to cure some diseases. Before this time, the religious treatments offered consisted of leeches, purge, suction cups and rosaries. Therapeutic vocation.
- Medicine as a science. Doctors and surgeons in hospitals.
- Professional regulations, inception of professional associations for its control.

- New hospital model: big block surrounding a cloister (with a rectangular courtyard in the middle) and Greek cruciform layout.
- Architecture of large dimensions (Fig. 4).
- Natural ventilation problems and circulation issues (there were no corridors, flows through hospitalization rooms). Increased the risk of nosocomial infections.

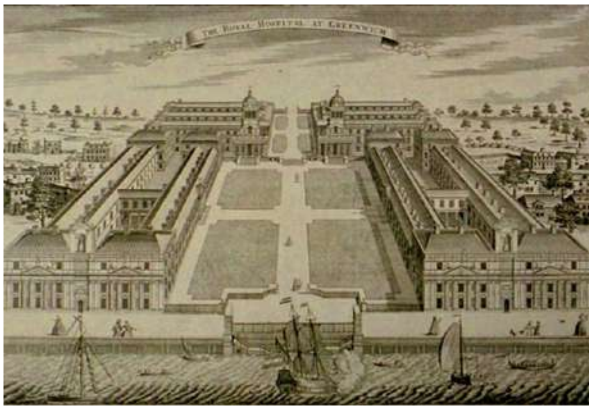

*Fig. 4 Royal Naval Hospital, Greenwich, London, UK. Christopher Wren, 1694. Figure by [3].*

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- Beginning of necropsy (17$^{th}$c. - 18$^{th}$c.).
- Beginning of rudimentary urine tests (18$^{th}$c.).
- Development of equipment for patient exploration.
- Development of clinical trials.
- Introduction of medicines, beginnings of pharmacology.
- Doctors started to consider patients for diagnosis (listening to them and palpating them).

- Introduction of the autopsy room in some hospitals.
- Development of the first laboratory for clinical tests.

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- Army development by professional soldiers (17$^{th}$c. - 18$^{th}$c.).
- The wars between states/nations produced a new type of patient whose health was key for the nation.

- The monarchs, who owned the army, promoted austere military hospitals.

- Paris 1772: fire in the medieval hospital Hôtel-Dieu (Fig. 5).

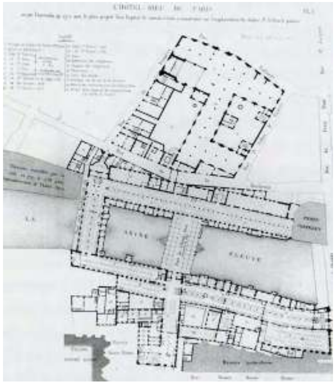


*Fig. 5 Hôtel-Dieu, Paris, France before the fire. Figure by [3].*

| | |
|---|---|
| • Hospitals were a threat for hospitalised patients. Hospital mortality was about 25%. Linked to dirtiness (inadequate sanitation) and diseases.<br>• Huge debate on social healthcare and its architectonic solution. | • Improve healthiness and environmental conditions in hospitalisation rooms.<br>• To study, with a scientific approach, the more adequate design for the new hospital model. |

*Tab. 4 Modern age summary.*

## Contemporary Age (18$^{th}$c - 20$^{th}$c.)

**Pavilions** [8]

| Background: | Architectonic solution: |
|---|---|
| • Birth of preventive health policies.<br>• According to hygiene theorists, the reason behind the high mortality rates was the lack of ventilation.<br>• Facilitate natural ventilation to avoid contagious diseases. | • Hospitals far away from the cities.<br>• Building as a ventilation machine. Pavilions to improve the natural ventilation of hospitalisation rooms. Pavilion height fixed according to the width of the courtyards and the needed air volume per floor. |

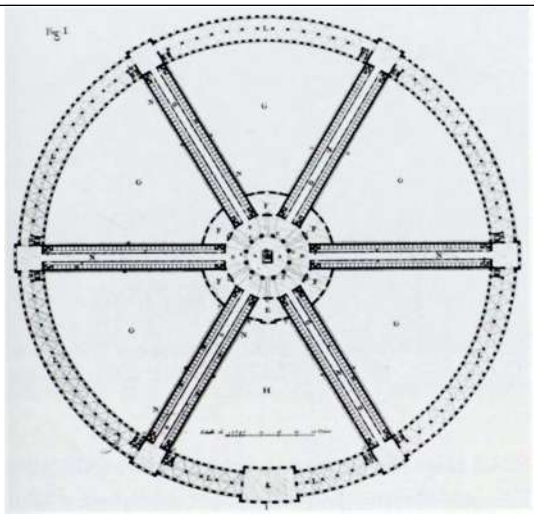
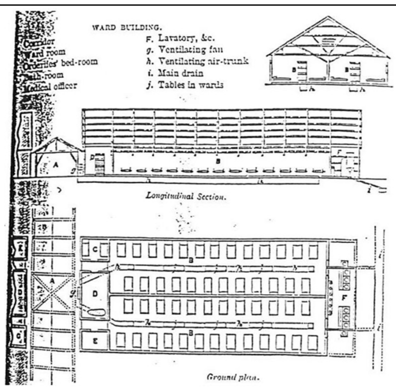


*Fig. 6 Design for the Hôtel-Dieu, Paris, France. Antoine Petit, 1774. Figure by [3].*

✪ Project for the new Hôtel-Dieu in Paris

- Proposal for the reconstruction of the burnt down hospital. Designed by the surgeon A. Petit (based on the Ideal Hospital by A. Desgodets in the 16$^{th}$c.).
- Hospital as a massive circle (Fig. 6). Radial hospitalisation rooms that work as a massive tube with air movement from the perimeter to the centre of the circle. Cylindrical central structure with a dome that performed as a chimney for the evacuation of smoke and was used as a church.

| | |
|---|---|
| • English Industrial Revolution (1760).<br>• Gross overcrowding of low-income populations in the cities, epidemics.<br>• Paris urban transformation by G.E. Haussmann (1848). | • Impact of hygiene studies in hospitals on urban planning. Application of ventilation, sanitation and sun-light principles to urban and building regulations.<br>• Cemeteries, asylums and hospitals far away from the urban centres. |
| • Improvement of citizens' living conditions ($19^{th}$c.).<br>• Healthcare politics depend on the State. Inception of the concept of public health and the right to healthcare. | |
| • Modernisation of surgical and medical education in all Europe.<br>• Developments in surgical anaesthesia, haemostasis, blood transfusions, antisepsis, asepsis, and equipment.<br>• Momentum of surgical development. Average mortality in operating rooms of 50%. | • New hospital model: healthcare + education + research.<br>• New and specific rooms for dissection, autopsy, laboratories, operating theatres, medical and surgical wards, and general services.<br>• Demand of rooms for surgical activities. Incorporation of specific space for surgical functions. |
| <br>*Fig. 7 Renkioi military hospital, Turkey (1855). Figure by [1].* | ✪ Renkioi Military Hospital (Fig. 7)<br>• Built by English engineers.<br>• Wooden barracks that accommodated wounded and sick patients in 3000 beds.<br>• Rooms with sanitary systems, drainage and support areas for nurses and doctors.<br>• The influential nurse Florence Nightingale worked in this hospital (see chapter 1.4).<br>• Hospital mortality 3%, against the 42% in the Hospital for Invalid Ladies in London where Nightingale worked at that time. |
| • Wars became a development factor for medicine and hospitals. Crimea war (1855-1856).<br>• Leading role of nursing staff in the hospital<br>• (hospitalisation room cleaning, patients washing; food service and drugs intake).<br>• When Florence Nightingale went back to the United Kingdom (1859), she published "Notes on Hospitals" and "Notes on Nursing" where she described best practices for hospital designs. These mainly consisted in the improvement of hygiene conditions.<br>• Her book propitiated a universal development of these hospital types until the beginning of the $20^{th}$c. | • Hospitalisation rooms:<br>  – Rectangular shape (40 m x 9 m).<br>  – For 30 patients.<br>  – Beds arranged in two lines, perpendicular to the walls with a central corridor.<br>  – Generous windows next to the beds (enough day light and natural cross-ventilation).<br>  – Sanitary facilities and support rooms .<br>• Pavilions:<br>  – One or two floors.<br>  – North-south orientation (optimal sunlight and ventilation).<br>  – Concrete foundations or air chamber (to avoid moisture).<br>• Outdoor area:<br>  – Gardens and pathways to connect pavilions.<br>  – Covered courtyards to allow outdoor physical activity. |

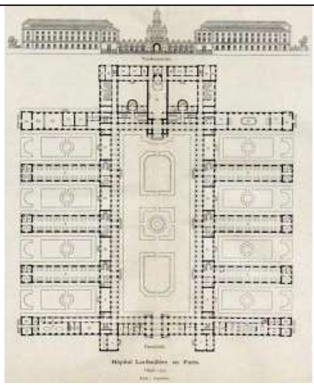


*Fig. 8 Hôpital Lariboisière, Paris, France, Martin-Pierre Gauthier, 1839-1854. Figure by [3].*

✪ Lariboisière Hospital (Fig. 8)

- Based on the reconstruction proposal for the Hôtel-Dieu in Paris by the surgeon J.R. Tenon and the architect B. Poyet 1787.
- Three pavilions at each side of the courtyard with a total number of 905 beds.
- Three-floor height.
- Auxiliary rooms at both end sides of each hospitalisation room, and at both extremes of the building.
- Pavilion orientation and dimension to maximise optimal sunlight.
- Endorsed by Florence Nightingale as a referent model.

**Monoblock Model** [1]

| Medical and social background: | Architectonic solution: |
|---|---|
| • Consolidation of the hospital as the general healthcare model.<br>• Decrease of nursing presence due to the development and increasing room demands of surgery and radiology procedures.<br>• Improvements in specialised medicine.<br>• Attraction of wealthy patients.<br>• Development of public and private models. | • Hospital extension to attend the whole population.<br>• Irruption of new specialised hospitals (such as sight, cancer or orthopaedics).<br>• More privacy and comfort in hospitalisation rooms. Hotel imitation: hospitalisation rooms compartmentalised with light partitions, hospitalisation rooms with sinks, beds oriented to the windows to provide external views to patients. |
| • Bacteria discovered as a disease transmitter (L. Pasteur).<br>• Discovery of antiseptic treatment of wounds.<br>• Scientist concluded that the hospital pavilion model did not offer better results than the preceding models. | • No need to provide fixed air volumes per bed. There was no longer justification for the pavilion model.<br>• Vertical development of hospitals:<br>  – Development of construction techniques (steel, reinforced concrete, and glass).<br>  – New installations (lifts, thermal power plant).<br>• Compact block, shorter and more efficient journeys than with the pavilion model.<br>• Less floor area needed in the plot. Encouraged the return of hospitals to the cities. |

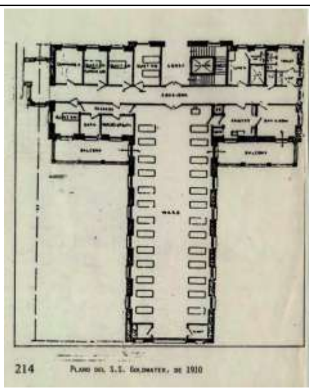


*Fig. 9 Hospital Goldwater. New York, USA (1910). Figure by [1].*

✪ Goldwater Hospital (Fig. 9)

- Hospitalisation pavilions stacked in vertical.
- Layout with a "T" shape with an area for the vertical communication cores plus the support areas, and another area for the hospitalisation room.
- Difficulty in organising the different hospital units and their functional relationships in an effective manner.

*Fig. 10 Hôpital Beaujon, Clichy, Paris, France, Jean Walter, Louis Plousey, Urbain Cassan, 1932-1935. Figure by [3].*

✪ Beaujon Hospital (Fig. 10)

- For the first time, there was a proposal to segregate the different user flows (sick people, visitors and staff) from the services.

- First World War (1914 - 1918).
- Development of antisepsis, asepsis, and surgical techniques.

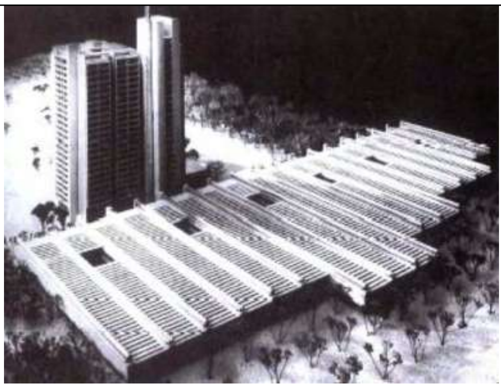
- Second World War (1939 - 1945).
- Acceleration of surgery development:
  - Introduction of penicillin.
  - Occlusive treatment of wounds.
  - Anaesthesia development.

**Poliblock** [1]

| Medical and social background: | Architectonic solution: |
|---|---|
| • Increase of hospital functional programme complexity.<br>• Development of diagnostic and treatment facilities (such as emergency department, operating rooms, out-patient consultations, laboratories or radiological intervention).<br>• Treatment for tuberculosis: sun, pure air, and nature. | • Need for connecting, grouping and spatial proximity between related units (according to user type).<br>• Need to move in-patient wards away from general services.<br>• Sanatorium in contact with nature (outdoor life), horizontal structures (do not block views, natural ventilation, and sunlight). |
| • Discovery of rifampin to cure tuberculosis. | • Demise of tuberculosis sanatoriums. Buildings converted into other functions (e.g. long-term hospitals). |

**Podium-tower** [1]

| Medical and social background: | Architectonic solution: |
|---|---|
| • Development and increase of clinical services. | • Monoblock and poliblock models were too rigid to cope with hospital changes, resulting in additional buildings being connected to the hospital or the dispersion of functions within several floor areas. Increase in difficulty of circulation flows and hospital management. |
| • The Athens Charter (1933, 1941) functional approach to urban planning. | • Functional zoning of the hospital:<br>– Lower areas: diagnostic and treatment, administration and general services.<br>– Higher areas: hospitalisation wards.<br>– Building annexes: staff residency, supplies, resources and others. |

| | |
|---|---|
| <br>*Fig. 11 Herlev Hospital, Denmark. G. Bornebsuch, M. Brüel, and J. Selchau (1965-1975). Figure by [1].* | ✪ Herlev Hospital (Fig. 11)<br>• Hospitalisation wards in vertical tower and the general services in the horizontal podium (treatment and diagnostic, support and general services).<br>• Concentration and efficiency of flows and staff and services journeys.<br>• Highly dependent on lift services. |

*Tab. 5 Contemporary age summary.*

## 2.1.5 Inflection point (20th c.)

| **End of hospital typology (from the late 1980) [1]** | |
|---|---|
| Background: | Architectonic solution: |
| • Shift in social demands and expectations over healthcare services.<br>• Patient-centred clinical activity, functionality, and design. | • Architecture as an added value. |
| • Shift in medical training and practice. | • Greater complexity and development of the functional programme. Shift in building scale and configuration. Hospital projects with more volumetric diversity.<br>• Prevalence of horizontal development. |
| • Increase in the importance of the healthcare sector for the national economy. Higher gross domestic product (GBP) investments.<br>• Healthcare systems reform (new funding and management models for hospitals). | • More efficient hospitals in terms of care and use of resources. |
| • Beginning of telemedicine development.<br>• Growth of out-patient assistance (out-patient department, day hospital, tests, and examinations).<br>• Increase in the number of people attended each year and decrease in the average length of stay at the hospital. | • The floor area dedicated for the in-patient department was reduced from 80% (since the 20th c.) to 25% of the whole building. |
| • Most acute patients can be treated. | • Increase in the floor area dedicated to the intensive care unit from 3% to 10% of the whole building. |

### National Health Service (United Kingdom) [5]

After World War II (1939-1945) and due to the progress of the welfare state in Great Britain, the National Health Service (NHS) was created. In addition to providing health care services, this institution had its own architectural department responsible for the analysis, development and evaluation of healthcare facilities. Since the National Health Act (1946) [6] all British hospitals became public which meant that there was a need for the reorganization of about 2000 national buildings. At that time (1950-1970) the predominant hospital model was still the podium-tower, but its configuration was becoming more and more inflexible due to the current change in needs and the small floorplan. The designers of this new institution experimented with new proposals based on several factors: low-rise, flexibility, smaller size, zonification of areas, prefabrication of construction systems, relevance of building services and special attention to environmental factors such as orientation, views or natural light. All their work was gathered in the Health Building Notes, documents created for its own evaluation and dissemination that are still in use and being updated [7].

*Fig. 12 Wexham Park. Figure by [1].*

✪ Wexham Park (1955-1966) (Fig. 12)

- Located in a park with a lake that had available land for future extension.
- Differentiation of accesses but mixed circulations (internal and external).
- Hospital arranged on one floor except for the administration tower.
- Natural light (windows and skylights), courtyards and outdoor views for all rooms with a permanent occupation.

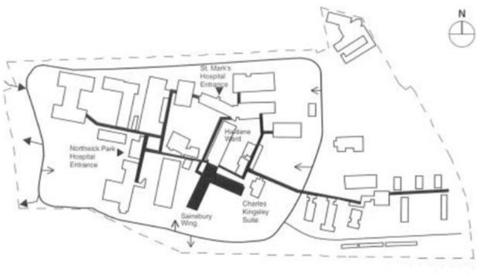



*Fig. 13 Northwick Park Hospital. Site plan and enclosed street. Figure by [1].*

✪ Northwick Park Hospital (1963-1972) (Fig. 13)

- Urban design, village with streets and independent buildings, able to be modified without interfering with the rest of the hospital. Organic extension according to needs.
- Enclosed street with segregation of circulation in height (two or three levels: highest for patients, staff and visitors, middle for supplies, and the lower for building services.
- Zonification of buildings with different shapes and heights adapted to specific needs.

*Fig. 14 Frimley Park Hospital. Best Buy concept. Figure by [1].*

✪ Standard Best Buy Hospital (1967) (Fig. 14)

- Experimental model or design concept to reduce the average budget and time: low-rise, ramps instead of lifts, electric cars for food and supply movement, nursing wards next to treatment and diagnosis services to shorten distances.
- Compact floor plan, rectangular grid structure with courtyards. Wards at the perimeter and clinical services in the middle of the building. Undefined limits between departments, shared use of equipment and rooms.
- Without available room for future demands. Only build what was needed.

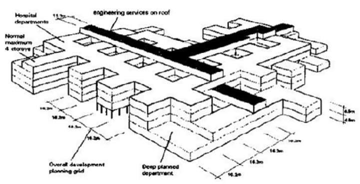


*Fig. 15 Diagram of a Harness Hospital System. Figure by [8].*

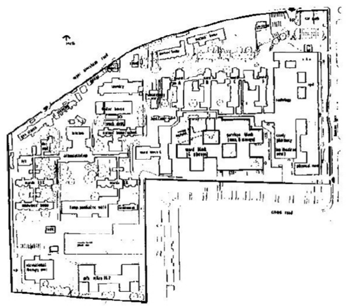


*Fig. 16 Development using Harness Departments. Figure by [8].*

✪ Harness Hospital System (1971) (Fig. 15-16)

- Best buy hospitals with their standard plans could not meet the need for more flexibility in hospitals.
- Standardised system of hospital design and construction.
- Prefabricated modular project generated by the addition of modular pieces which had a crossed shape. Harness framework for the whole hospital.
- The modular pieces were joined to a main corridor (that hosted all the building services, communications and people flow). Each piece consisted of a structural grid of 15 $m^2$ with clear spans of 15 m.
- There were courtyards between the crossed modules.
- Each department to be resolved on one floor and covered by one or more basic pieces.

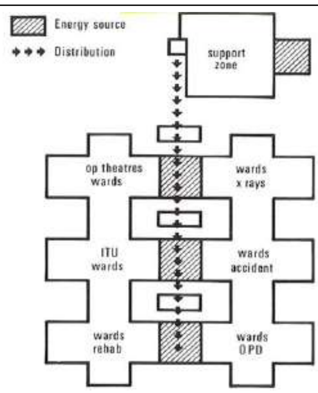



*Fig. 17 Nucleus Standard Hospital with decentralised energy sources and cruciform templates. Figure by [9].*

*Fig. 18 Newham Hospital, UK. Figure by [9].*

✪ Nucleus Hospital System [9] (Fig. 17-18)

- Combination of the cruciform shape and structural grid from harness and economical space use from Best Buy, after the oil crisis (1973).
- Definition of independent modular pieces for the growth and change of old hospitals. Hospital renovation by sections without interrupting its functioning, resulting in a new hospital with all parts plugged in.
- A cross-shaped basic piece with a 16.2 m side (able to host two nursing units of 28 beds each) allowed for natural lighting and ventilation. Able to stack up to three pieces in height, plugged into a main corridor with segregated circulation. Courtyards between the modules.

**Mega-structures (Germany and Canada)** [1]

During the economically prosperous years preceding the oil crisis (1973) hospital projects were conceived as gigantic transformers to cope with clinical and technological evolution. These sophisticated containers allowed for maximum flexibility of change and extension, with rooms capable of being converted in almost any required place.  Such massive buildings had a highly specialised engineering solution. They used a grid of service rooms connected to vertical and horizontal flows with interstitial plan floors for the engineering pipes and conduits. Their façades had an industrial look. This design trend was influenced by the architectural movement lead by Archigram (Cedric Price) that promoted high tech solution for technological buildings (such as hospitals or universities). However, the oil crises shifted the context completely and the healthcare systems had to reconsider their investments to optimise their own resources.

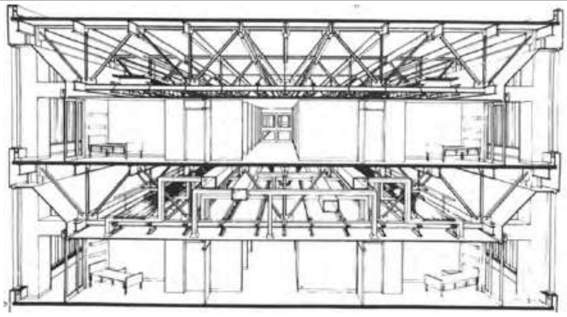


*Fig. 19 McMaster University Medical Centre interstitial floors. Figure by [10].*

✪ McMaster University Medical Centre, Ontario [11] (1969) (Fig. 19)

- Structural mesh without columns of 25.6 m per 28.8 m, supported by 55 towers located at the corners with a size of 3.2 m per 6.4 m. The towers carried the loads to the ground as well as hosting the vertical communication cores.
- Interstitial floors for building services that allowed for maintenance flows and activities without interrupting the performance of the hospital.
- This mega-structure allowed future extensions in vertical, lengthening the service towers.

*Fig. 20 University Hospital Aachen. General view by Uniklinik RWTH Aachen.*

✪ University Hospital Aachen (Germany) (1969 – 1982) (Fig. 20)

- Goal to create a healing machine with maximum flexibility.
- Orthogonal grid with four main circulation streets (parallel and longitudinal), associated with the vertical communication cores and connected to each different hospital unit. Interstitial floor for building engineering services.

**Modern Movement and Great Master of Architecture (20th c.)** [1]

During the 20th c. there are well-known examples of hospital projects and buildings that surpass regular hospital prototypes. This was due to the work of great architectural masters of the Modern Movement that dared to confront healthcare design challenges in an innovative, compromised, and brave manner. Next, there is a small selection of interesting projects that take into account the synergies between functional and environmental factors.

*Fig. 21 Zonnestraal. Hilversum, the Netherlands. Bernard Bijvoet, and Jan Duiker (1926-31). Figure by [12].*

- Zonnestraal (1926-31), Hilversum, the Netherlands. Bernard Bijvoet (1889-1979) & Jan Duiker (1890-1935) (Fig. 21)
- Tuberculosis sanatorium where treatment is based on contact with nature, air, heliotherapy, food and resting.
- Buildings far away from the cities, with linear and horizontal shapes. Narrow and low height volumes to maximise sunlight and views.
- Disaggregation of volumes organised as small clusters adapted to the site.

*Fig. 22 Views from the Paimio Tuberculosis Sanatorium. Figure by [10].*

- Paimio Tuberculosis Sanatorium (1929-33), Paimio (Finland), Alvar Aalto (1898-1976) & Aino Aalto (1894-1949) (Fig. 22)
- Organic adaptation to the site with a therapeutic and functional vocation (optimal sunlight and views).
- Sensory architecture that takes into account the physiological and psychological qualities of the spatial experience so that it does not interfere in the patients' hypersensitivity.
- Double windows to avoid air flows, curved sinks to avoid water noise, light points away from the patient's direct sight, soft colours for interior design and soft and pleasant finishing materials for doorhandles.

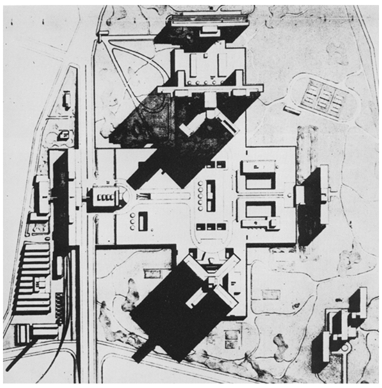


*Fig. 23 Hospital City in Lille Site plan. Figure by [10].*

- Hospital City in Lille (1932), France. Proposal. Paul Nelson (1895-1975) (Fig. 23)
- Consequence of the North American urban zoning: separation of the city into specialised areas with the same function (university city, sports city, sanitary city).
- Proposal dismissed from consideration for being too innovative and utopic for the time.
- Urban planning as an essential part of the hospital complex, connection to the city transportation and communication networks.
- Unitary and autonomous project. A cluster for all the healthcare resources in the city (medical faculty, acute-care hospital, geriatric hospital, long-term hospital, administration and general services).
- Monoblock geometry, two cruciform towers.

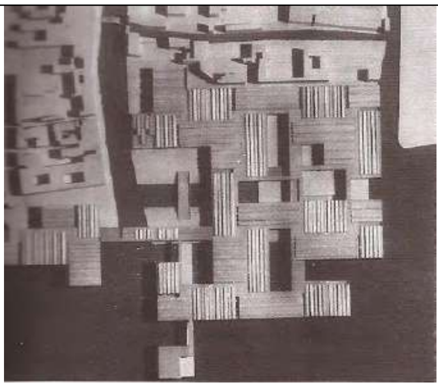


*Fig. 24 Venice Hospital. Le Corbusier. Figure by [12].*

✪ Venice Hospital (1964-65), Italy. Proposal. Le Corbusier (1887-1965) (Fig. 24)

- Contest winning project. Different approach to hospital design, compared to the contest opponents.
- Plastic adaptation of the building to the site constraints.
- During the design stage there was a drastic reduction of the in-patient department, but the design proposal was able to cope with it without losing the essence of the project.
- Careful design on a lower scale of detail for the in-patient bedroom. The in-patient bedroom becomes the module of the project that with an internal order configures the whole modular hospital.

*Fig. 25 Outdoor areas and courtyards. Hospital SARAH. Figure by [10].*

*Fig. 26 Hospitalisation room. Hospital SARAH. Figure by [10].*

✪ Hospital SARAH Salvador, 1994, Brazil, João Filgueiras Lima (Lelé) (1932-2014) (Fig. 25-26)

- Sarah Kubistchek Network of Rehabilitation Hospital.
- Rational and sensitive usage of prefabricated architecture. Prefabricated components of reinforced concrete to design light shapes at a low production cost.
- Efficient construction processes with lower costs and shorter completion times.
- Detailed study of environmental factors: natural site locations, adaptation to the place (orientation according to sunlight and natural ventilation), indoor rooms linked to outdoor gardens, zenithal light, ceilings with different heights according to the room function, horizontal development, furniture designed for patient, white colour to avoid heat and art to humanise spaces.
- Structural originality gives shape and character to the project. Conceptual clarity of the form and structure of the building.

*Tab. 6 Inflection point summary.*

## 2.1.6 Present Paradigm (21stc.)

### Sustainability & Evidence-Based Design [13]

Since the late 20th century, hospital design has evolved to cope with the constant changes in technology, diagnosis and treatment techniques, new devices and equipment, growth of out-patient surgery and patient care philosophy [14]. Fortunately, hospital architecture has moved from being considered as a difficult and slow field for invention and progress (losing skills and commitment in their development) to the frontline of architecture with unique design challenges [3]. Both the advances in psychology, medical technology, digital revolution and science are fundamental in the design of hospital buildings that should provide the best quality to its end users [3]. Next, there are several recent examples of hospital design. These showcase architectural firms that embrace the challenges of hospital complexity as a source of design inspiration.

*Fig. 27 General view New Hospital North Zealand. Figure by [15].*

✪ New Hospital North Zealand (ongoing in 2020) (Fig. 27)

- Hillerød (Denmark). Vilhelm Lauritzen Architects with Herzog & De Meuron
- Low-rise with an organic composition, set in a Danish forest. All the perimeter is stacked with patient bedrooms (maximising views and natural light) and the medical services are found in a subterranean basement. The hospital project is integrated into the surrounding landscaping work and a new urban area that includes commercial and residential buildings.

*Fig. 28 General view Parametric Hospital in Puyo. Photographer Sebastian Crespo [16].*

✪ Parametric Hospital (2013) (Fig. 28)

- Puyo (Ecuador). PMMT Arquitectura
- A parametric system designed to meet the extremely tight time requirements of an urgent national need that demanded the completion of the design, construction and equipment of the new facility in a time period shorter than a year. The solution is a modular project with a high degree of prefabrication and an inner organizational system.

*Fig. 29 Atrium view at Haraldsplass Hospital in Bergen. Figure by [17].*

✪ New Ward Building at Haraldsplass Hospital (2020) (Fig. 29)

- Bergen (Norway), C.F. Møller Architects
- The location of this new building was chosen to maximise the views of the surrounding natural elements (mountain Ulriken and river Møllendalselven). In addition to site, the building follows the river's course, the floor layout is arranged surrounding two covered atriums that provide natural light and visual perspective to the inner rooms.

**COVID-19 Pandemic** [18]

| Background: | Architectonic solution: |
|---|---|
| | |

Background:

- Setback to public health policies from the 19thc.
- Temporary design solutions to increase hospital capacity (Fig. 30-31).
- Natural cross-ventilation to reduce the spread of infection.
- Reduction of social interaction and economic activity. Increase of mental health disorders.
- Highlighted disparities among people with different purchasing power.
- Highly specialised staff unable to change activities during an emergency.
- Boom of tele-medicine and virtual care. Patients in need of access to digital devices.
- Understanding of need for a culture approach rather than an individual approach to healthcare.
- Fragmented healthcare system, lack of coordination between primary and acute-care hospitals.
- Political incompetence to coordinate a national healthcare net, fragmentation between regional powers.
- Economic recession.

Architectonic solution:

*Fig. 30 Temporary hospital in Wuhan (China). Figure by [19].*

*Fig. 31 Transformation of the exhibition centre IFEMA into a hospital. Madrid, Spain. Figure by [20].*

| Future horizon | |
|---|---|
| Background [18]: | Possible architectonic solution [21]: |
| • Need for proactive and cross-functional skills. Need for multiple non-health related profiles in hospitals.<br>• Interconnectedness of the healthcare system at every level (from primary to acute care). Healthcare nets.<br>• Increase of usage of predictive tools, artificial intelligence (AI) tools to simulate and predict future scenarios.<br>• Governments with no more public money to invest in healthcare systems.<br>• Investment in public health, health promotion and preventive medicine.<br>• Community health centres to reduce stress in emergency departments and promote preventive medicine.<br>• Dystopia, increase of inequality. | • Diversification of the supply chain with at least some of the supplies and PPE material kept locally. Storage areas in the hospital.<br>• Hospital plots with available area to increase capacity during emergencies.<br>• Isolated areas for infectious patients.<br>• Empty areas inside hospital departments to facilitate the reconfiguration of the building.<br>• Additional filter rooms for dressing and undressing in the ICU.<br>• External decontamination areas for ambulances and for pre-triage activities.<br>• Rest rooms with natural themes for staff. Outdoor green areas to help support anxiety and depression.<br>• Technical installations in areas to be reconverted (such as parking, rehabilitation, operating theatres, halls or waiting areas).<br>• Heating, ventilation, and air conditioning (HVAC) flexible recirculation/all-air system and positive/negative pressure.<br>• Reduce viral load by using long-lasting and easy to clean finishing materials.<br>• Storage area for keeping corpses at low temperatures.<br>• Segregated flows in all hospital.<br>• Further segregated flows in the emergency department: 1) for staff; 2) for trauma patients; 3) for suspected infected patients; 4) for other patients.<br>• Single-bed patient bedrooms with double capacity. This will allow the transformation into double rooms. Preinstallation of bed head beams and gases. |

*Tab. 7 Present paradigm summary.*

# 2.2 Units Evolution

Chapter 2.1 considered the evolution of the acute-care hospital as a whole. However, since this thesis focuses on six ward types and the circulation spaces (see chapter 1.5), there can be further description of these areas. Next, there is the historical evolution and the latest research on functional and environmental factors within the areas of the study.

## 2.2.1 Circulation spaces

The circulation spaces of an acute-care hospital could be defined as an extensive group of volumes that provide all needed flows of resources (people, goods and services) for the permanent acute-care hospital activity.

Through history, the rapid evolution of clinical, technological and user demands has produced different hospital typologies shaped mainly by the circulation spaces strategy. The circulation spaces have always reflected the healthcare delivery process and determined the final shape of the acute-care hospital. Both with the functional and spatial compartmentalization between religious and secular spaces in the Middle Ages and the isolation of contagious patients thanks to the discovery of germs in the 19thc. [22]. That is the reason why the historical evolution of these spaces corresponds with that of the acute-care hospital as a whole (see chapter 2.1).

The acute-care hospital is an open system due to its functional programming instability. In a similar way to any high scale building, the circulation spaces are the ones that unite the functional programme [23]. These vital places of void or no apparent initial function do not appear in the functional programme and remain hidden between the conversion factor from net to gross area [23, 24].

One of the basic functions of acute-care hospital circulation spaces is the interdepartmental connection. They work as arteries linking different departments for optimal distribution of resources as well as for ensuring an optimal delivery of the healthcare path (Fig. 32).

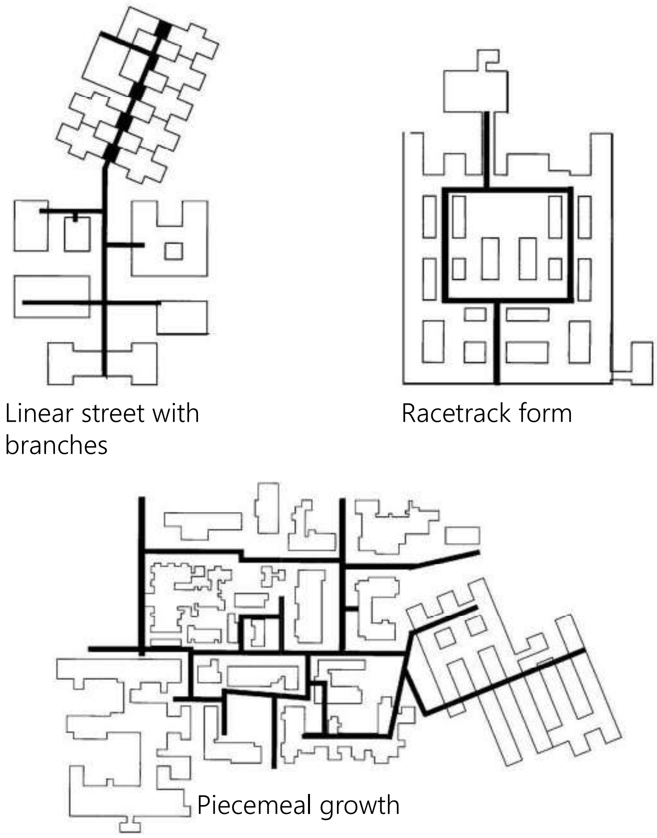



*Fig. 32 Samples of different strategies for general hospital circulation [25].*

Acute-care hospitals are, together with airports, one of the architectural typologies in which there is a wide variety of different flows that include not only people but also supplies (fungible materials, equipment, linen, rubbish, and food). Acute-care hospitals are one of the major consumers of goods and services that have to be distributed within the building. Their circulation depends on the thorough understanding of the acute-care hospital's policies for supply, storage and disposal of laundry, catering, sterilization, pharmacy, pathology, and other services [1, 25]. This understanding will affect the amount of movement in the corridors (number of journeys per day), the space requirement for centralised or localised storage and the number of lifts needed according to the analysis of the vertical flow [25]. A negative consequence of overlooking this aspect is the informal usage of circulation space to store bulky equipment that has no other room. That is a constant challenge as there is never enough convenient storage space and it might become a potential hazard and cause inconvenience and inefficiency [25-27].

The acute-care hospital general shape determines the need for circulation space. While compact buildings might reduce the area of circulation, extended volumes might need longer circulation arteries. Excessive and long corridors might be exhausting for patients and staff (inefficient use of workload) and might reduce the floor area available for functional rooms, as well as increasing the number of lifts needed, the cost of cleaning and maintenance. On the contrary, not providing enough circulation spaces might cause chaos, inefficiencies in the healthcare delivery path and poorer user experience [1]. Circulation spaces might take from 10% to 40% of functional floor areas, which makes them expensive and extensive [27]. Therefore, designers tend to reduce them to the minimum to comply with existing fire safety and building regulations [26].

However, the circulation spaces are the ones that allow the coordinating function of the shape and are responsible for ensuring building efficiency at many levels [23]. There exists a duality between the strict requirements of acute-care hospital areas and the permeability of circulation spaces that have to join (both horizontally in plans but also vertically in section) all areas into a consistent whole. Exploring circulation spaces not only horizontally but also vertically might produce interesting volumes that link different levels, allowing for an enriched complexity in social and labour interactions [1]. This transition from a pure functional approach of the circulation routes to considering the social and spatial aspects of people movement is nowadays fundamental for the optimal design of an acute-care hospital [28].

Furthermore, the greater emphasis on patient-centred care together with caregivers and relatives' empowerment, the increase in out-patient activity and the reduction of average length of stay for hospitalised patients has raised the need for careful planning of acute-care hospital circulation spaces and specifically for the public movement of people in the building [22, 28]. Many circulation spaces are public spaces which means that the public can move independently [28]. The main volume of pedestrian flow is directed to the out-patient area (out-patients and their companions).

Recent studies have shown that, in practice, circulation spaces become the framework for a wide range of activities associated to health-related outcomes. A literature review identified the following research themes associated to acute-care hospital circulation zones [22]: wayfinding difficulties; communication and socialization patterns; measures to control excessive noise; patient fall incidents; user stress level; user satisfaction level; and other patient-centred care issues.

Additionally, there is the impact of connectivity with nature, natural light and the sense of visual transparency, positive distraction and meaningful contact with the outdoor environment (Fig. 33) [22, 29, 30].

*Fig. 33 Corridor intersection in the Helsingor Psychiatric Hospital, in Denmark.* Photo: Iwan Baan.

*Fig. 34 Photography exhibition by Juan Manuel Castro Prieto. HD.*

Moreover, studies have shown that circulation spaces provide neutral settings that give rise to more multidisciplinary communication among staff than in formal rooms [27]. This fact is fundamental as nowadays the delivery of healthcare depends on the performance of multidisciplinary teams [27]. Instead of guidelines for minimum width of corridors, these documents should include design help that promotes additional roles and experiences for these sometimes undervalued spaces to encourage informal interaction such as conversation nooks, quiet spaces, ledges for writing notes or leaning on, small stools or chairs [27].

Corridors can also be considered to have a medicinal function for patients with certain levels of ambulant capabilities who can use their immediate circulation spaces for rehabilitation exercise [22]. In the same way, they become part of the physical work environment for clinical and non-clinical staff [22].

Apart from their articulating function within the acute-care hospital, circulation spaces might also serve as transition places for entrance; from the outdoor to the indoor of each room [28]. This in-between situation gives them the opportunity to adjust peoples' emotional disposition for example before the announcement of the final diagnosis or a transcendental communication. Hence, sensitive attention to detail and environmental qualities might reduce the anxiety and tension that accompanies acute-care hospital experience [23]. Artistic installations can also make a positive contribution to highly-specialised care environments, making them more human and welcoming, providing a framework for thought, feelings and bringing peace of mind (Fig. 34) [31].

Building services spaces such as vertical and horizontal distribution conduits (for energy, fluids, gases, communication, transport and evacuation), service rooms, machine rooms (technical floors at intermediate levels, basements or roofs) are closely linked to circulation spaces as they need to reach any acute-care hospital ward and unit [1]. Rapid technological innovation (transmission and communication), diverse and changing regulations and standards and their short life usefulness (from 20 to 25 years) need to be integrated into the circulation design so that it allows for further modifications (maintenance and upgrading) without compromising functional activity [1]. Their design is even more compromising for future remodulation than the building structure itself [1]. Circulation spaces are fundamental for ensuring future building expansion [1]. The general circulation routes not only determine the general layout of the acute-care hospital but also determine the future expansion of the building [1]. Acute-care hospitals are places built and expanded in phases across a wide period of time [22].

### 2.2.2 Intensive Care Unit

Even though intensive care is no different to medicine itself, the idea to accommodate a specific department within the acute-care hospital for seriously ill patients emerged in the middle of the 20$^{th}$c. The concept of intensive care was of a nursing unit with concentrated care for seriously ill patients under more intense surveillance and treatment conditions [14]. This concept evolved into specialised intensive-care units for specific disease, trauma, or complications of the chronically ill, in order to save the lives of patients that otherwise would die [14, 32].

Previously to the ICU severely ill patients stayed in their beds in the open bay wards and were taken for specialised treatment and then brought back to the ward. At the end of the 19$^{th}$c., these kinds of patients (contagious or moribund) were located into smaller rooms next to the ward rooms, separated from the rest of the less ill patients of the ward, mainly for the good of the healthier ones. The shift from the larger Nightingale type ward (see chapter 2.1.4) towards smaller patient bedrooms (with four to eight patients) developed during the beginning of the 20$^{th}$c., together with the development of surgical procedures, required a higher need of nursing knowledge in special care. As the number of specialised nurses was insufficient, staff started to arrange patients with similar illnesses and care needs into room clusters to be cared for by specially trained nurses [14].

Postoperative recovery care and cardiac care were the medical specialities that promoted the consolidation of the ICU concept [14]. Postoperative or postanaesthetic special-care units emerged between World Wars I and II. This unit became the ICU for surgical patients. The first ICU designed was very similar to the post-anaesthetic care room: large open rooms with bed areas separated by curtains (to promote visual control and patient accessibility in emergency situations). However, patients in the ICU needed longer lengths of stay which increased the risk of cross-infection. Open rooms were inadequate also for providing patient privacy and resulted in the shared usage of equipment between different patients [33]. All these factors contributed to the design conversion into individual rooms. At the end of the 20thc., there was a tendency to separate surgical intensive care from postoperative care. In contrast to post-anaesthetic recovery units where patients were highly sedated and stayed for only a few hours, the patients in the ICU had the longest length of stay in all the acute-care hospital and could be conscious. Staff movement was also impeded by curtains and it favoured cross-infection. Hence, control over environmental factors such as noise, temperature or privacy became more important and could only be achieved by a new design based on individual rooms or boxes [34, 35].

ICU design has been determined by clinical progress, technological development of clinical equipment and the evidence of the effect of environmental factors on patient recovery process [36]. Studies have shown the importance of the relative location of the staff communication base to guarantee the safety and control of patients [37]; the importance of natural light for the patients' circadian rhythm [38]; the location of hand basins to promote hand hygiene [39]; the influence of noise levels on the patients' rest and recovery; the support rooms needed for the relatives' comfort [40]; and the therapeutic gardens to reduce relatives' stress and anxiety levels [41]. The current ICU tendency is to encourage the presence of relatives for psychological and emotional support of the patient, which increases the need of floor area per patient. Moreover, the mortality rate of an ICU is the highest in the whole acute-care hospital and the relative's engagement in palliative care needs to be promoted by the unit design [42].

An ICU in an acute-care hospital is linked to several health-related services (emergency department, operating theatre, diagnostic imaging, functional assessments, pharmacy, laboratory, rehabilitation and standard wards) as well as support services (linen, cleaning, maintenance, kitchen) [33]. According to the patient types and the healthcare services provided by the acute-care hospital, the ICU could be classified as [43]: medical surgical (including coronary); medical surgical (without coronary); medical (general, respiratory, digestive, hepatic or others); surgical (general, cardiac, transplants or others); coronary; neurocritical; traumatology; burns; paediatric; neonatal (see chapter 2.2.6); and others.

The provision of acute medical and surgical beds for the ICU has risen from a conventional 3 to 5% of the total number of acute-care hospital beds [14] to 10% for an acute-care hospital of reference [44]. Even though the optimal percentage needs to be tailored to the acute-care hospital population and healthcare offer, this increasing tendency responds to a higher demand of acute care (due to clinical advances, an ever-elderly population, and the increase in comorbidity patients) [45, 46]. Additionally, particular situations such as Influenzavirus A (in 2009) or the pandemic by COVID-19 (from 2020 and ongoing) produce an urgent need to increase the capacity to attend critically ill patients. These seasonal needs manifest the higher complexity of effective planning and management of one of the most expensive acute-care hospital resources [47]. However complicated, preparedness for emergencies could improve the healthcare response to the increasing outbreaks of infectious diseases [48].

### 2.2.3 Standard Ward

In-patient accommodation has historically been the core of the hospital [49]. The ward was the place where sick or poor people were put together in a common room for receiving the care of nurses (see chapter 2.1.3). The ward design followed the evolving clinical needs as well as the patients' demands (safety, privacy and comfort). While the initial open room was used for all patients and basic treatments (Fig. 35), there emerged the need for additional support rooms that started to configurate a more complex layout arrangement for locating specific functions in specific rooms of the ward (Fig. 36). This progressive evolution in room specialisation was also linked to the separation of patients by gender, pathology and age. As the ward was the core of the hospital, the number of beds was the variable that determined the size of it.

*Fig. 35 View of the open ward. Hôtel-Dieu Paris. Figure by [12].*

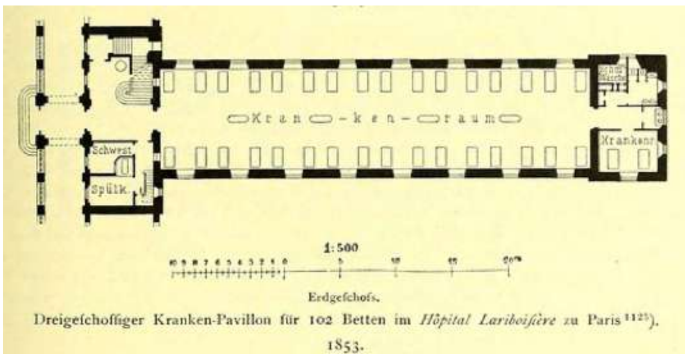



*Fig. 36 In-patient ward at Hôpital Lariboisière Paris by architect Gauthier in 1853. Figure by [51].*

However, since the 20$^{th}$c., ward size in relationship to the whole hospital, and in consequence the number of in-patient beds, has been reduced due to technological advances in treatment and diagnosis, changes in treatment methods, the growth of out-patient treatment, the increase in day-stay surgery, public health measures, changes in nutrition, and preventive medicine [14]. Simultaneously, there has been an increase in the demand for special-care facilities as more and more acutely ill patients can now be treated. This may prolong their lifespan and in turn older patients are increasingly being admitted to acute-care hospitals [50].

Despite the global tendency towards shorter lengths of acute-care hospital-stay and the reduction in the number of beds, in-patient accommodation still accounts for a large amount of the floor area in an acute-care hospital [49]. Due to the shift towards individual in-patient bedrooms and the space requirements for sanitary facilities (to be used independently or with staff assistance) the floor area dedicated per bed has increased [49]. Hence it has been important to research the most cost-effective layouts with efficient circulation patterns (Fig. 37) [52].

The functional relationships of the in-patient ward are key to ensure flexibility and health care process efficiency. The departmental relationship mainly depends on the vertical and horizontal transportation strategy. Ward flexibility relies on its design capacity to cope with the different user demands over time [44]. Several specialities may require adjustments to the standard ward design, such as cardiac (space for telemetry monitoring), neurosurgery, respiratory units (isolation rooms with anterooms), infectious disease, orthopaedic (additional space for bathrooms and storage) or oncology (isolation rooms) [53].

As length of stay will be further reduced, in-patient wards might play a subsidiary role in the acute-care hospital, or even be externalised with the use of patient hotels, and the diagnostic and treatment departments might become the fundamental part of the acute-care hospital.

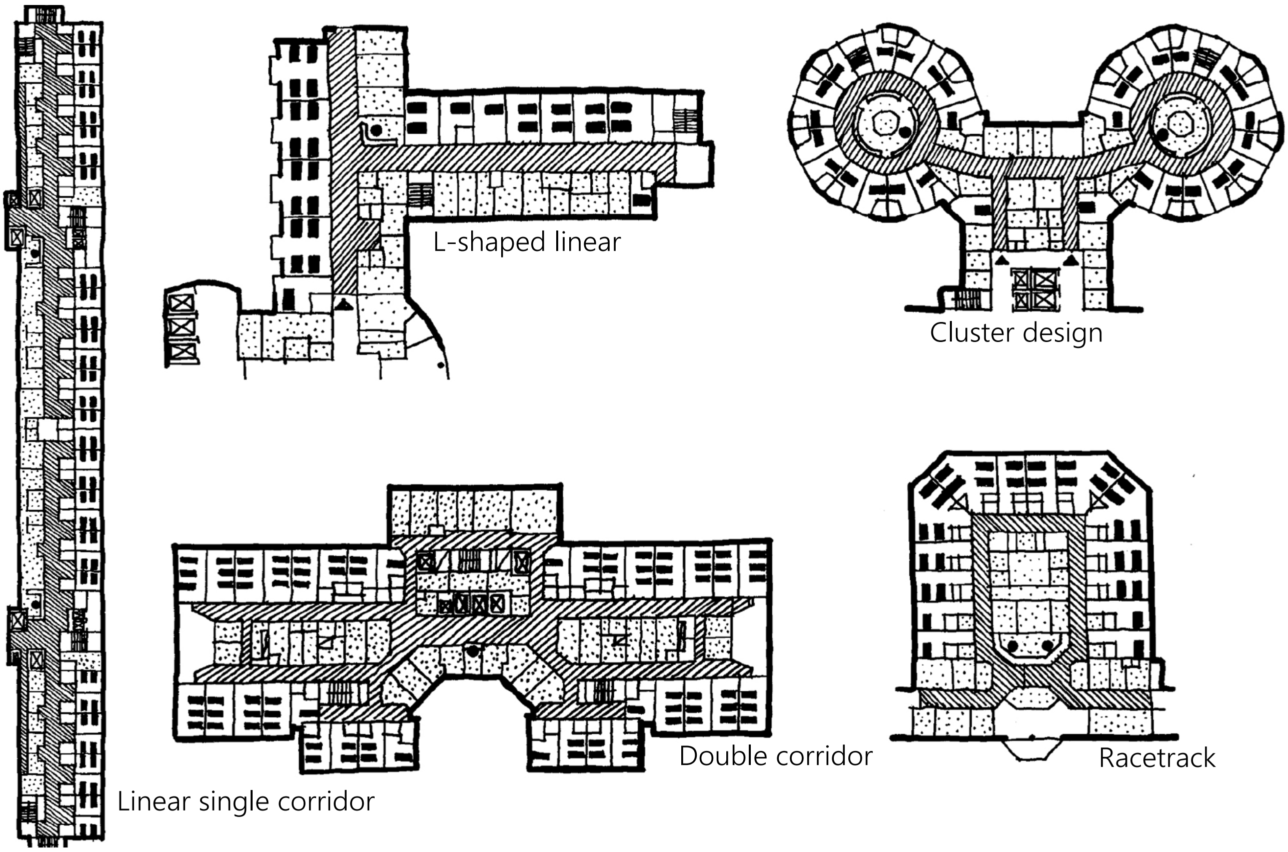



*Fig. 37 Ward layout typology [52].*

### 2.2.4 Obstetric Ward

The inclusion of the labour ward into the hospital (see chapter 2.2.7) resulted in the progressive specialisation of a standard ward (see chapter 2.2.3) for mothers into an obstetric ward.

After the shift of labour from home to the hospitals, the process became more and more medicalised (see chapter 2.2.7). Mothers were unable to freely move during the dilatation phase and had to take a passive and immobile role. This stiffness emphasized the need for pain control and analgesia started to be widely used [54]. However, the analgesic doses were so powerful that when the babies were born, mothers were unable to take care of them. Hence, both mother and baby were supervised by healthcare staff. This fact produced a separation pattern in which mother and babies were treated in separate places (the bedroom for mothers and the nest room for babies). This separation resulted in artificial feeding of babies according to strict schedules.

However, scientific progress has shown the benefits of babies co-sleeping with their mothers in terms of sleep quality for both, breastfeeding rates, and bonding [55]. Thus, nowadays the obstetric ward does not differ much from the standard ward (see chapter 2.2.3) but for some rooms for specific needs of mothers.

In Spain, mothers stay in the labour ward (see chapter 2.2.7) for the immediate recovery just after delivery (about two hours) and then the healthy baby with the mother are moved to the obstetric ward. The standard length of stay in the obstetric ward after a vaginal birth is 48h and 72h after a caesarean section [56].

### 2.2.5 Paediatric Ward

The paediatric ward is very similar to the standard ward (see chapter 2.2.3) but for several rooms needed for the specific needs of children and their families. Current research focuses on: the impact on social support of the usage of single occupancy rooms rather than multibed accommodation [57]; the symbolic experiences of children in non-medical spaces of the acute-care hospital such as atriums [58]; colour preferences and cultural implications [59]; impact of positive distractions on children's activities in waiting areas [60,61]; barriers in the use of healing gardens [62]; and multisensory stress reduction among others [63].

### 2.2.6 Neonatal Ward

Through history, the natural environment of a newborn infant had always been the family. Until the 19$^{th}$c. babies were born at home, thanks to their mothers' effort and the occasional help of a relative. Mothers did not receive any health care while giving birth. Consequently, the maternal and child mortality rates were very high, mainly due to the spread of infection because of inadequate hygiene conditions. Family members had to accept this fact as a part of the natural selection process.

At the end of the 19$^{th}$c. the technological advances brought about by the industrial revolution, enabled the invention of the incubator. This equipment consisted of a closed chamber that allowed for personalised control of the neonates' environmental conditions. This invention was first displayed by Martin Couney at the 1896 World Exhibition in Berlin. To demonstrate it, premature babies with little chance of survival were presented in the incubators. The exhibit got exceptional attention and from 1903 to 1940s the "Child Hatchery" was showcased in several exhibitions and freak shows around the world, where humans with disabilities were shown for financial gain (Fig. 38) [64]. Despite this ethically questionable procedure, the invention of the incubator was proven to reduce infant mortality, thus it was extensively used during the 20$^{th}$c. Before this invention, it was believed that weak children did not deserve additional care and naturally died. The new paradigm of the incubator, where preterm children could be saved with extra equipment and care, raised the need for neonatal spaces in hospitals. The original design of this new hospital area was a literal copy of the perinatal facilities in the exhibition stalls with the incubators located in lines, one next to the other, for the exclusive care of nurses in an open-bay room (Fig. 39).


*Fig. 38 Entrance to the "Infant incubators with living infants" stand. Figure by [65].*

*Fig. 39 Nurses caring for preterm infants during the exhibition. Figure by [65].*

In 1961, Dr. Mildred Stahlman successfully tested a miniature of a respirator prototype scaled down for the tiny body of a preterm girl. This combination of the incubator with the ability to monitor vital signs led to the first neonatal intensive care unit (NICU) [66]. As the perinatal medicine speciality evolved, so did the development of sophisticated NICU, offering the maximum medical support to preterm infants. The prevailing thinking of the NICU from the 1960s was that the open-space room allowed for an efficient usage of space, better staff satisfaction while allowing for the isolation of all babies from each other with strict hand-washing measures [67].

The extensive usage of the incubator and technological equipment resulted in the extreme separation of the infant from his or her mother and relatives (Fig. 40). Firstly, while pregnant, the mother was separated from her family members in the hospital and secondly, after giving birth the baby was taken away from the mother and cared exclusively by staff. The strict measures in hospitals limited family participation and promoted artificial feeding of infants.

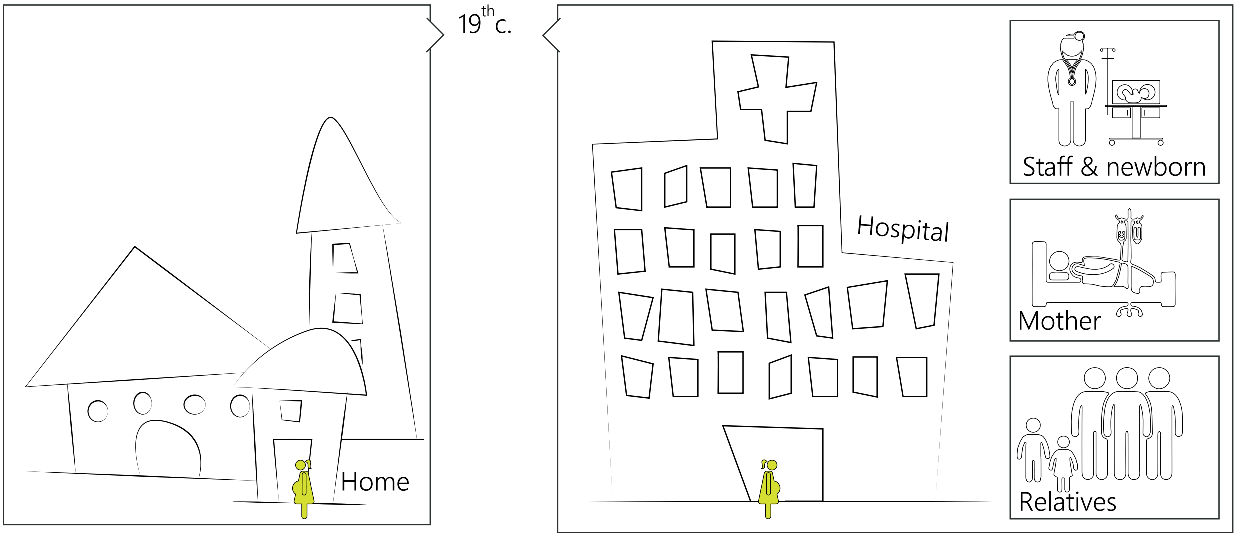



*Fig. 40 Birth process from home to hospital and newborn infant separation.*

Although remaining unquestioned during decades, from the 1970s parental involvement timidly started to become important in the NICU [68]. Even Martin Cooney found that when infants were ready to be discharged from his perinatal facility, parents had lost their parental-infant attachment, and they could not be found [67]. Later studies showed that parental presence and involvement was key to promote the parental-infant attachment and hence the neonatal development [67,69-71]. Parental presence promoted a gradual shift from the open-bay rooms to more separated spaces. From 2000 the Single-Family Room (SFR) has been established as a referent for quality of care [72]. Among the benefits of the SFR, the main ones are: 1) reduction of nosocomial infection [73], 2) control of noise and light levels [74] and 3) major parental involvement.

Several design standards and the European Foundation for the Care of Newborn Infants [75] have included SFR as the optimal design for the units [75-77] and there is a global tendency of NICU from open-bay design to SFR, being the hybrid units an alternative solution to facilitate this transition. The goal of this family-oriented units is to promote a concept shift towards "Neonatal Intensive Parenting Units" [78].

## 2.2.7 Labour Ward

The labour ward in an acute-care hospital is intimately linked to the obstetric ward (see chapter 2.2.4) and the neonatal ward (see chapter 2.2.6).

Until the 16th c. deliveries were a kind of mystery that belonged to feminine wisdom where women with midwifery skills were often accused of witchcraft [54]. Pregnant women were helped by other women during the delivery process. The empirical knowledge was learnt by experience and transmitted through generations. It was in the 16$^{th}$c. when several male doctors started to get interested in obstetrics and the traditional practice was questioned. This transition gradually shifted the domain of female midwives to male doctors. By the 17$^{th}$c. deliveries were assisted by doctors and from the 18$^{th}$c. mothers' reproductivity was a matter of the government and their interest in population increase [54].

From 19$^{th}$c. European hospitals started to include labour wards. However, maternal mortality was very high as doctors attended labouring women just after practising autopsies without adequate hand hygiene [54]. Around the 20$^{th}$c. hygiene measures improved at hospitals and consequently, maternal mortality rates decreased.

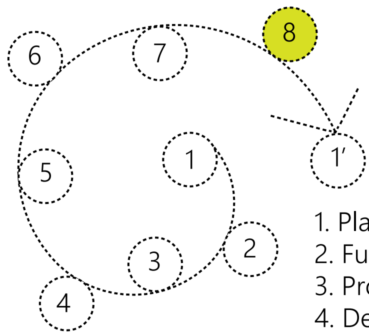
As an example of birth control, particularly in Spain, the Franco regime (1939-1975) had influence on fertility rates [54]. Political, medical and religious institutions promoted natality and banned contraceptive measures. That is why women had an average of 2.77 children in 1975 against the 1.24 in 2019 [79]. Nowadays in Spain, healthcare at birth follows an interventionist institutionalized model, where mothers are attended by medical staff and midwives at acute-care hospitals [56]. Delivery is one of the most frequent causes of admission at Spanish acute-care hospitals [56]. The total number of childbirths in 2018 was 369363 with a 24.64% of caesarean sections [80]. Traditional labour wards in Spain had a sequential model in which the mother was moved during the different stages of the delivery process (dilatation, labour, delivery of the placenta and recovery) [56]. Even though this model was shifted towards a more integrated one with labour-delivery-recovery (LDR) rooms, there are still plenty of labour wards with the outdated configuration. Not surprisingly, the depersonalization of the obstetric care at acute-care hospitals caused an increasing demand for home delivery, which has also led to the spread of alternative birth centres such as out-of-hospital birth centres [14].

As for any mammalian mother, women require a safe, private and secure environment to give birth [81-83]. Design factors of the labour environment might affect the outcomes of giving birth, which will be remembered by women throughout their lives and condition the women's birth decisions for future pregnancies [81,84,85]. A supportive environment where women feel relaxed and empowered impacts positively on the birth process [81, 86]. On the contrary, an unsettling atmosphere might inhibit oxytocin release and interrupt the natural labour process [81]. This might result in an increase in medical intervention, higher rates of synthetic oxytocin usage for augmentation of labour, and elevated percentages of caesarean sections [81-83,86,87]. Nowadays, there is a global concern about the increase in intrapartum intervention rates [88]. Apart from the economic effects of medical intervention during the birth process [89], they have an impact on the health of mother and child both in the short and long term [88]. This increase in interventions should be considered as a multifactorial factor, the built environment being one of them [88].

# 2.3 Post-Occupancy Evaluation

The constant evolution of the acute-care hospital units just analysed (chapter 2.2) and hence of the whole building (chapter 2.1) due to the changes in the healthcare field highlight the need of a dynamic design process for a building that will never be finished [90]. The creation process of an acute-care hospital is highly complex and consumes large amounts of different resources such as workload, time and budget. In order to improve the final building, evaluation mechanisms are being put in place as the last stage of the process (Fig. 41).

Post-occupancy evaluation (POE) is "a process of systematically evaluating the performance of buildings after they have been built and occupied for some time" [91]. It blossomed in the UK in the late 1960s and in the USA in the 1970s [92] and its theoretical fathers were mainly Wolfgang Preiser and Craig Zimring [93]. Environmental assessments are based on the impressions of a place or building of several observers who can be user groups, experts or special groups and it consists of the record of information through walking tours, photos, videos, models, sketches or audios in order to produce an appraisal [94].




1. Planning
2. Functional programme
3. Project tender
4. Design
5. Works tender
6. Construction
7. Occupancy
8. Post-occupancy evaluation

*Fig. 41 A circular production process for acute-care hospitals.*

POE might focus on different domains such as safety, aesthetic quality, satisfaction, health, psychological comfort or efficiency [91]. But it can also be focused on other terms like: technical building performance, function/usability or form/beauty [95]. POE can be arranged as three perspectives of building evaluation: 1) occupants (demands and needs), 2) environmental performance (energy and water efficiency) and 3) economic performance (value and return on investment) [96]. POE has many benefits, among which are considering buildings as laboratories [97] and using them as tools for the learning process of architects, a link between professional practice and architectural research [98]. It also provides a structure or framework for collecting data, tests current guidelines and provides feedback for current and future review processes [93]. Some other benefits but also barriers that hinder POE development are summarised in Tab. 8.

| **Positive** [99, 100] | **Negative** [95, 96, 100,101]: |
|---|---|
| + Provision of feedback to design teams, feedback loop to enhance continuous improvement. | - Long and expensive process excluded from professional curricula and delivery expectations. |
| + Provision of information to support future designs, validation of real needs. | - Fragmented incentives within the procurement and operation processes. |
| + Generation of new knowledge. | - Multidisciplinary, it spans professions. |
| + Clarification of programming issues. | - Potential liability for owners. |
| + Enhancement of practitioner credibility, improved competitive advantage in the marketplace. | - Expensive process. |
| + Enhancement of designer-client relationships. | - Lack of standardisation, lack of agreed and reliable indicators. |
| + Corroboration of the effectiveness of prototypes and innovations, reduce expenses. | - Inconsistencies in data collection and/or data analysis. |
| + Justification of design decisions that helps the selection of alternatives at the design stage. | - Reporting of conclusions in a useful format. |

*Tab. 8 Positive aspects and negative barriers of POE.*

Because of the consolidation of governments as major clients of the healthcare systems, several countries like Norway [102], United Kingdom [103-107], Australia [101] or Canada [108] have included building evaluation into their accountability requirements. Spain has yet to include building evaluation procedures for the healthcare sector, which only timidly appear in a Catalan initiative [109].

In order to assist in the evaluation process, there is a need for usable and valid tools that evaluate the healthcare environment to help designers and users when thinking about building quality [103, 110, 111]. Tools are also needed for managing and combining the knowledge generated by isolated studies in a holistic way [112]. A review on evaluation tools carried out in academic literature in English from 1990 to 2016 found 23 tools [111]. A follow-up study carried out between 2010-2013 found 13 assessment tools [113]. There are several certification tools [114, 115] and also tools to evaluate healthcare environments [116-121] as well as residential or long-term care facilities for older people [122-126]. However, in many cases these tools are not used by actors other than the developers [111]. Another handicap is that they lack the rigour needed to make them scientifically consistent in terms of reliability (inter-rater or interobserver reliability, test-retest reliability, parallel-forms reliability and internal consistency reliability) as well as validity (internal validity, external validity, construct validity and conclusion validity) [111, 127]. These barriers mean that most evaluations focus on measurable quantitative criteria (temperature, energy, air quality), which are useful for scientific research but fail to grasp the intangible aspects of quality [128]. Building evaluation can be manageable if it focuses on a few factors of a big number of buildings. Despite being of less interest for academic research, building evaluation as an empirical field is very useful for gathering lessons learnt, providing useful feedback to some case studies with a deep understanding rather than statistical data with generalizable outcomes [96]. Following are described several evaluation tools and in chapter 4.1 there is the description of the tool CURARQ, created as a result of this thesis.

### 2.3.1 Existing POE Tools

#### BUDSET: Birth Unit Design Spatial Evaluation Tool [129, 130]

- Why?

  To assess and design better birth units that provide optimal childbirth.
- How?

  1. Literature reviews, government documents and reports: "What are the ideal design elements to support optimal childbirth?"
  2. Group and individual interviews: midwives, clinicians, researchers and architects (13 in total).
  3. Expert panel: the research team during a 2-year period.
- What?

  The result was a set of domains and characteristics (design principles) with a list of requirements (Tab.9). The checklist provides a whole score for the birth unit and an average for any domain.
- When?

  For both existing and new units.
- Who?

  The evaluation process consists of a one-hour visit of researchers to collect the data, with informal conversations with staff and field notes.

| Domain | Characteristic | Item |
|---|---|---|
| Fear Cascade | • Space—Arrival<br>• Space—Reception<br>• Sense of domesticity<br>• (...) | *"A small table and chairs placed near the window in the birth room provide both utility and a domestic feel."* |
| Facility | • Birth bath<br>• En suite bathroom facilities | *"Two-sided access to the bath."* |
| Aesthetics | • Colour<br>• Texture<br>• (...) | *"Use of wood or wood like materials in the rooms".* |
| Support | • Food and drink for woman<br>• Accommodation for companions and birth attendants | *"Presence of playroom and/or provisions for the entertainment of additional children."* |

*Tab. 9 Organisation of items at BUDSET tool [129].*

## EVOLVE [131]

- Why?

  To evaluate older people's housing.

- How?

  1. Literature review: academic, standards, guides.
  2. Field trips: recent projects.
  3. Focus groups: people living in housing for elderly and their relatives.
  4. Interviews: architects, housing providers, care scheme managers, staff and commissioners.

- What?

  About 500 items for a single dwelling and 2000 for a housing scheme. Each item scores 1 point (possible answers are yes, no, not in use or not applicable).

- When?

  Both for the design of new schemes (an aid for commissioners, providers and architects) and the evaluation of existing ones (an aid for housing managers, housing providers and academic research).

- Who?

  By architects, commissioners, researchers, housing providers or house buyers.

| File | Characteristic | Place | Domain | Item |
|---|---|---|---|---|
| • Living unit | • Generic | • Layout | • Personal realisation and choice | *"The bathroom is separate from other rooms"* |
| • Communal facilities | • Entrance | • Building element | • Dignity and privacy | |
| • Circulation spaces | • Hall | • Environmental design | • Social support inside building | |
| • Staff facilities | • Lounge | • Services and systems | • (...) | |
| • Scheme site & location | • Kitchen | • Finishes | | |
| | • Double-bed-room | | | |
| | • (...) | | | |

*Tab. 10 Organisation of items at EVOLVE tool [131].*

### Patient Room Design Evaluation Tool [132]

- Why?

  To evaluate how well an acute-care hospital patient room (adult medical-surgical, adult intensive care or maternity care) performs against key evidence-based design elements and healthcare goals.
- How?

  Review of research, site tests, surveys, validation and review by expert advisory council members.
- What?

  Items organized around 23 evidence-based design goals or healthcare outcomes impacted by building design.
- When?

  After construction and occupancy.
- Who?

  By interior designers or an interdisciplinary team.

| Room | Category | EBD Goals | Assessment item | Assessment aid |
|---|---|---|---|---|
| Adult medical-surgical | • Patient safety<br>• Worker Safety & effectiveness<br>• Quality of care & patient experience<br>• Organizational performance | • Provide efficient delivery of care<br>• Improve communication<br>• Improve staff health<br>• Improve job satisfaction | *"There is sufficient illumination for caregivers to provide care around the patient bed."* | Lighting to support patient care activities in the room without disturbing the patient at any time of the day/night. |

*Tab. 11 Organisation of items at Patient Room Design Evaluation tool [133].*

# 2.4 References

## 2.4.1 Tablas



## 2.4.2 Figures

## 2.4.3 Glossary

- Anaesthesia: the use of anaesthetics in medicine (Longman Dictionary of Contemporary English Online). Anaesthetics: a drug that stops you feeling pain (Longman Dictionary of Contemporary English Online).
- Antisepsis: the destruction of germs causing disease (Online Medical Dictionary).
- Asepsis: the prevention of access by infecting organisms to the locus of potential infection (Online Medical Dictionary).
- Augmentation of labour: induced labour: Artificially induced uterine contraction. (Medical Dictionary Online).
- Autopsies: postmortem examination of the body. (Medical Dictionary Online).
- Blood transfusions: the introduction of whole blood or blood component directly into the blood stream (Online Medical Dictionary).
- Caesarean section: extraction of the foetus by means of abdominal hysterotomy. Hysterotomy: an incision in the uterus, performed through either the abdomen or the vagina. (Medical Dictionary Online).
- Cardiac care: a specialty concerned with the nursing care of patients suffering from disorders of the cardiovascular system as well as those identified as at risk for adverse cardiac or vascular events (Online Medical Dictionary).
- Comorbidity: the presence of co-existing or additional diseases with reference to an initial diagnosis or with reference to the index condition that is the subject of study (Online Medical Dictionary).
- Clinical trials: a work that reports on the results of a clinical study in which participants are assigned to receive one or more interventions so that researchers can evaluate the interventions on biomedical or health-related outcomes (Online Medical Dictionary).
- Contraceptive: chemical substances that prevent or reduce the probability of conception. (Medical Dictionary Online).
- Cross-infection: nosocomial infection: any infection which a patient contracts in a health-care institution (Online Medical Dictionary).
- Haemostasis: the process which spontaneously arrests the flow of blood from vessels carrying blood under pressure. It is accomplished by contraction of the vessels, adhesion and aggregation of formed blood elements (Online Medical Dictionary).
- Hatchery: a place for hatching large numbers of eggs, especially fish or chicken eggs. Hatching: to come out of an egg (Cambridge Dictionary Online).
- Heliotherapy: the treatment of disease by exposing the body to sunlight, a therapeutic use of sunbathing (Online Medical Dictionary).
- Intrapartum intervention: all interventions occurring from the onset of labour up to and including the expulsion of the placenta and membranes. Intrapartum interventions include, but are not limited to, the induction of labour, the use of intravenous oxytocin, artificial rupture of the amniotic membranes, epidural anaesthesia, electronic foetal health rate monitoring, episiotomy, caesarean section. [47]
- Leech: a small soft creature that fixes itself to the skin of animals in order to drink their blood (Longman Dictionary of Contemporary English Online).
- Length of stay: the period of confinement of a patient to a hospital or other health facility (Online Medical Dictionary).
- Midwifery: the practice of assisting women in childbirth. (Medical Dictionary Online).
- Midwives: the practice of assisting women in childbirth. (Medical Dictionary Online).
- Mortality rates: all deaths reported in a given population (Online Medical Dictionary).
- Necropsy: the examination of a body after death; autopsy (Dictionary.com).
- Nosocomial: Any infection which a patient contracts in a health-care institution. (Online Medical Dictionary).
- Obstetrics: a medical-surgical specialty concerned with management and care of women during pregnancy, parturition, and the puerperium. (Medical Dictionary Online).

- Occlusive: occluding or tending to occlude. Occlude: to close, shut, or stop up (Dictionary.com).
- Oxytocin: a hormone made in the brain that plays a role in childbirth and lactation by causing muscles to contract in the uterus (womb) and the mammary glands in the breast. (MedicineNet).
- Palliative care: care alleviating symptoms without curing the underlying disease (Online Medical Dictionary).
- Penicillin: a group of antibiotics that contain 6-aminopenicillanic acid with a side chain attached to the 6-amino group (Online Medical Dictionary).
- Perinatal care: the care of women and a foetus or newborn given before, during, and after delivery from the 28th week of gestation through the 7th day after delivery (Online Medical Dictionary).
- Postanaesthetic care: the specialty or practice of nursing in the care of patients in the recovery room following surgery and/or anaesthesia (Online Medical Dictionary).
- Postoperative care: the period of care beginning when the patient is removed from surgery and aimed at meeting the patient's psychological and physical needs directly after surgery (Online Medical Dictionary).
- Preterm: a human infant born before 37 weeks of gestation (Online Medical Dictionary).
- Psychological: related to psychology. Psychology: the science dealing with the study of mental processes and behaviour in man and animals (Online Medical Dictionary).
- Physiological: the functions and properties of living organisms, including both the physical and chemical factors and processes, supporting life in single- or multi-cell organisms from their origin through the progression of life (Online Medical Dictionary).
- Purge: to take a substance that makes your bowels empty (Longman Dictionary of Contemporary English Online).

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# 3. Method

# 3.1 Methodology

The research methodology used is a mixed method (or multi-method) approach with an emphasis on qualitative methods inspired by different references [1-5]. While the goal of qualitative approach is to understand complex topics from personal interactions, perspectives and experiences [6, 7], the quantitative methods allowed me to measure some variables and draw conclusions [8]. In order to fulfil the aim of the study, a four-stage-strategy was designed as indicated in Tab. 1.

| | **Acute-care hospital placement** | **Literature analysis** | **Acute-care hospital visits** | **Acute-care hospital cases** |
|---|---|---|---|---|
| **Approach** | Field. | Theory. | Future. | Present. |
| **Aim** | To explore the evaluation of functional & environmental factors from the user's perspective. | To explore the evaluation of functional & environmental factors from the literature perspective. | To explore the evaluation of functional & environmental factors from the analysis and documentation of best practice designs. | To explore the evaluation of functional & environmental in current acute-care hospitals in Spain. |
| **Research design** | Ethnographic study. | Literature analysis. | Ethnographic study. | Case study. |
| **Measurement tools** | Observation & interviews. | Existing data (content analysis of national standards, design guidelines and papers). | Existing data (architectural layouts) and observation (site visits and photographs). | CURARQ tool, existing data (annual memoranda and architectural layouts), and observation (photographs). |
| **Results** | Acute-care hospital design feedback. Users' scripts. Users' concerns on functional and environmental factors. Content for CURARQ tool. | Framework and content for CURARQ tool. | Analysis of architectural layouts. Commented photographs. Content for CURARQ tool. | Percentages of achievement with CURARQ tool. Online feedback on improvement measures. |

*Tab. 1 Overview of the four stages of the study.*

The research design, which consists of the framework of the research study that organises various components together [9], has consisted in the ethnographic study, the literature analysis, and the case study. The literature analysis allowed for identifying the functional and environmental factors from the academic and institutional field. However, the ethnographic study was appropriate for learning about current working conditions and usage of actual facilities. It was convenient to get an in-depth understanding of the context by focusing on a specific setting and a group of people [10]. Finally, the case study was useful for a deep investigation of several cases using different methods such as, observation, interviews or drawings. Different research measurement tools have been used for data collection at each stage of the work, which are:

- Observation: for the understanding of how people interact with the physical environment [5]. Of the three possible types of observation (causal, systematic, and participant observation [11]), only casual observation was used. This kind of observation is usually useful at the beginning of the study to familiarize the researcher with the setting and to develop the structure and instruments for other techniques (such as interviews or systematic observation). Observation was widely used during the acute-care hospital placement and it was also appropriate during the acute-care hospital visits and the acute-care hospital cases.
- Interview: to examine people's opinions and feelings about complex topics. Allows for a higher rate of participation, more detailed answers and analysis of non-verbal behaviour. Two unstructured interviews were used at the beginning of the study for the development of the final semi-structured interviews. This tool was used exclusively during the acute-care hospital placement to get users perspective.
- Existing data: information from institutional reports, design guidelines, scientific papers, communications, annual memoranda of the acute-care hospital and architectural layouts. Mostly used during the literature stage (written material) but also at the acute-care hospital visits and acute-care hospital cases (graphical material).
- CURARQ tool (see chapter 4.1): developed mainly from the literature analysis for the Spanish context (see chapter 3.3), and also from the acute-care hospital placement (see chapter 3.2) and acute-care hospital visits (see chapter 3.4). It permitted quantitative variables to be added to the qualitative analysis of the acute-care hospital cases. The purpose of this tool is to evaluate existing acute-care hospitals in order to point out improvement measures (Fig. 1).

Next, there is the description of each of the four stages followed.

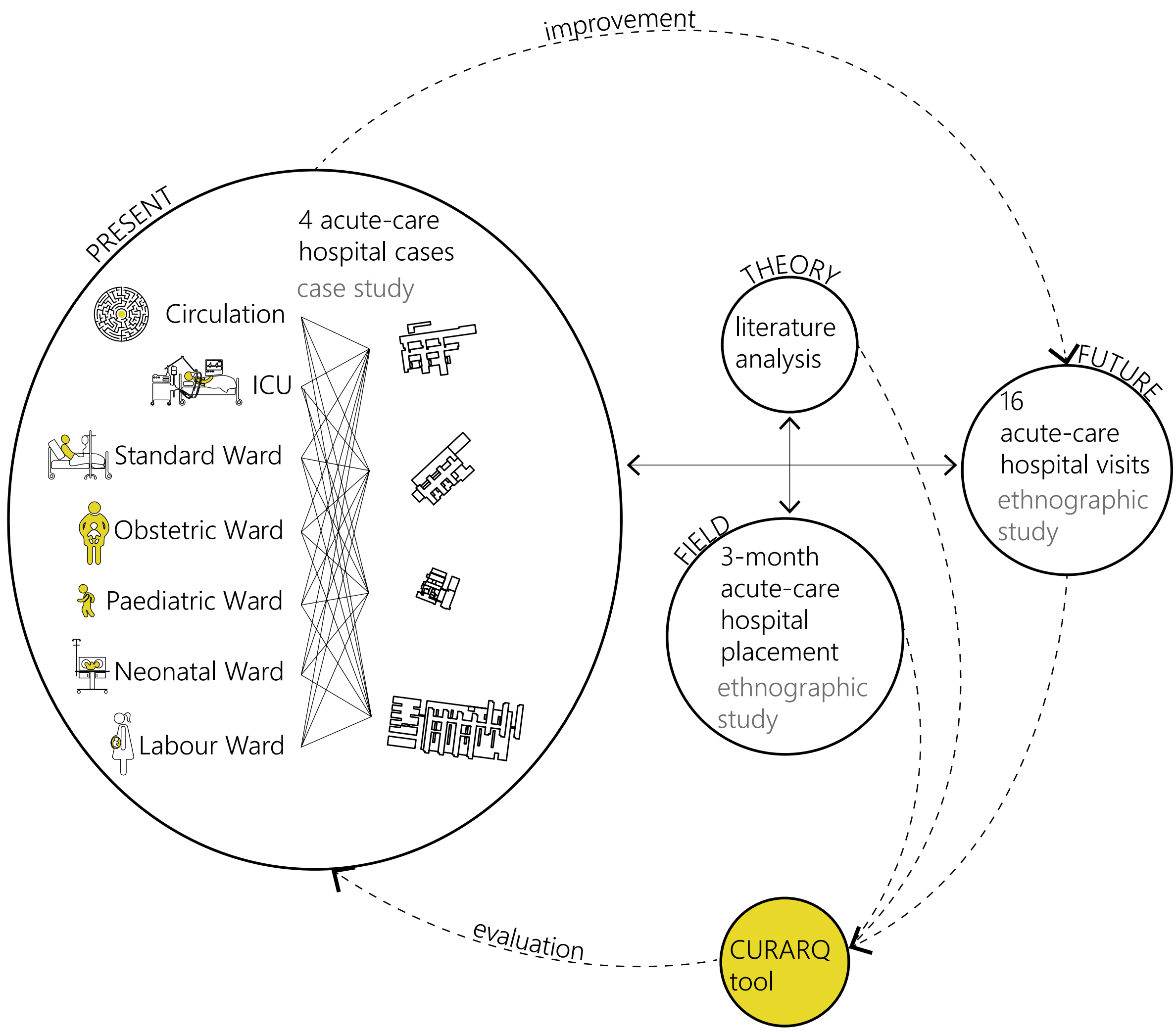



*Fig. 1 Research design overview for each approach.*

# 3.2 Acute-care Hospital Placement

*Fig. 2 Bedroom and office at "Hospital de Dénia".*

According to architect Steen Eiler Rasmussen, architecture is not only an aggregation of plans, sections, and elevations [12]. The author argues that it is through a multisensorial experience that architecture should be analysed and not only by sight. Hence, the best text to learn architecture, is the architecture itself and the multisensorial experience can only be achieved by living in the spaces. This is the reason why a hospital placement was arranged for three months (April-June 2016). Thus, it was possible to live and work in and from the acute-care "Hospital de Dénia" (Fig. 2) (see chapter 3.5.1) thanks to the scholarship "Beca DKV Arte y Salud". The aim of this experience was to explore the functional & environmental factors from the user's perspective. The placement was structured in several phases previously published [13] to optimise the immersive experience.

## 3.2.1 Part 1 preparation (January-March 2016)

"Hospital de Dénia" had an art commission responsible for the promotion of artists' residences and the focus on the links between health and art. Prior to the placement came the analysis and study of graphical material (such as layouts, sections or elevations). Several coordination meetings were held online with the hospital art commissioners and in person with the head of the quality department and the head nurses.

## 3.2.2 Part 2 learning by drawing (April-May 2016)

This part was developed in the hospital (during weekdays). The first tasks included those that involved the least interaction with occupants, i.e., studying the building as a physical object: in-situ observation of the areas to study, analysis of the hospital by preparing graphical material such as functional diagrams, unit diagrams, sketches and pictures.

## 3.2.3 Part 3 learning by talking (May-June 2016)

The final part was also done in the hospital, this time in collaboration with the Hospital Quality Department in order to understand how quality was defined and measured in the hospital and also to agree on interview procedures.

For the interviews, the nodes of interaction between the occupants and the building (such as arriving, entering, storing personal belongings, working, visiting, resting, eating or sleeping) were identified and users were asked to rate their experience on these key points. In total, 28 members of staff and 12 patients or caregivers were interviewed. The interview results were used to describe user daily routines in each unit, user concerns on functional and environmental factors, and for providing specific feedback of the design of "Hospital de Dénia" (see sample in chapter A.4).

- Staff interview:
  · Participants: 28 persons, made up of nurses (n=10), midwives (n=3), assistant nurse (n=1), doctors (n=4), teacher (n=1), and general services specialists (n=9).
  · Eligibility criteria: the nursing supervisor named the most suitable staff for the study according to their interest or availability on the day.
  · Interview type: walking interviews, on the go talks and informal conversations.
  · Interview structure: To ask about their daily routine and the rooms where it takes place. To write and take notes about their experiences with the architectural design.
- Room interview:
  · Participants: 12 interviews with patients (n=5) and caregivers (n=7).
  · Eligibility criteria: patients or caregivers selected by the nursing team who were in a non-critical condition and had been at the acute-care hospital for a long period of time.
  · Interview type: semi-structured interviews arranged by a nurse in the patient's room.
  · Interview structure. Beginning: To knock on the door, to ask for permission to enter. To introduce myself, the project and the goal of the interview. To wash my hands. Development: To ask about the daily routine and the rooms where it takes place. To write about the activities, experiences and expectations of the architectural design at every key point of interference. End: To ask for additional comments or any further information. To sign photograph consent. To take a photograph. To express appreciation. To wash my hands and leave.

# 3.3 Literature Analysis

The literature analysed has been studied both for the historical research (see chapter 2.1 and chapter 2.2) as well as for the content and framework of the tool CURARQ (see chapter 4.1). The main way to proceed for generating CURARQ tool content (see chapter 4.1) was to elaborate a checklist from the Spanish design standards (available for most of the units studied and written by the Ministry of Health) [14] and to incorporate small additions from other sources found online and from the acute-care hospital placement and acute-care hospital visits. When the Spanish guidelines were available, a snowballing approach was used to follow the cited references in the guidelines. When the national guidelines did not exist, as was the case for the circulation spaces for example, I used Scopus database with the following keywords in the title/abstract/keywords: ("environmental factor" OR "environmental element") AND ("circulation" W/16 "hospital"); ("evidence based design") AND ("corridor" W/16 "hospital"); ("evidence based design") AND ("corridor" W/16 "hospital"). Tab. 2 shows the variety of sources and several samples.

| Source type | Sample |
|---|---|
| Technical reports, regulations and guidelines | • Spanish "Standards and Recommendation for Hospital Units" documents written by the "Ministerio de Sanidad, Política Social e Igualdad", in collaboration with "Agencia de Calidad del Sistema Nacional de Salud" and expert groups.<br>• Health Building Notes, Department of Health. United Kingdom.<br>• Australasian Health Facility Guidelines. |
| Existing tools (see chapter 2.3.1) | • BUDSET: Birth Unit Design Spatial Evaluation Tool.<br>• EVOLVE: A tool for evaluating the design of older people's housing.<br>• Patient Room Design Checklist and Evaluation Tool.<br>• PLACE: Patient-Led Assessments of the Care Environment.<br>• PHEQIs: Perceived Hospital Environment Quality Indicators.<br>• ASPECT: A Staff and Patient Environment Calibration Toolkit.<br>• The Environmental Audit Tool. |
| Websites | • The Center for Health Design.<br>• AIA Academy of Architecture for Health.<br>• Hospitecnia. |

*Tab. 2 Source types and samples.*

# 3.4 Acute-care Hospital Visits

Tab. 3 shows a summary of the key information of all the acute-care hospital visited. The selection criteria for these visits were based on expert opinion (according to one of my supervisors for the Spanish hospitals and my Swedish tutor, during my international placement in Gothenburg, for the Swedish hospitals) and in convenience sampling for the Norwegian visit.

| City | Hospital | Area of interest |
|---|---|---|
| Barcelona | "Hospital de la Santa Creu i Sant Pau" | Circulation spaces, out-patient and in-patient areas. |
| | "Hospital Sant Joan de Déu" | Paediatric in-patient wards, labour ward, emergency unit and circulation areas. |
| | "Hospital del Mar" | Circulation spaces, in-patient wards, intensive care units, research building ("Parc de la Recerca"). |
| | "Hospital Sant Joan Despí Moisès Broggi" | Circulation spaces, out-patient department and in-patient wards. |
| Madrid | "Hospital Materno-Infantil 12 de Octubre" | Neonatal Intensive Care Unit. |
| | "Maternidad Gregorio Marañón" | Circulation spaces, paediatric and obstetric in-patient wards, labour ward, neonatal and paediatric intensive care units. |
| | "Hospital Madrid Nuevo Belén" | Labour ward. |
| Oviedo | "Hospital Universitario Central de Asturias" | Circulation spaces, out-patient and in-patient areas, labour ward and intensive care units. |
| Ciudad Real | "Hospital General Universitario de Ciudad Real" | Circulation spaces, out-patient and in-patient areas, labour ward and intensive care units. |
| Göteborg | "Sahlgrenska Universitetssjukhuset" | Bild och interventionscentrum (BOiC), Thorax Intensive Care, Post Operation, In-patient Wards, Cancer Centre Klinik. |
| | "Östra Hospital" | Acute Psychiatry Ward, Intensive Care, Queen Silvia Children's Hospital. |
| | "Angereds Närsjukhus" | Whole building. |
| Malmö | "Skånes Universitetssjukhus" | Intensive Care Unit, Emergency Department, Department of Internal Medicine, Department of Infectious Disease. |
| Linköping | "Universitetssjukhuset i Linköping" | Översikt förlossnigen, Neonatal Intensive Care, Ortopeden Ward. |
| Stockholm | "Nya Karolinska Solna" | Circulation spaces and public areas. |
| Trondheim | St. Olav's Hospital | Mother and Child hospital |

*Tab. 3 Areas of interest in the acute-care hospital visited.*

Next, the basic information of each building is provided. For further information on their healthcare services there are the links to the hospital websites.

## 3.4.1 “Hospital de la Santa Creu i Sant Pau” (HSCSP)

The “Hospital de la Santa Creu i Sant Pau” is located in Barcelona (Spain) and was visited on 09/10/2017 (Fig. 3-Fig. 4). The origins of the hospital date back to 1401 after the unification of six hospitals in Barcelona. Due to growth demands, a new building designed by Lluís Domènech i Montaner was inaugurated in 1930. This building became a referent of the Catalan Art Noveau movement and was declared a World Heritage site by UNESCO in 1997. Later, the acute-care hospital activity was relocated to a new building designed by “Bonell i Gil Arquitectes” and inaugurated in 2009. This acute-care hospital is analysed in chapters 4.2.3, 4.4.3 and 4.6.3.

*Fig. 3 General view HSCSP.*

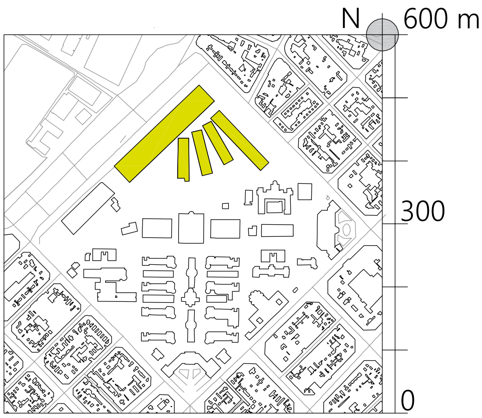



*Fig. 4 Site plan HSCSP.*

## 3.4.2 “Hospital Sant Joan de Déu” (HSJD)

The “Hospital Sant Joan de Déu” is a maternity and children’s acute-care hospital located in Barcelona (Spain) and was visited on 10/10/2017 (Fig. 5-Fig. 6). This acute-care hospital is analysed in chapters 4.5.3, 4.6.3, 4.7.3 and 4.8.3.

*Fig. 5 General view HSJD.*

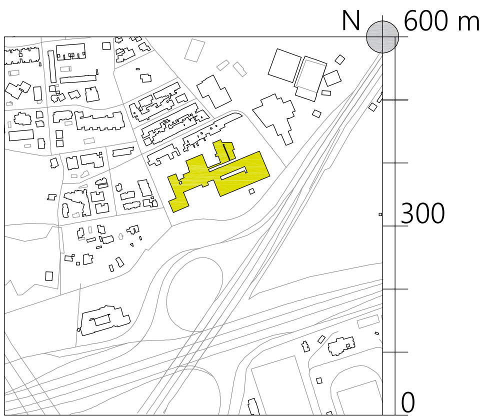



*Fig. 6 Site plan HSJD.*

## 3.4.3 “Hospital del Mar” (HdM)

The “Hospital del Mar” is located on the Barcelona coast (Spain) and was visited on 11/10/2017 (Fig. 7-Fig. 8). The origins of this hospital date back to 1914 when it was created as an infectious disease hospital. In 1929, because of the Universal Exhibition, it was moved to a new pavilion hospital. This building had renovation works carried out during the 60s and main building and urban remodelations for the 1992 Olympic Games with a new out-patient building on the sea front with commercial areas, a new support and technical building, and a new public square for transit from the sea to the acute-care hospital. In 2006 the research institute was created, and the teaching facilities were enlarged. There was an expansion and remodelation project under way to increase its capacity. The design work since the 90s has been carried out by Pinearq. This acute-care hospital is analysed in chapters 4.2.3 and 4.3.3.

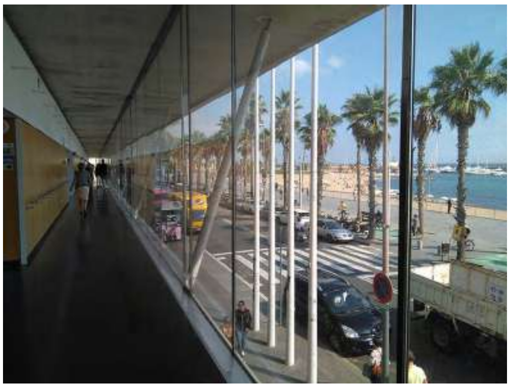


*Fig. 7 General view HdM.*

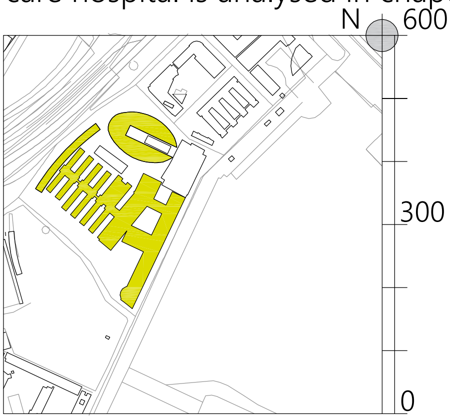



*Fig. 8 Site plan HdM.*

## 3.4.4 “Hospital Sant Joan Despí Moisès Broggi” (HSJDMB)

The “Hospital de Sant Joan Despí Moisès Broggi” is located in Sant Joan Despí, a city 15 km away from Barcelona (Spain) and was visited on 11/10/2017 (Fig. 9-Fig. 10). This new built acute-care hospital was designed by Pinearq with Manuel Brullet and inaugurated in 2010. This acute-care hospital is analysed in chapters 4.2.3 and 4.4.3.

*Fig. 9 General view HSJDMB.*

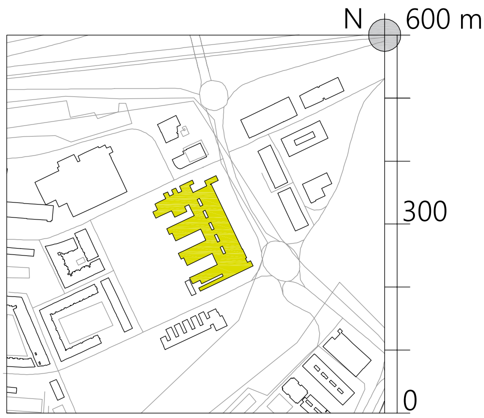



*Fig. 10 Site plan HSJDMB.*

## 3.4.5 "Hospital Materno-Infantil 12 de Octubre" (H12O)

The neonatal unit in the "Hospital Materno-Infantil 12 de Octubre" is located in Madrid and was visited on 30/11/2017 (Fig. 11-Fig. 12). This maternity and child's acute-care hospital belongs to "Hospital Universitario 12 de Octubre" and even though the original hospital dates from 1973 (with its previous name as "Ciudad Sanitaria 1º de Octubre") the building for the maternity acute-care hospital and its neonatal unit were inaugurated in 1980. The unit had renovation works carried out during 2019-20 by EACSN Estudio de Arquitectura. This acute-care hospital is analysed in chapter 4.7.3.

*Fig. 11 Entrance to family rooms in H12O. Figure by [16].*

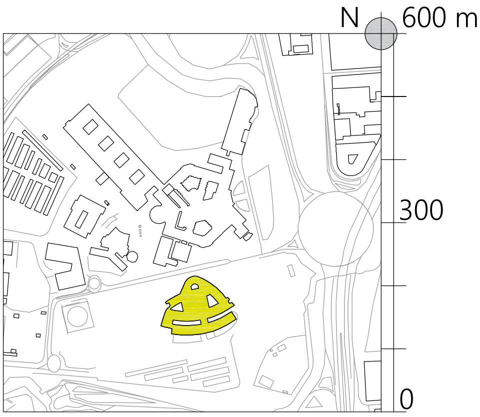



*Fig. 12 Site plan H12O.*

## 3.4.6 "Maternidad Gregorio Marañón" (MGM)

The "Maternidad Gregorio Marañón" is a maternity and children's acute-care hospital located in Madrid (Spain) and was visited on 02/11/2017 (Fig. 13-Fig. 14). This acute-care hospital belongs to "Hospital General Universitario Gregorio Marañón" located in the adjoining plot, with more than 400 years of history. The MGM originated from the merge of a paediatric acute-care hospital and a maternity acute-care hospital all in one building. This new building was designed by José Rafael Moneo Vallés with José María de la Mata Gorostizaga and was inaugurated in 2003. This acute-care hospital is analysed in chapters 4.2.3, 4.5.3, 4.6.3 and 4.8.3.

*Fig. 13 Access view MGM.*

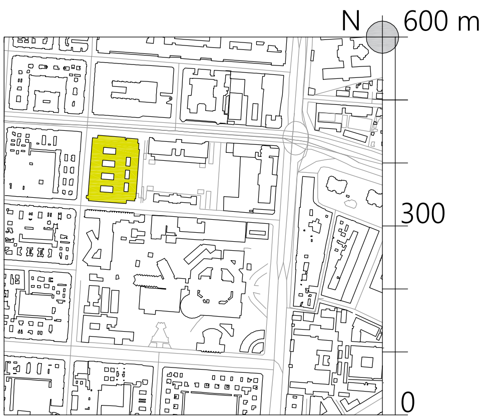



*Fig. 14 Site plan MGM.*

### 3.4.7 "Hospital Madrid Nuevo Belén" (HMNB)

The "Hospital Universitario HM Nuevo Belén" is a private maternity and child acute-care hospital located in Madrid and inaugurated in 2011 (Fig. 15-Fig. 16). The building was visited on 01/07/2019. In 2013 and 2014 some renovation works were carried out in the in-patient ward for its conversion into four labour-delivery-recovery (LDR) rooms to facilitate natural birth. The design was done by Parra - Müller Arquitectura de maternidades. This acute-care hospital is analysed in chapter 4.8.3.

*Fig. 15 View of LDR room by David Frutos. HMNB.*

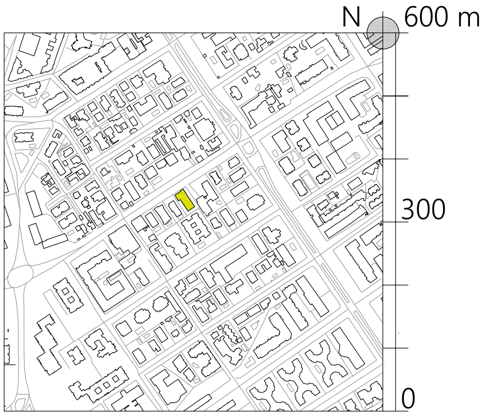



*Fig. 16 Site plan HMNB.*

### 3.4.8 "Hospital Universitario Central de Asturias" (HUCA)

The "Hospital Universitario Central de Asturias" is located in Oviedo (Spain) and was visited on 23/11/2017 (Fig. 17-Fig. 18). This building has its origins in the unification of three pre-existing healthcare facilities: "Hospital Nuestra Señora de Covadonga", the "Instituto Nacional de Silicosis" and, the "Hospital General de Asturias". The new acute-care hospital was inaugurated in 2014 and designed by Juan Navarro Baldeweg with Ángel Fernández Alba. This acute-care hospital is analysed in chapters 4.2.3, 4.4.3, 4.7.3 and 4.8.3.


*Fig. 17 General view HUCA.*


*Fig. 18 Site plan HUCA.*

## 3.4.9 "Hospital General Universitario de Ciudad Real" (HGUCR)

The "Hospital General Universitario de Ciudad Real" is located in Ciudad Real, 200 km away from Madrid (Spain) and was visited on 20/02/2018 (Fig. 19-Fig. 20). This newly built acute-care hospital was inaugurated in 2005 and designed by Ángel Fernández Alba with Soledad del Pino Iglesias. This acute-care hospital is analysed in chapters 4.2.3, 4.3.3, and 4.7.3.

*Fig. 19 General view HGUCR.*


*Fig. 20 Site plan HGUCR.*

## 3.4.10 "Sahlgrenska Universitetssjukhuset" (SAHLH)

Sahlgrenska Hospital is located in Gothenburg (Sweden) and was visited several times in April and May 2018 (Fig. 21-Fig. 22). This acute-care hospital belongs to "Sahlgrenska Universitetssjukhuset" or Sahlgrenska University Hospital together with several acute-care hospitals located in the Gothenburg region: Östra Hospital, Mölndal Hospital and Högsbo Hospital. The foundation of Sahlgrenska Hospital dates from the end of 1700 but its relocation to the current site was done in 1900. Since then, there has been considerable renovation work. The buildings considered in this thesis were designed by Pyramiden Arkitekter ("Bild och interventionscentrum" BOiC and "Intensivvard") and FO Arkitektkontor (Cancer Centre Klinik and in-patient ward). This acute-care hospital is analysed in chapters 4.2.3, 4.3.3, and 4.4.3.

*Fig. 21 Terrace for patients at the cancer clinic. SAHLH.*

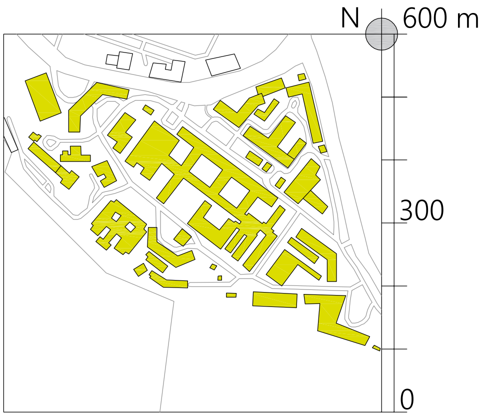



*Fig. 22 Site plan SAHLH.*

## 3.4.11 Östra Hospital (ÖH)

Östra Hospital is located in Gothenburg (Sweden) and was visited several times in May 2018 (Fig. 23-Fig. 24). This acute-care hospital belongs to "Sahlgrenska Universitetssjukhuset" or Sahlgrenska University Hospital together with several other hospitals located in the Gothenburg region: Sahlgrenska Hospital, Mölndal Hospital and Högsbo Hospital. The origin of this multiblock hospital dates back to 1965. Since then, several buildings have been built, upgraded or adapted to cope with healthcare needs. The departmental buildings visited were Psychiatric Ward (inaugurated in 2009 by White Arkitekter) and Queen Silvia's Hospital for Children and Young People (under construction during the visit and designed by White Arkitekter). This acute-care hospital is analysed in chapters 4.2.3, 4.3.3, and 4.6.3.

*Fig. 23 Psychiatric ward external view ÖH.*

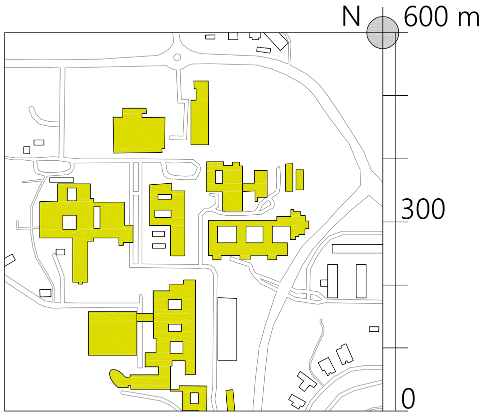



*Fig. 24 Site plan ÖH.*

## 3.4.12 "Angereds Närsjukhus" (AN)

"Angereds Närsjukhus" is located in Gothenburg (Sweden) and was visited on 24/05/2018 (Fig. 25-Fig. 26). The term "Närsjukhus" stands for a healthcare typology that addresses local healthcare needs with a focus on diseases caused by life-style factors. This building provides out-patient services that combine primary and specialist care. The design process considered the participation of key stakeholders with great emphasis on health promotion. The project was developed by SWECO and the building opened in 2015. This acute-care hospital is analysed in chapter 4.2.3.

*Fig. 25 General view AN.*

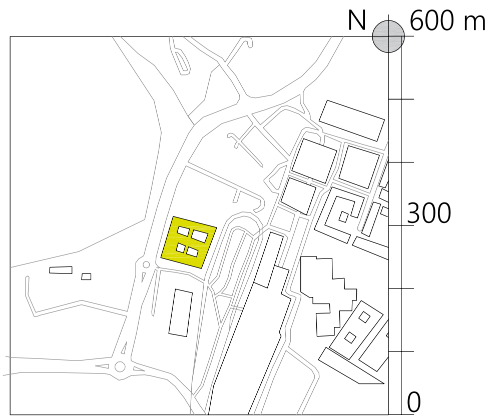



*Fig. 26 Site plan AN.*

### 3.4.13 "Skånes Universitetssjukhus" (SKU)

"Skånes Universitetssjukhus" is located in "Malmö" (Sweden) and was visited on 08/05/2018 (Fig. 27-Fig. 28). This acute-care hospital belongs to Skåne University Hospital together with other acute-care hospitals in "Trelleborg", "Ystad" and "Landskrona". The buildings visited for the object of this thesis were the Intensive Care Unit, Emergency Department, Department of Internal Medicine and the Department of Infectious Disease (inaugurated in 2016 and designed by Tage Møller Arkitektbyrå). This acute-care hospital is analysed in chapters 4.2.3, 4.3.3, and 4.4.3.

Fig. 27 General view SKU.

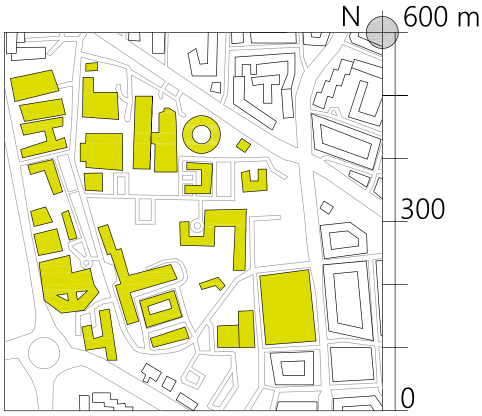



Fig. 28 Site plan SKU.

### 3.4.14 "Universitetssjukhuset i Linköping" (ULKÖ)

Linköping University Hospital  is located in "Linköping" (Sweden) and was visited on 17/04/2018 (Fig. 29-Fig. 30). The whole acute-care hospital is undergoing major rebuilding and new construction work that includes the demolition of obsolete buildings, the renovation of several existing facilities and the construction of new buildings. These works started in 2011 and are planned to be finished in 2024. The building visited was designed by White Arkitekter and inaugurated in 2016. This acute-care hospital is analysed in chapters 4.4.3, 4.7.3, and 4.8.3.

Fig. 29 General View ULKÖ.


Fig. 30 Site plan  ULKÖ.

## 3.4.15 "Nya Karolinska Solna" (NKS)

New Karolinska Solna is located in Stockholm (Sweden) and was visited on 16/05/2018 (Fig. 31-Fig. 32). This acute-care hospital is one of the largest acute-care university hospitals in Europe. Its location next to the "Karolinska Institutet" and other new research building centres and educational facilities constitute a world leading cluster in life sciences. The project for the NKS was developed by White Arkitekter with Tengbom arkitektkontor, and the building opened in 2018. This acute-care hospital is analysed in chapters 4.2.3 and 4.4.3.

*Fig. 31 General view NKS.*


*Fig. 32 Site plan NKS.*

## 3.4.16 St. Olav's Hospital (OLAV)

The Women and Children Center at the University Hospital of St. Olav's is located in Trondheim (Norway) and was visited on 13/06/2019 during the "ARCH19: 4th Conference on Architecture Research Care & Health" (Fig. 33-Fig. 34). The building belongs to a masterplan development of healthcare facilities (Neuro Centre, Gastro Centre, Mobility Centre, Knowledge Centre and the Centre for Pulmonary and Cardiovascular Disease) integrated into the existing urban framework. The aim of the whole acute-care hospital was to transform them from megastructures to friendly villages. The design of this new acute-care hospital was developed by the Nordic Office of Architecture and inaugurated in 2005. This acute-care hospital is analysed in chapter 4.6.3.

*Fig. 33 General view OLAV.*


*Fig. 34 Site plan OLAV.*

# 3.5 Acute-care Hospital Cases

The four study cases of this thesis, chosen by convenience sampling, are located in the "Comunitat Valenciana" region. The next table (Tab. 4) shows information related to the healthcare activity of each acute-care hospital.

| | "Hospital de Dénia" | "Hospital Universitario del Vinalopó" | "Hospital Clínico Universitario de Valencia" | "Hospital Universitari i Politècnic La Fe" |
|---|---|---|---|---|
| Abbreviation | **HD** | **HUV** | **HCUV** | **HUPF** |
| Year of inauguration | 2009 | 2010 | 1960 | 2010 |
| Healthcare Department | "Dénia" | "Elche-Crevillent" | "Valencia-Clínico-Malvarrosa" | "Valencia-La Fe" |
| Population assigned to the department | 166 108 | 154 017 | 341 972 | 281 720 |
| Nº beds | 262 | 230 | 582 | 1 050 |
| Built area ($m^2$) | ±55 000 | ±45 000 | ±80 000 | ±250 000 |
| Bed/$m^2$ ratio | 210 | 196 | 137 | 238 |
| Nº of emergencies | 58 544 | 89 467 | 161 488 | 237 328 |
| Total admissions (both emergency and planned) | 11 908 | 12 846 | 24 105 | 45 109 |
| Average length of stay (days) | 5.54 | 5.09 | 6.39 | 6.48 |
| Total nº of external consultations (first and successive) | 207 668 | 240 761 | 574 215 | 618 050 |
| Successive/first ratio | 1.66 | 2.13 | 2.17 | 2.24 |

*Tab. 4 Healthcare system information for each acute-care hospital.*

In the following pages there is a general description of the case studies both literary and graphically.

## 3.5.1 “Hospital de Dénia” (HD)

Designed by architects Albert de Pineda (Pinearq) and José León Paniagua (supervisor of this doctoral dissertation), this acute-care hospital was inaugurated in 2009 as a public-private concession (Fig. 35-Fig. 39).

Located near the port city of Dénia, with a population of about 40 000 inhabitants that can reach over 200 000 during summer, attracting specially tourists and foreign residents.

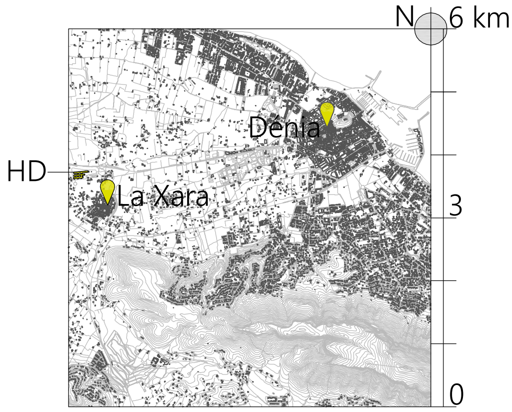



*Fig. 35 HD location.*

The building is placed in its plot to maximise optimal orientation: sunlight exposition and views towards the sea, “Montgó” Natural Park and orange groves.

The volumetric composition consists of three longitudinal bars of low height, crossed by three transversal bars that create internal rectangular courtyards to ensure natural light in both circulation and service rooms.

The main materials used are white concrete for the structural and façade pieces, glass surfaces and wood finishes for sun protection.

*Fig. 36 North façade HD.*

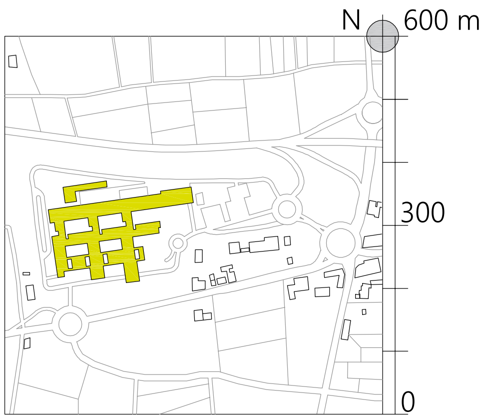
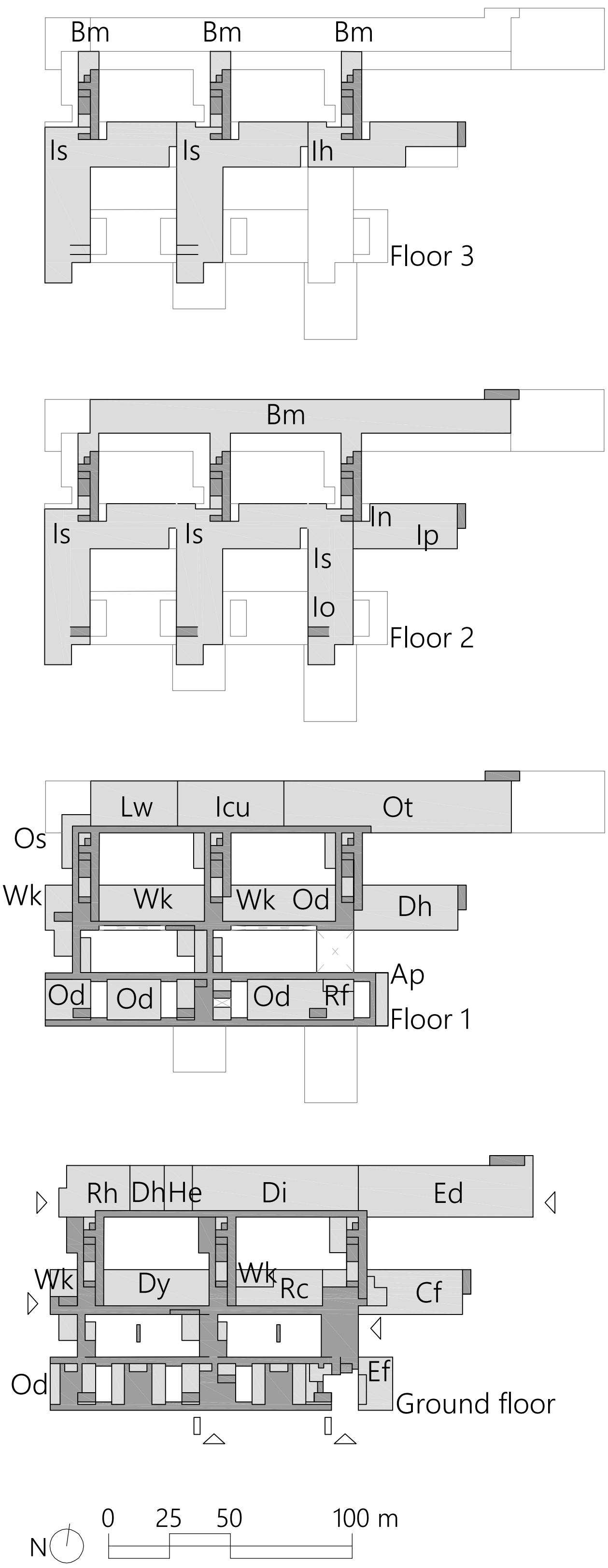
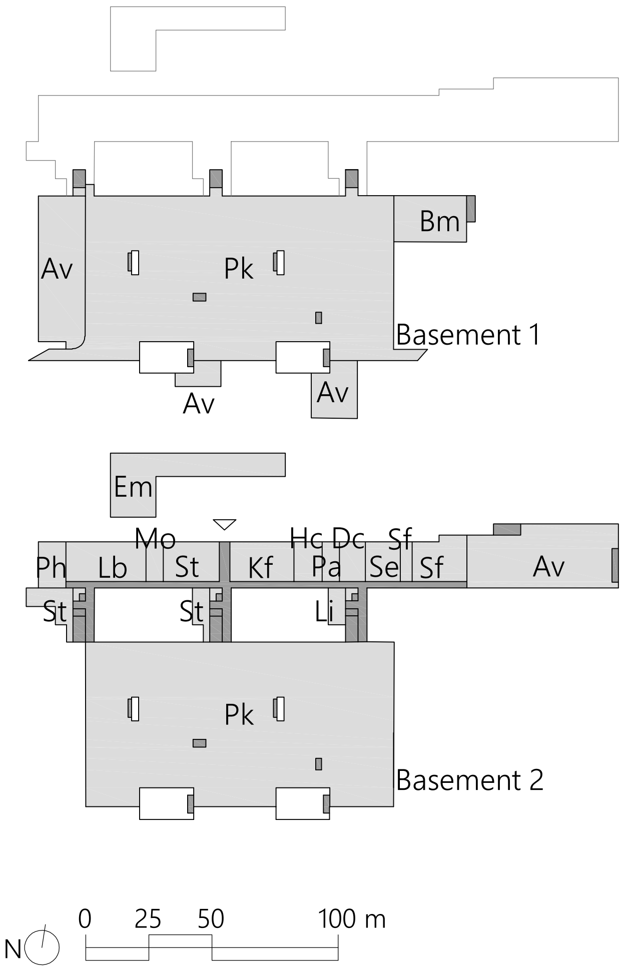



*Fig. 37 Site map HD.*




| | |
|---|---|
| O | Out-patient Area |
| Dh | Day Hospital |
| Od | Out-patient Department |
| Dy | Dialysis |
| Rh | Rehabilitation |
| | |
| I | In-patient Area: |
| Rc | Reception |
| Cf | Cafeteria |
| Icu | Intensive Care Unit |
| Is | Standard Ward |
| Io | Obstetric Ward |
| Ip | Paediatric Ward |
| In | Neonatal Ward |
| Ih | Psychiatry Ward |
| | |
| D | Diagnostic & Treatment Area: |
| Lw | Labour Ward |
| He | Haemodynamic |
| Ed | Emergency Department |
| Di | Diagnostic Imaging |
| Ot | Operating Theatres |
| | |
| T | Teaching & Research Area: |
| Ef | Education Facilities |
| Rf | Research Facilities |
| | |
| S | Logistical & Medical Supply Area: |
| Wk | Workspaces |
| Os | Overnight Stay |
| Ap | Apartments |
| Bm | Building Maintenance |

*Fig. 38 Acute-care hospital departments at HD. Ground floor to third floor.*




| | |
|---|---|
| D | Diagnostic & Treatment Area: |
| Ph | Pharmacy |
| Se | Sterilisation |
| Lb | Laboratory |
| Pa | Pathological Anatomy |
| Mo | Mortuary |
| | |
| S | Logistical & Medical Supply Area: |
| Sf | Staff Facilities |
| Li | Linen |
| Kf | Kitchen, Food |
| Hc | Housekeeping, Cleaning |
| Dc | Data Centre |
| St | Storage |
| Em | Equipment Maintenance |
| Bm | Building Maintenance |
| Pk | Parking Area |
| Av | Available Space |

*Fig. 39 Acute-care hospital departments at HD. Basement 1 and 2.*

### 3.5.2 "Hospital Universitario del Vinalopó" (HUV)

Designed by architects Carlos Ferrán, Fernando Navazo, Luis Herrero and José León Paniagua (supervisor of this doctoral dissertation). The HUV was inaugurated in 2010 as a public-private concession (Fig. 40-Fig. 43).

This acute-care hospital is located in the south-west part of Elche. The city, with a population of 230000, has two healthcare departments Elche- Crevillent (to which this acute-care hospital is assigned) and Elche-Hospital General.

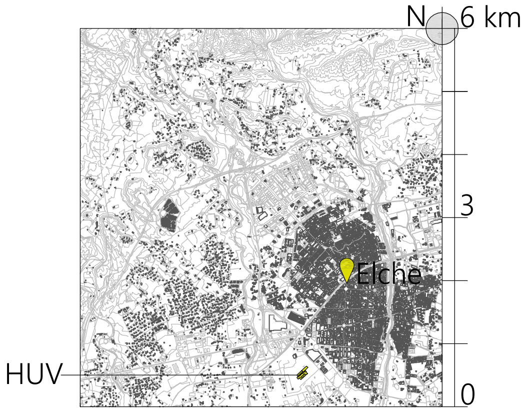
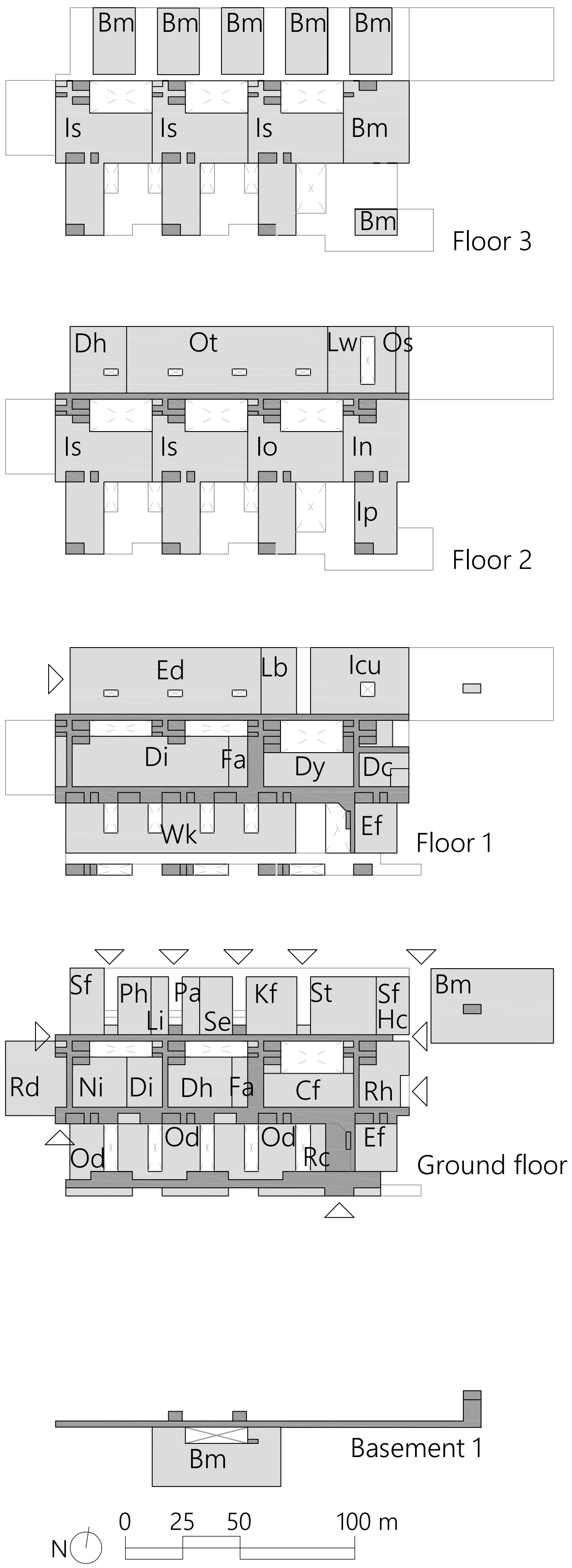



*Fig. 40 HUV location.*

The building is arranged in three longitudinal bars (two of them for diagnosis and treatment services and one for out-patients) and L-shaped in-patient wards.

*Fig. 41 South-east façade HUV.*


*Fig. 42 Site map HUV.*




| | |
|---|---|
| O | Out-patient Area |
| Fa | Functional Assessments |
| Dh | Day Hospital |
| Od | Out-patient Department |
| Dy | Dialysis |
| Rh | Rehabilitation |
| I | In-patient Area: |
| Rc | Reception |
| Cf | Cafeteria |
| Icu | Intensive Care Unit |
| Is | Standard Ward |
| Io | Obstetric Ward |
| Ip | Paediatric Ward |
| In | Neonatal Ward |
| D | Diagnostic & Treatment Area: |
| Lw | Labour Ward |
| Ni | Nuclear Imaging |
| Ed | Emergency Department |
| Rd | Radiotherapy |
| Di | Diagnostic Imaging |
| Ot | Operating Theatres |
| Ph | Pharmacy |
| Se | Sterilisation |
| Lb | Laboratory |
| Pa | Pathological Anatomy |
| T | Teaching & Research Area: |
| Ef | Education Facilities |
| S | Logistical & Medical Supply Area: |
| Wk | Workspaces |
| Ef | Education Facilities |
| Sf | Staff Facilities |
| Os | Overnight Stay |
| Li | Linen |
| Kf | Kitchen, Food |
| Hc | Housekeeping, Cleaning |
| Dc | Data Centre |
| St | Storage |
| Bm | Building Maintenance |

*Fig. 43 Acute-care hospital departments at HUV.*

### 3.5.3 "Hospital Clínico Universitario de Valencia" (HCUV)

The origin of this healthcare institution goes back to 1875 when the hospital was physically and legally linked to the current "Facultad de Medicina y Odontología de la Universitat de València" (Fig. 44-Fig. 49). The hospital was initially built in 1960 and has suffered many transformations such as the ones due to a fire in 1986 and a major remodelation in 1994 [15].

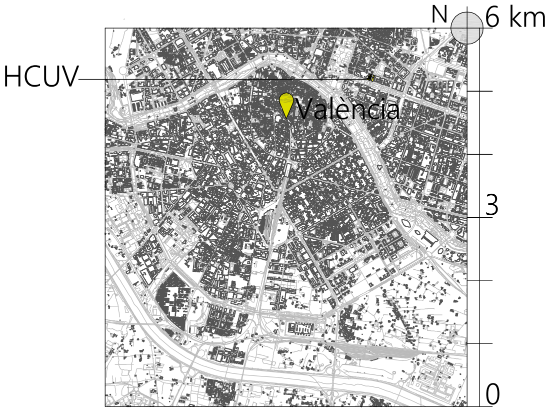



Fig. 44 HCUV location.

It is an urban acute-care hospital in the north-east part of València located over two different blocks separated by a road. The acute-care hospital units are placed in two different buildings linked by two bridges and some rooms of the "Facultad de Medicina y Odontología de la Universitat de València" are also connected at the basement level.

Fig. 45 West façade and main access HCUV.

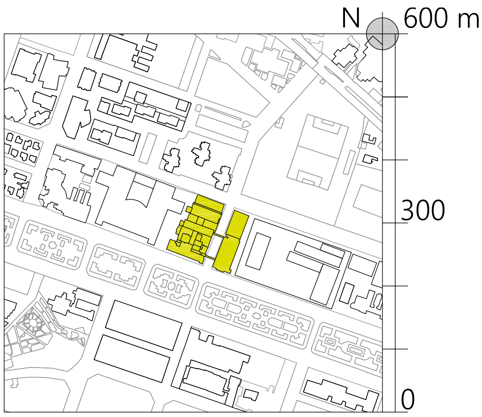
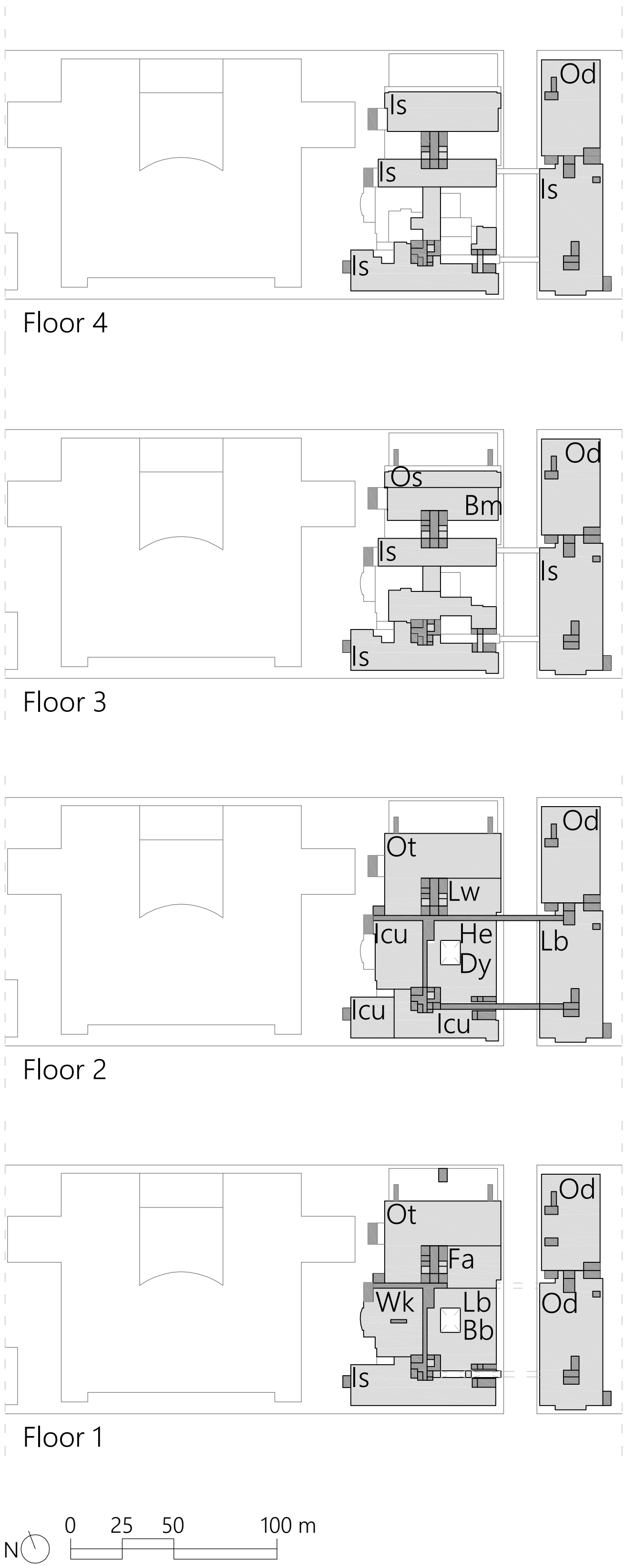



Fig. 46 Site map HCUV.

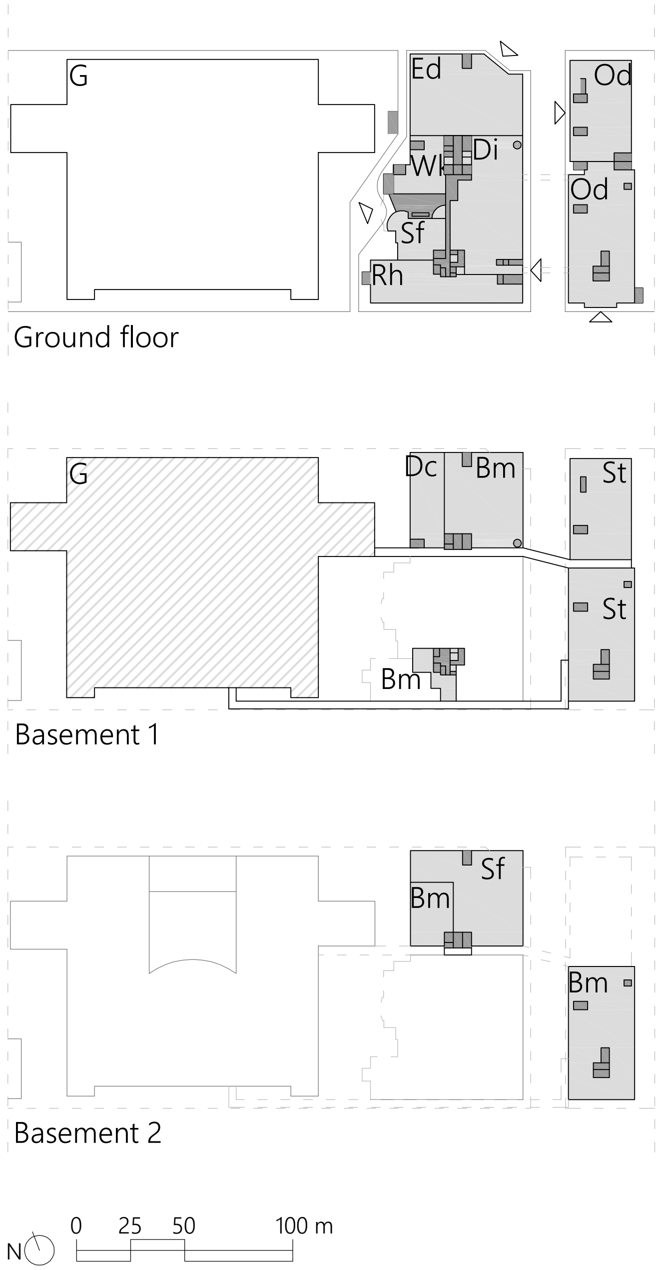

| | |
|---|---|
| O | Out-patient Area |
| Dh | Day Hospital |
| | |
| I | In-patient Area: |
| Icu | Intensive Care Unit |
| Is | Standard Ward |
| Io | Obstetric Ward |
| Ip | Paediatric Ward |
| In | Neonatal Ward |
| Ih | Psychiatry Ward |
| | |
| S | Logistical & Medical Supply Area: |
| Bm | Building Maintenance |

*Fig. 47 Acute-care hospital departments at HCUV. Fifth floor to eight floor.*




| | |
|---|---|
| O | Out-patient Area |
| Fa | Functional Assessment |
| Od | Out-patient Department |
| Dy | Dialysis |
| I | In-patient Area: |
| Icu | Intensive Care Unit |
| Is | Standard Ward |
| D | Diagnostic & Treatment Area: |
| Lw | Labour Ward |
| He | Haemodynamic |
| Ot | Operating Theatres |
| Lb | Laboratory |
| Bb | Blood Bank |
| S | Logistical & Medical Supply Area: |
| Wk | Workspaces |
| Os | Overnight Stay |
| Bm | Building Maintenance |

*Fig. 48 Acute-care hospital departments at HCUV. First floor to fourth floor.*




O Out-patient Area
Od Out-patient Department
Rh Rehabilitation

D Diagnostic & Treatment Area:
Ed Emergency Department
Di Diagnostic Imaging

S Logistical & Medical Supply Area:
Wk Workspaces
Sf Staff Facilities
Dc Data Centre
St Storage
Bm Building Maintenance

*Fig. 49 Acute-care hospital departments at HCUV. Basements and ground floor.*

## 3.5.4 “Hospital Universitari i Politècnic La Fe València” (HUPF)

The origin of this healthcare institution was the “Ciudad Sanitaria de la Seguridad Social la Fe” opened in 1972 located in the north-west part of “València” (Fig. 50- Fig. 55). In 2010, the acute-care hospital moved to a new building in the south of the city designed by architects Alfonso Casares and Ramón Esteve.


*Fig. 50 HUPF location.*

This massive building is arranged as a large basement with six towers, a seventh tower for research and two low-rise blocks for teaching and building services.

The façade is made of prefabricated blocks of white concrete.

*Fig. 51 South façade HUPF.*

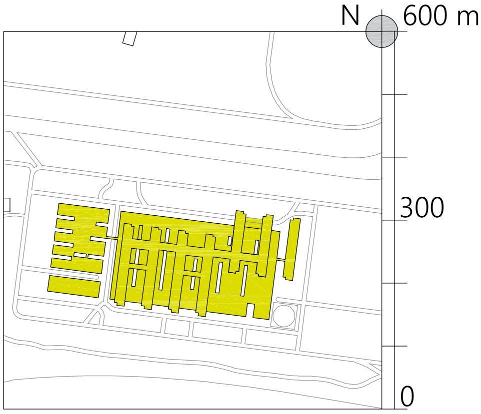



*Fig. 52 Site plan HUPF.*

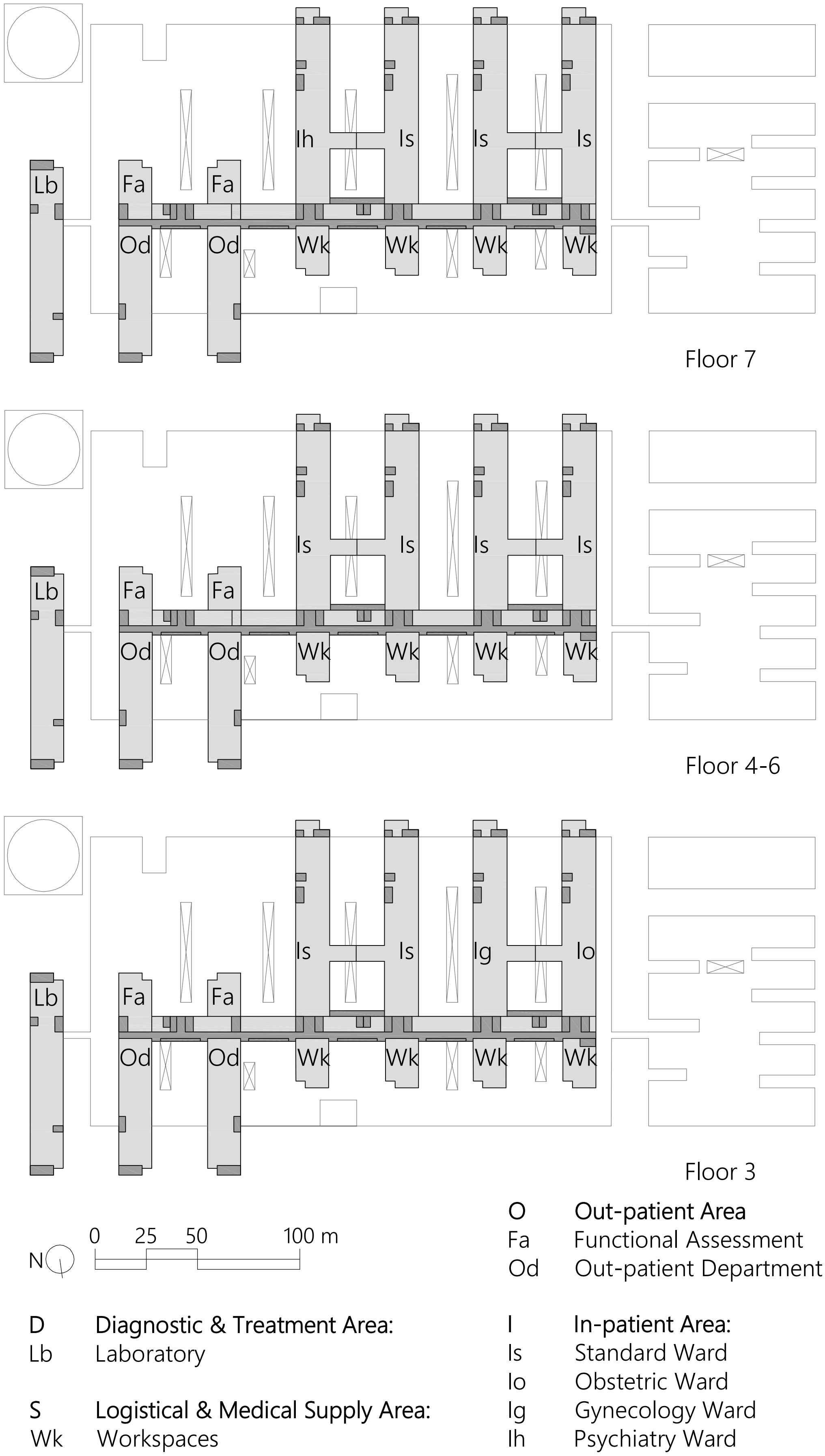
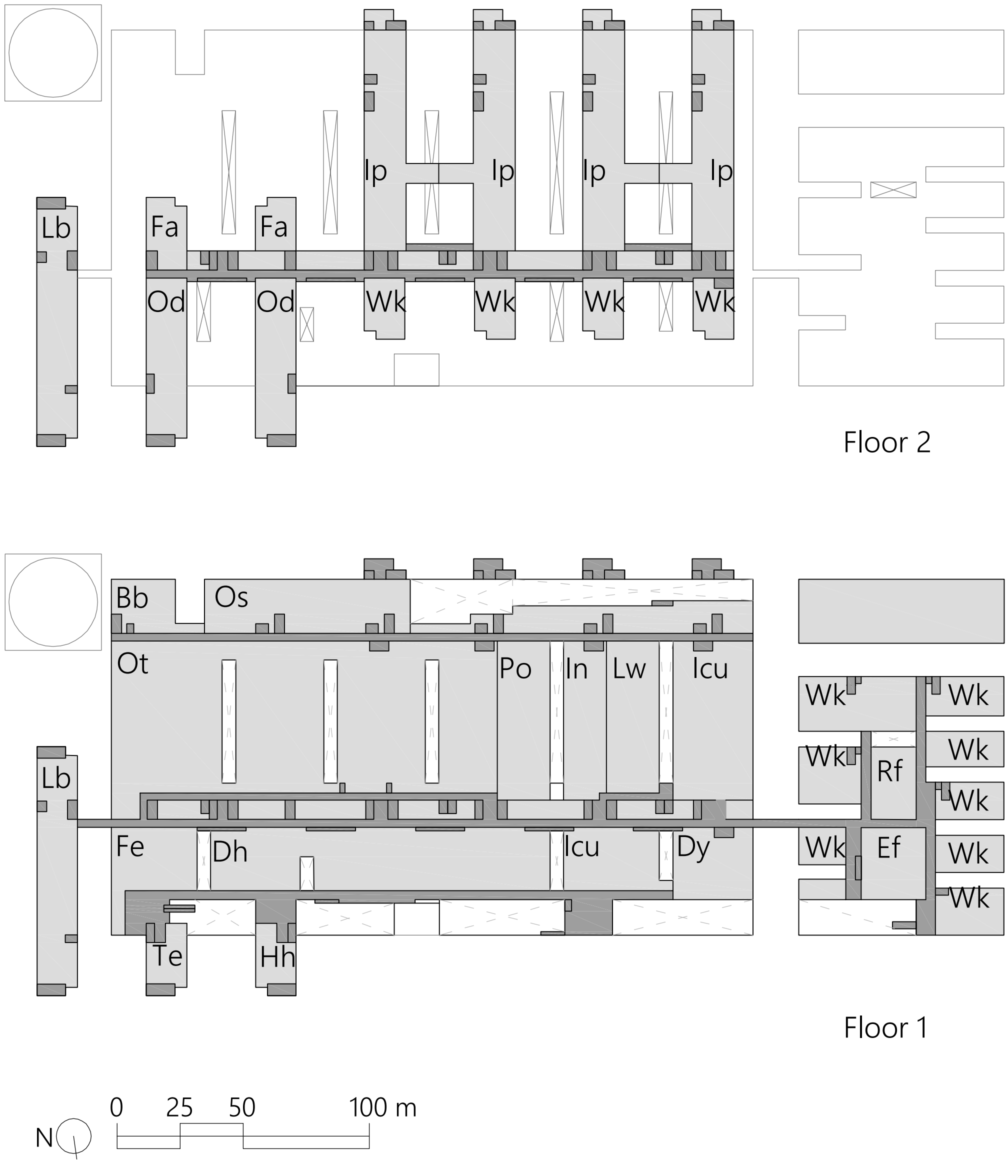



*Fig. 53 Acute-care hospital departments at HUPF. Third to seventh floor.*




O Out-patient Area
Fa Functional Assessment
Dh Day Hospital
Od Out-patient Department
Dy Dialysis
Te Telemedicine
Fe Fertility
Hh Home Hospitalisation

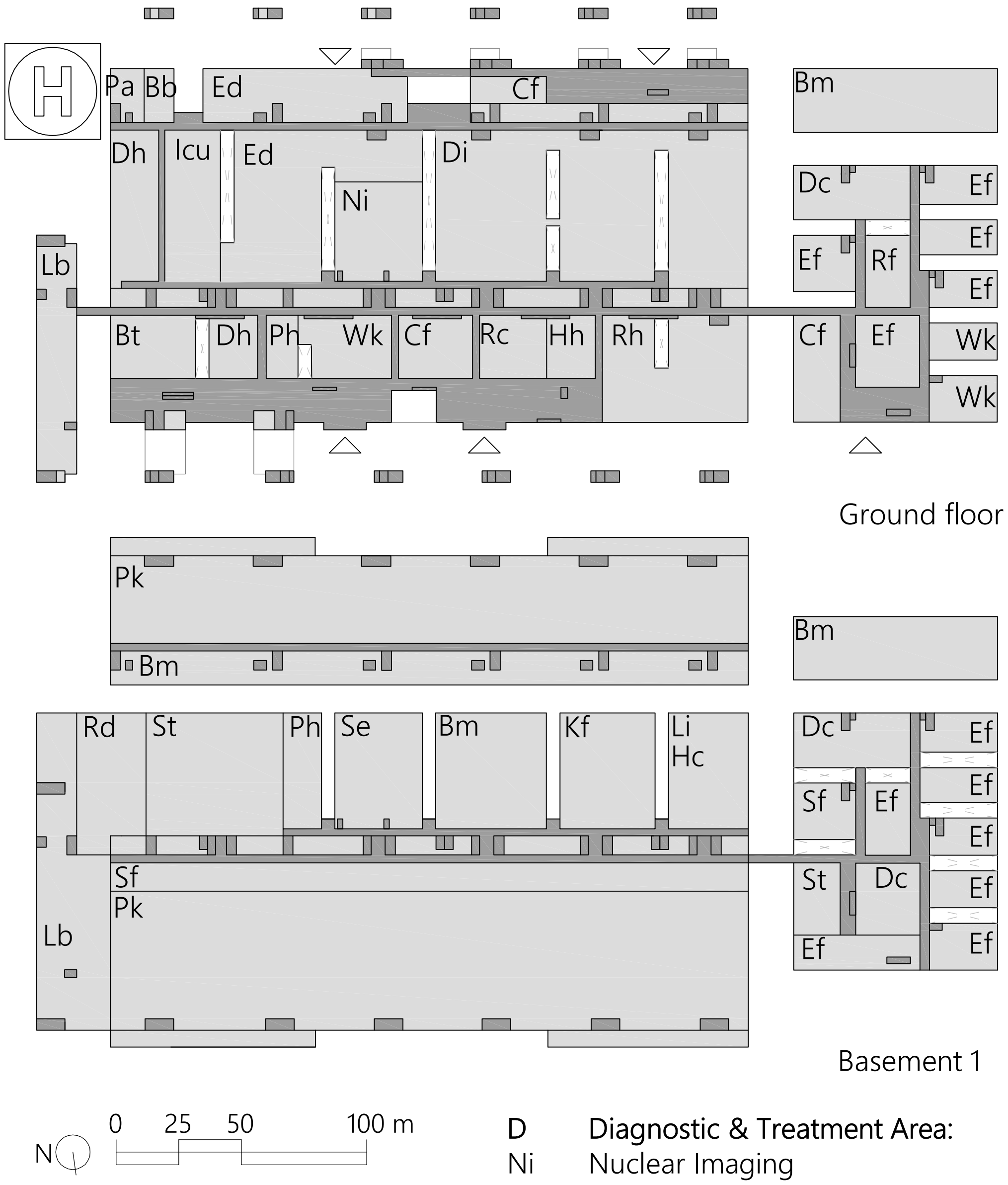
I In-patient Area:
Icu Intensive Care Unit
Ip Paediatric Ward
In Neonatal Ward

D Diagnostic & Treatment Area:
Lw Labour Ward
Ot Operating Theatres
Po Post-anesthesia Care
Lb Laboratory
Bb Blood Bank

T Teaching & Research Area:
Ef Education Facilities
Rf Research Facilities

S Logistical & Medical Supply Area:
Wk Workspaces
Os Overnight Stay

*Fig. 54 Acute-care hospital departments at HUPF. First and second floor.*




| | |
|---|---|
| O | Out-patient Area |
| Bt | Blood Tests |
| Dh | Day Hospital |
| Rh | Rehabilitation |
| Hh | Home Hospitalisation |
| | |
| I | In-patient Area: |
| Rc | Reception |
| Cf | Cafeteria |
| Icu | Intensive Care Unit |
| | |
| T | Teaching & Research Area: |
| Ef | Education Facilities |

| | |
|---|---|
| D | Diagnostic & Treatment Area: |
| Ni | Nuclear Imaging |
| Ed | Emergency Department |
| Rd | Radiotherapy |
| Di | Diagnostic Imaging |
| Ph | Pharmacy |
| Lb | Laboratory |
| Bb | Blood Bank |
| Pa | Pathological Anatomy |
| | |
| S | Logistical & Medical Supply Area: |
| Wk | Workspaces |
| Sf | Staff Facilities |
| Li | Linen |
| Kf | Kitchen, Food |
| Hc | Housekeeping, Cleaning |
| Dc | Data Centre |
| St | Storage |
| Bm | Building Maintenance |
| Pk | Parking Area |

*Fig. 55 Acute-care hospital departments at HUPF. Basement and ground floor.*

# 3.6 References

## 3.6.1 Tables



## 3.6.2 Figures

## 3.6.3 Bibliography

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# 4. Results & Discussion

# 4.1 CURARQ Tool

As shown in Tab.1 of chapter 3.1, CURARQ tool is both a result of this thesis and a measurement tool for the evaluation of acute-care hospital cases (see chapter 3.6). Next, there is the same framework used for the analysis of existing POE tools (see chapter 2.3.1), but now for the description of CURARQ tool.

## 4.1.1 Tool Content

### Why?

For the evaluation of environmental and functional factors in several units of Spanish acute-care hospitals in use. To allow researchers to analyse existing facilities and define improvement measures to align with existing knowledge. The whole acute-care hospital, and consequently, the design of its units is in constant change according to different variables (socio-demographic trends, healthcare systems, technologies, cultural changes, among others). Several documents, like planning guides, norms or recommendations, gathered the scientific evidence and best practice that define the design of the unit. These documents come from diverse healthcare organizations (public and private, scientific or research associations and healthcare services). In Spain the "Estándares y Recomendaciones de unidades clínicas" written by a group of experts and published by the "Ministerio de Sanidad, Consumo y Bienestar Social" includes information from the analysis of a wide group of international and national documents. The tool CURARQ includes mainly the recommendations of these documents and several others. That is why this tool has been written in Spanish and is adapted to the social, economic, and cultural context of the Spanish Healthcare System.

### How?

Literature analysis, three-month acute-care hospital placement and sixteen acute-care hospital study visits.

### What?

There are seven CURARQ Excel files, one for each area of this study:

- CURARQ-Circ: Circulation spaces
- CURARQ-UCI: Intensive Care Unit (Fig. 1)
- CURARQ-H: Standard Ward
- CURARQ-Hobste: Obstetric Ward
- CURARQ-Hpedi: Paediatric Ward
- CURARQ-UNeo: Neonatal Ward
- CURARQ-Pari: Labour Ward

Each file evaluates about 250 items that are aimed at one or more outcomes, taken from the Patient Room Design Evaluation Tool (see chapter 2.3.1), which allows for a detailed classification:

- Patient safety (reduce falls, reduce risk of contamination, improve hand sanitization) e.g.: "El suelo es continuo, las juntas están selladas y no hay cambios de nivel".
- Worker safety & effectiveness (improve job satisfaction, provide efficient delivery of care, improve staff health, improve communication) e.g.: "Equipamiento en columnas de techo o en pared para permitir la circulación completa alrededor de la incubadora".
- Quality of care & patient experience (reduce patient stress and anxiety, improve patient engagement, improve patient satisfaction, improve comfort, respect privacy) e.g.: "Cada cuna o incubadora dispone de dos sillones exclusivos, cómodos y reclinables para los familiares del neonato".
- Organizational performance (ensure durability, enable readiness for changes, enhance sustainability, provide a secure environment) e.g.: "Pared de fácil limpieza, lisa, continua y no porosa. Permite una limpieza agresiva y dispone de protecciones para resistir los impactos ocasionales de carros y equipos portátiles pesados".

To facilitate the evaluation process, the items are organised according to the area studied (circulation, access, patient, staff, nursing, support, or unit configuration as a general category for the unit as a whole), the specific room (such as the corridor, hall, patient bedroom, doctors' office, counter, or dirty utility room) and the design element. Each design element has an associated cost (in a scale from 1 to 5) as it would be more expensive for example to change the layout of a room than simply modify the furniture (Tab. 1):

| Cost | Design element |
|---|---|
| 5 | layout |
| 4 | light openings, installation |
| 3 | equipment, flooring |
| 2 | ceiling, wall, door |
| 1 | furniture, signage or art |

*Tab. 1 Cost category for each design element.*

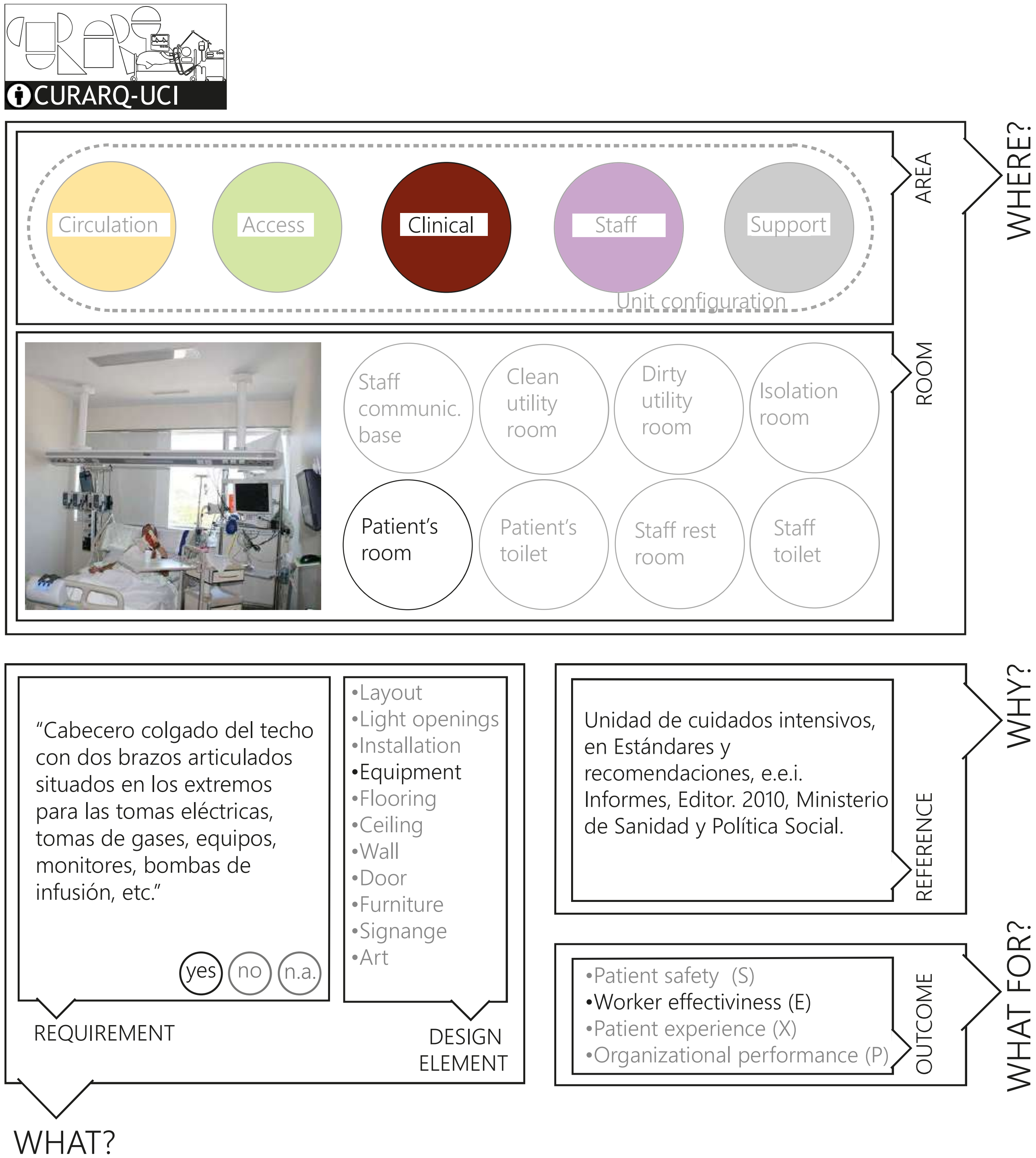



*Fig. 1 CURARQ-UCI content structure.*

## When?

For the post-occupancy evaluation of acute-care hospital units in order to identify the aspects that could be improved and start a diagnostic of the current design stage of the unit and its needs that could lead to a new design.

For the evaluation of new predesigns, to start a discussion about design aspects. In this case, not all items could be answered.

### Who?

By architects or architecture students. It could also be used by acute-care hospital staff as the language used is quite simple.

## 4.1.2 Evaluation Process

### Data collection

- A first email to the medical directors of the acute-care hospitals studied.
- A first meeting with the acute-care hospital representative appointed (medical director, institutional relationships, teaching or infrastructures manager). A short presentation for the introduction of the project.
- Approval from the acute-care hospital and schedule evaluation dates.
- During the evaluation (January-February 2018) the acute-care hospital representative introduced me to the head nurses of each unit studied.
- In each unit, I was introduced to staff, and to the unit through a tour and then I carried out the data collection on paper that lasted approximately two hours.
- I had informal conversations with staff during data collection and took notes about room names and functions as well as photographs.
- For each acute-care hospital, about four days were needed to gather all the data.

### Data analysis

- Data on paper was transcribed to Excel files, in accordance with the following instructions:
  - · A "yes" response when all the item text was met with a 5% allowance for dimensions.
  - · A "no" response when the item was not met with a description of the reason in the comment section.
  - · A "n.a." response that means "not available" or "not applicable" when the item was not available to check or not applicable due to the level of the unit.
- The Excel files were checked by one of the supervisors.
- Graphic material was generated, plans, ward location in the acute-care hospital, identification of the rooms evaluated in each unit in plan and photo.

### Results

- Quantitative results with the CURARQ tool for each room and area:
  - · A "yes" response: points are added to the score and the total points.
  - · A "no" response: points are not added to the score, but they count on the total points.
  - · A "n.a." response: points are neither added to the score nor to the total points.
- Qualitative results to visualise graphically the design strategies found.

## 4.1.3 Discussion

CURARQ tool has been generated from existing information sources that vary according to the unit considered. For example, the items for the standard ward came from the sources shown in Fig. 2:

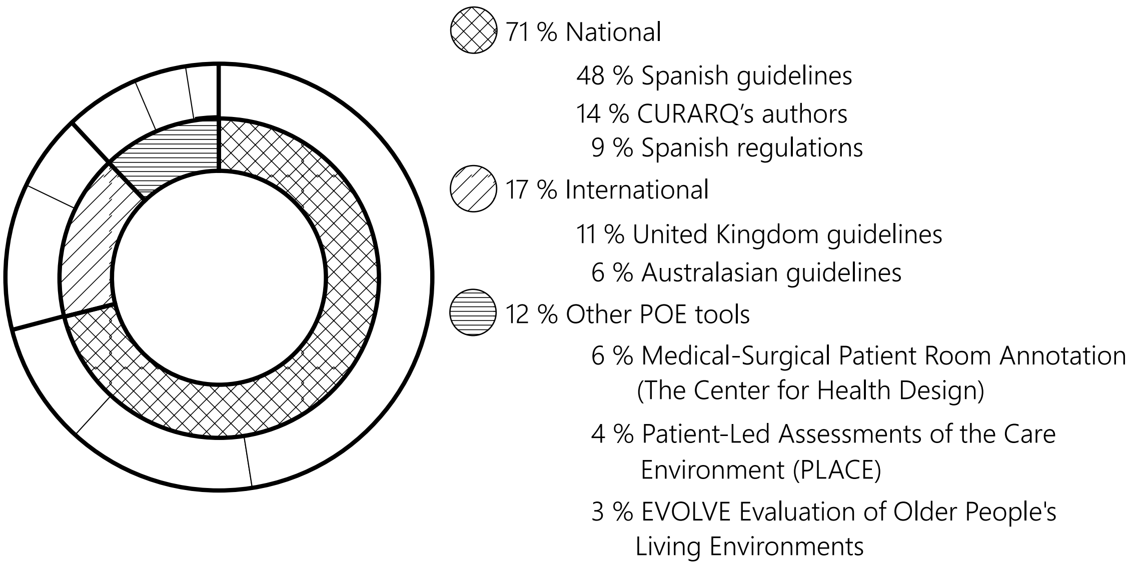



*Fig. 2 Source's type for the standard ward items.*

However, when Spanish guidelines were not available (as is the case for the paediatric ward and circulation spaces), I have reutilised information from guidelines for similar units, international guidelines, and personal knowledge gathered from the acute-care hospital placement and acute-care hospital visits. Spanish guidelines were published around 2010 and some of their content is outdated, which shows the need for updating national guidelines as is done in other countries [1]. The tool item generation was carried out from a review of relevant literature, but also from the three-month acute-care hospital placement and the sixteen acute-care hospital visits. In order to increase its validity, which is related to the credibility of the conclusions, I have described each case, and used data triangulation from the tool results, the architectural layouts and the commented photographs [2]. Additionally, in order to improve its reliability, which is related to the consistency of the method, I have documented each stage of the process and have shared the tool's content online [2, 3]. It would have been very beneficial to validate the framework of the tool by external reviewers [4].

Regarding the tool usability, it depends on the healthcare services provided by the acute-care hospital studied which define the functions and rooms needed in the building. Hence, it was difficult to match the tool's room schedule with all acute-care hospitals. In many cases some ward rooms were in other acute-care hospital areas, for examples on call bedrooms in a staff facilities area instead of in the ward or centralised staff changing rooms. In other cases, there were additional rooms like a room for administrative work in highly complex wards. It was difficult to evaluate the rooms when several functions were combined (e.g. dirty utility room with cleaners' room; mixed storage for material and equipment). It was also relevant to understand the acute-care hospital approach to logistical services and their needed space resources (central kitchen and trolley vs. regeneration kitchen in wards; dirty clothing management and real usage of pneumatic pipes) [5]. Alternative evaluation methods could be used for strengthening the results [6]. It would also be useful to gather additional information from the occupants regarding the real functions of the rooms, the possibilities of combining functions in the same room (due to functional convenience or space limitation) and the floor area needed.

Even though medicine is universal, the social, economic, and cultural context of each country play a major role in determining the final acute-care hospital design. For example, while in Sweden the single-family room in the neonatal ward is the present, in Spain this design is still considered as a future goal. That is why the CURARQ tool is written in Spanish and does not aim to be extrapolated to international contexts. Indeed, this tool can be used for updating the guidelines on healthcare facilities as it is customized to the context of Spanish society [7].

# 4.2 Circulation

## 4.2.1 Acute-care Hospital Placement

From the interviews held with miscellaneous staff (such as porters, barmen or receptionist), at "Hospital de Dénia", the topics that came up were related to the signage system, wayfinding, security, lift size and location, art, natural light, and views (Fig. 3-Fig. 4). Additionally, the following information arose.

*The most frequent movements of porters were the ones that linked:*

- *The ICU with in-patient wards, operating theatres and blood bank.*
- *The labour ward with obstetric ward and emergency access.*
- *The post-anaesthesia unit with in-patient wards.*
- *Within in-patient ward for patient relocation.*

*There was a general acceptance of artistic sculptures and exhibitions in the hospital with some exceptions with not appropriate pieces. Other comments were made regarding the chapel and the lack of intimacy due to the transparency of the walls. The finishing materials of the service/bed lifts were criticized. The corridor width and door width were too narrow in some cases. Other comments had to do with wayfinding problems due to a poor signage system and not enough previous information.*

*Fig. 3 Angry child trying to play with an artistic swing that cannot move. HD.*

*Fig. 4 Detail of water lilies and fish at an outdoor fountain. HD.*

### 4.2.2 Literature Analysis

From the literature analysis, came the organisation of the acute-care hospital areas, user groups, acute-care hospital unit types and the classification of circulation flows as follows:

- Areas:
  - · Out-patient area: out-patient department and public area.
  - · In-patient area: in-patient wards.
  - · Diagnostic and treatment area: of clinical domain, it attends both out-patient and in-patients.
  - · Teaching and research area: education and research facilities.
  - · Logistical and medical supply area: support to the healthcare activity.
- User groups:
  - · Out-patients: patients who are treated in the acute-care hospital during the day (such as out-patient department or day hospital) but sleep at their homes.
  - · Companions: relatives and patient carers.
  - · In-patients: bedridden patients that stay overnight.
  - · Clinical staff: such as doctors, physicians, nurses, midwives, nursing assistants, pharmacists, social workers, speech therapists, dietitians, or physiotherapists.
  - · Non-clinical staff: such as porters, administrative staff, librarians, architects, engineers, technicians, teachers, drivers, telephonists, cleaners or waiters.
- Unit type:
  - · Restricted access units exclusively used by clinical and non-clinical staff (red units in Fig. 5).
  - · Accessible units for clinical and non-clinical staff, in-patients, out-patients and companions (orange units in Fig. 5).
  - · Accessible units for clinical and non-clinical staff, out-patients and companions (green units in Fig. 5).
- Circulation flow:
  - · External circulation for out-patients and companions (green in Fig. 5).
  - · Internal circulation for staff, supplies and in-patients (orange in Fig. 5).
  - · Internal circulation for staff and supplies (red in Fig. 5).
  - · Internal circulation for building services and their maintenance (black in Fig. 5).

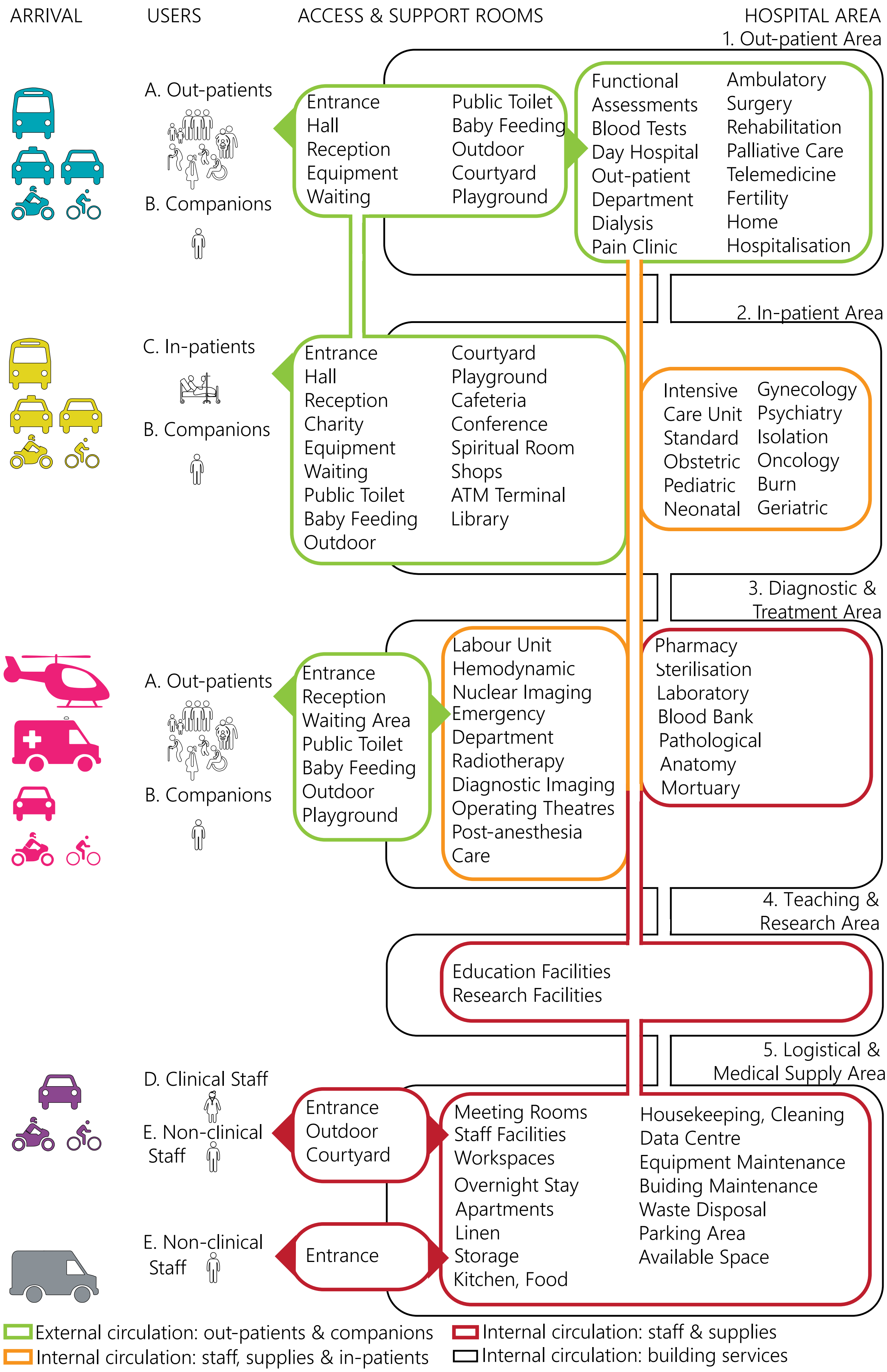



*Fig. 5 Link between acute-care hospital areas and user groups.*

The CURARQ tool framework developed for the evaluation of acute-care hospital cases in Spain, considered an acute-care hospital sample with five accesses (Fig. 5). This preliminary organization of areas and rooms (see Tab. 2) is based on numerous references [8-15], but may vary depending on the healthcare activity and the volumetric arrangement of the whole acute-care hospital evaluated. The following room schedule is not a standard but a representation of the most frequently visited acute-care hospitals in Spain. In addition to this room schedule, all the CURARQ-Circ tool requirements per each room can be read online.

| | Type | Room | Function |
|---|---|---|---|
| Out-patient | Arrival spaces | 1. Car parking area | To park cars. |
| | | 2. Motorbike parking area | To park motorbikes. |
| | | 3. Bike and scooter parking area | To park bikes and electrical scooters. |
| | | 4. Taxi stop | To get in and out of the taxi. |
| | | 5. Public transportation stop | To get on and off the bus or metro. |
| | | 6. Entrance | To enter the out-patient department. |
| | | 7. Hall | To group people from the outdoors into the building. |
| | | 8. Reception and information | To provide basic information and directions. |
| | | 9. Equipment parking area | To park wheelchairs for patient transport. |
| | | 10. Waiting area | To spend time while waiting. |
| | | 11. Public toilet | To empty the body of urine or solid waste. |
| | | 12. Baby feeding and nappy changing room | To breast or bottle feed babies and for nappy changing. |
| | Support spaces | 13. Outdoor | To provide respite and connection with nature. |
| | | 14. Courtyard | To provide an outdoor area within the building. |
| | | 15. Playground area | To entertain children and young people. |

| | | | |
|---|---|---|---|
| In-patient | Arrival spaces | 16. Car parking area | To park cars. |
| | | 17. Motorbike parking area | To park motorbikes. |
| | | 18. Bike and scooter parking area | To park bikes and electrical scooters. |
| | | 19. Taxi stop | To get in and out of the taxi. |
| | | 20. Public transportation stop | To get on and off the bus or metro. |
| | | 21. Entrance | To enter the in-patient department. |
| | | 22. Hall | To group people from the outdoors into the building. |
| | | 23. Reception and information | To provide basic information to programmed in-patients. |
| | | 24. Charity area | To provide space for NGOs to carry out their work at the acute-care hospital. |
| | | 25. Equipment parking area | To park wheelchairs for patient transport. |
| | | 26. Waiting area | To spend time while waiting. |
| | | 27. Public toilet | To empty the body of urine or solid waste. |
| | | 28. Baby feeding and nappy changing room | To breast or bottle feed babies and for nappy changing. |
| | Support spaces | 29. Outdoor | To provide respite and connection with nature. |
| | | 30. Courtyard | To provide an outdoor area within the building. |
| | | 31. Playground area | To entertain children and young people. |
| | | 32. Cafeteria | To offer food and drinks. |
| | | 33. Conference | To allow for scientific meetings or outreach events. |
| | | 34. Spiritual room | To provide a space for meditation and prayer. |
| | | 35. Shops | To allow people to buy miscellaneous items. |
| | | 36. ATM terminal | To withdraw money and do monetary transactions. |
| | | 37. Library | To promote the joy of reading in the acute-care hospital. |

| | | | |
|---|---|---|---|
| Emergency | Arrival spaces | 38. Heliport | To allow the unloading of patients transported by helicopter. |
| | | 39. Ambulance loading area | To allow the unloading of patients transported by ambulance. |
| | | 40. Car parking area | To park cars. |
| | | 41. Motorbike parking area | To park motorbikes. |
| | | 42. Entrance | To enter the emergency department. |
| | | 43. Reception and information | To provide basic information. |
| | | 44. Waiting area | To spend time while waiting. |
| | | 45. Public toilet | To empty the body of urine or solid waste. |
| | | 46. Baby feeding and nappy changing room | To breast or bottle feed babies and for nappy changing. |
| | Support spaces | 47. Outdoor | To provide respite and connection with nature. |
| | | 48. Playground area | To entertain children and young people. |
| Staff | Arrival spaces | 49. Car parking area | To park cars. |
| | | 50. Motorbike parking area | To park motorbikes. |
| | | 51. Bike and scooter parking area | To park bikes and electrical scooters. |
| | | 52. Entrance | To enter the building. |
| | Support spaces | 53. Outdoor | To provide respite and connection with nature. |
| | | 54. Courtyard | To provide an outdoor area within the building. |
| Supplies | Arrival spaces | 55. Loading dock | To allow the unloading of supplies transported by vans and trucks. |
| | Support spaces | 56. Entrance | To enter the building. |

| | | | |
|---|---|---|---|
| External circulation | Out-patients and companions | 57. Gallery | To connect the public areas. |
| | | 58. Lift lobby | To allow for the gathering of people while waiting for the lift. |
| | | 59. Lift | To transport vertically. |
| | | 60. Staircase | To transport diagonally. |
| Internal circulation | Staff, supplies and in-patients | 61. Gallery | To connect the internal areas. |
| | | 62. Lift lobby | To allow for the gathering of people and supplies while waiting for the lift. |
| | | 63. Lift | To transport vertically. |
| | | 64. Staircase | To transport diagonally. |
| Internal circulation | Staff and supplies | 65. Gallery | To connect the most internal areas. |
| | | 66. Lift lobby | To allow for the gathering of people and supplies while waiting for the lift. |
| | | 67. Lift | To transport vertically. |
| Internal circulation | Building services | 68. Gallery | To maintain and access to the building installations. |

*Tab. 2 Room schedule for the circulation spaces.*

## 4.2.3 Acute-care Hospital Visits

### "Hospital de la Santa Creu i Sant Pau" (HSCSP)

The HSCSP is organised in five buildings: a rectangular volume for the out-patient department and four smaller wings arranged like fingers that house the in-patient wards. These five buildings are connected by a communication space that organises the user flow (Fig. 6-Fig. 13). There are also three courtyards that vertically cross the communication space that has a different usage at each level: 1) internal circulation area in the basement; 2) the external circulation area on the ground floor; and 3) the terrace for paediatric and psychiatric patients. The basements house the logistical areas as well as the operating theatres. The circulation flows are segregated, with the out-patient department generating the main public flow, and an internal flow for supplies and in-patients.

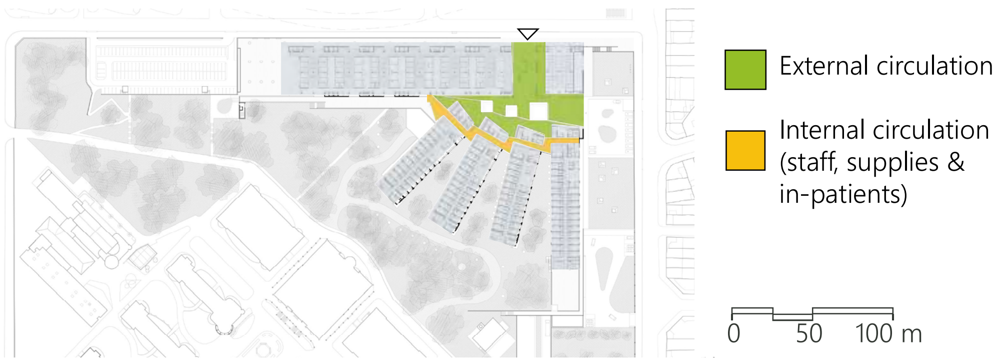



*Fig. 6 Ground floor with out-patient access, external circulation spaces and the three courtyards. HSCP.*

*Fig. 7 Automatised system for linen cleaning and delivery. There is no laundry in the acute-care hospital as the service is externalised. Staff have to identify themselves electronically each day and get their uniform. HSCP.*

*Fig. 8 At the end of their working day they have to return their clothing to a different machine. HSCP.*

*Fig. 9 Daylight openings between the internal circulation of the out-patient department. HSCP.*

*Fig. 10 Natural light in the internal corridor of the basement between pharmacy and laboratories. HSCP.*

*Fig. 11 Open space in the laboratories with natural light for staff. HSCP.*

*Fig. 12 View of the in-patient wards from the education facilities with the Sagrada Familia in the background. HSCP.*

*Fig. 13 Out-patient department public circulation with escalators. HSCP.*

## "Hospital del Mar" (HdM)

This acute-care hospital has undergone several renovation works during its long history (Fig. 14-Fig. 24). There is a research centre, an educational building and the acute-care hospital itself. The circulation strategy is based on the original structure in pavilions. For the connection of the existing acute-care hospital to the out-patient block at the sea front, there is a public square that provides a soft transition between the sea and the building. At the back of the acute-care hospital is the teaching department.

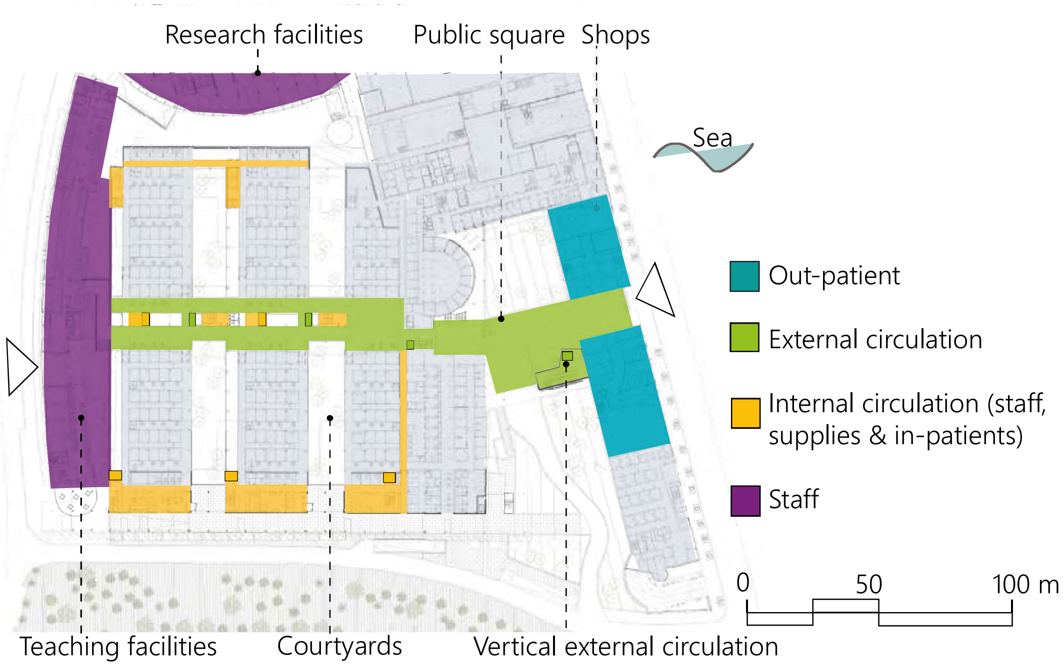



*Fig. 14 Ground floor HdM.*

*Fig. 15 External view of the out-patient department. HdM.*

*Fig. 16 Public atrium built in the 90s. HdM.*

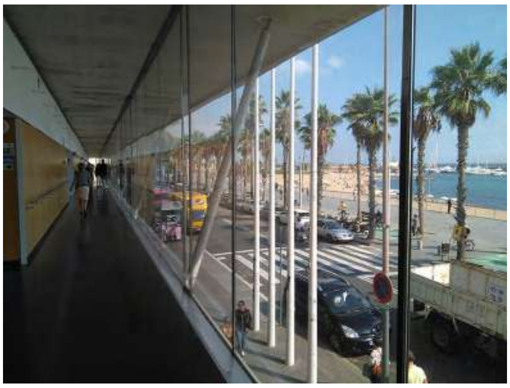


*Fig. 17 Public corridor in the out-patient department. HdM.*

*Fig. 18 Waiting areas built in the 90s. HdM.*

*Fig. 19 Internal corridor. HdM.*

*Fig. 20 Cafeteria in the teaching facilities pavilion. HdM.*

*Fig. 21 Reading area with double height in the teaching facilities pavilion. HdM.*

*Fig. 22 Library and reading area at the back with continuous lighting fixtures for creating a virtual ceiling and promote concentration. HdM.*

*Fig. 23 "Parc de recerca biomèdica" or research institute. HdM.*

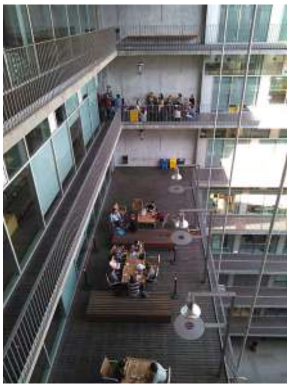


*Fig. 24 Socialising areas in the research institute. HdM.*

## "Hospital Sant Joan Despí Moisès Broggi" (HSJDMB)

The out-patient access to the acute-care hospital provides a clear flow strategy with a "U" shape for external circulation and a herringbone shape for internal circulation (Fig. 25-Fig. 28). Next to the access there is the cafeteria, the public gallery leads to the external vertical transportation cores with the lifts and staircase that connect the gallery with the in-patient wings at the higher levels.


*Fig. 25 Ground floor (HSJDMB).*

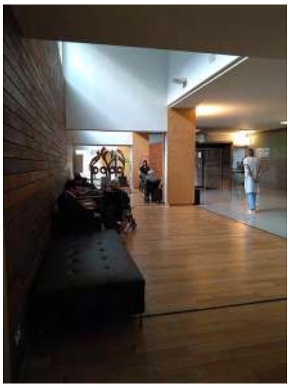


*Fig. 26 Public access. Flooring changes for delimitating waiting from circulation area. (HSJDMB).*

*Fig. 27 Public circulation for out-patient department with natural light. (HSJDMB).*

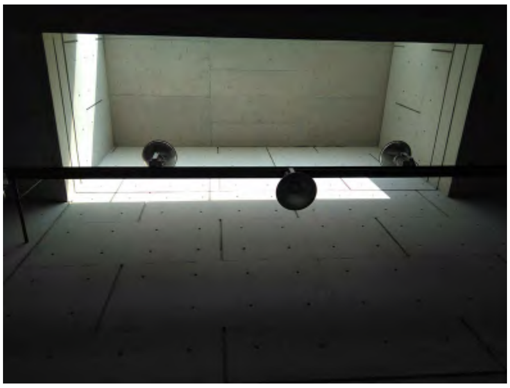


*Fig. 28 Ceiling openings for providing natural light. (HSJDMB).*

## “Maternidad Gregorio Marañón” (MGM)

The MGM is an urban acute-care hospital with a compact structure organised around eight courtyards (Fig. 29-Fig. 32). The building houses two acute-care hospitals in one (maternity and paediatric). These two acute-care hospitals have their own accesses, consultancies and in-patient wards but share some departments such as operating theatres, emergency department, diagnostic department and general services. This independency of services is achieved by the circulation strategy. There are two independent access levels, one for maternity patients on the ground floor and another on the first floor for paediatric patients.

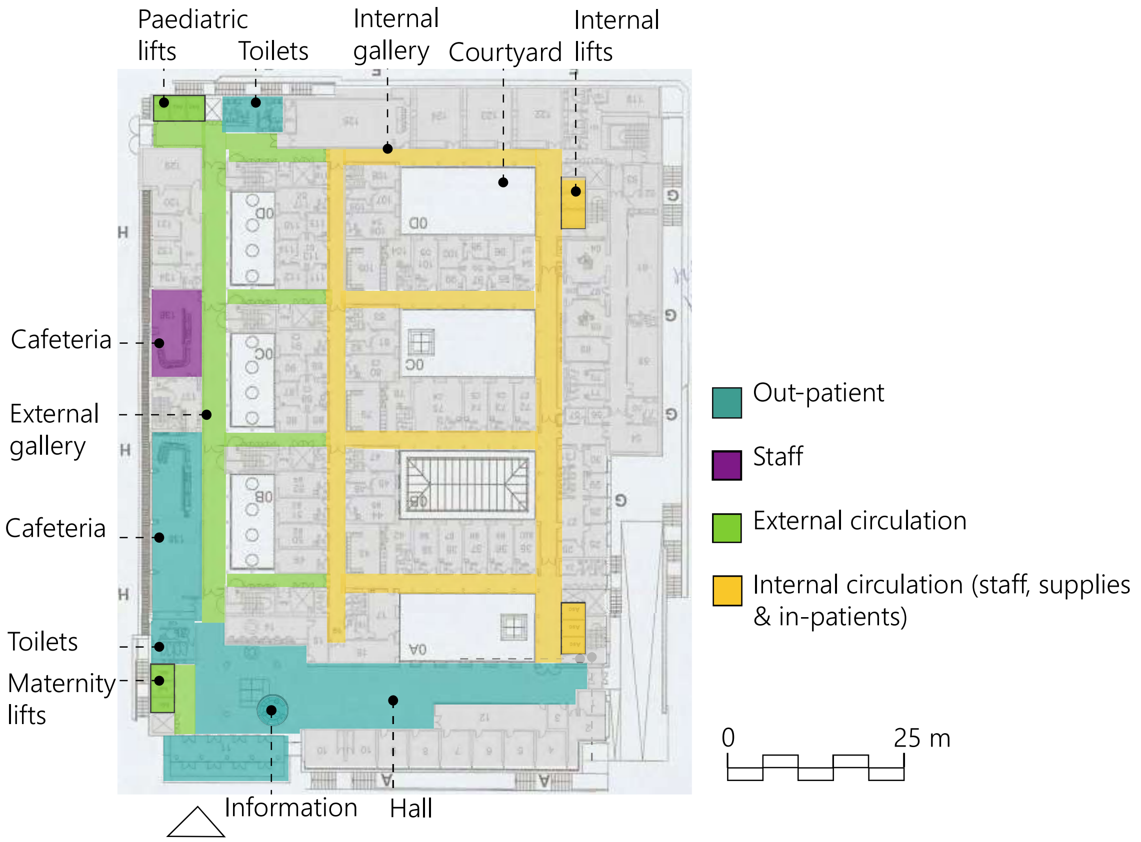



*Fig. 29 Ground floor MGM.*


*Fig. 30 Access to the children’s departments. MGM.*

*Fig. 31 Circulation space and waiting area. MGM.*

*Fig. 32 Daylight opening in the basement. MGM.*

## "Hospital Universitario Central de Asturias" (HUCA)

The HUCA is a highly complex building organised around five parts: 1) out-patient department; 2) general services that combine the diagnostic and treatment facilities with the logistical and medical supply areas; 3) the in-patient department; 4) teaching department; and 5) technical department (Fig. 33-Fig. 41). Each of these areas has independent arrival and access areas.

There is privacy limiting gradation from the public areas in the periphery of the building (out-patient department and entrance to in-patient departments) to the inner parts of the acute-care hospital with the internal areas exclusively used by restricted flows.

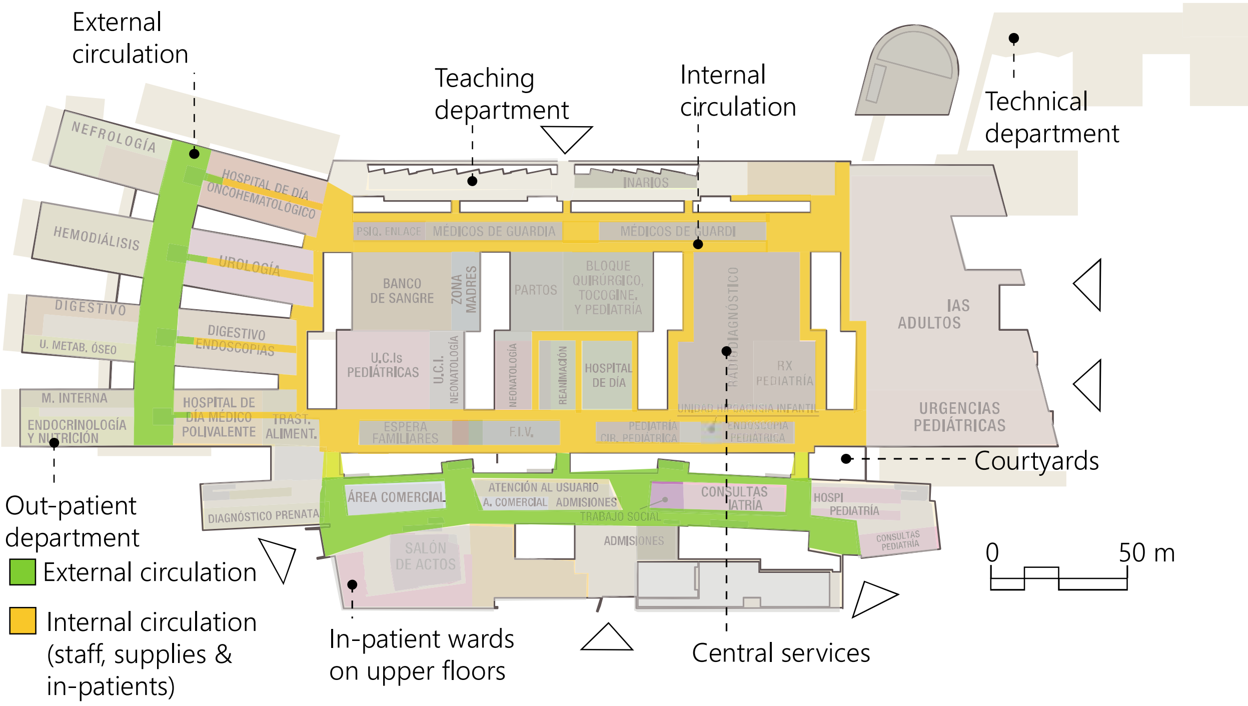



*Fig. 33 Ground floor and diagram of departments. HUCA.*

*Fig. 34 Atrium that separates the hospitalisation building from the general services building. HUCA.*

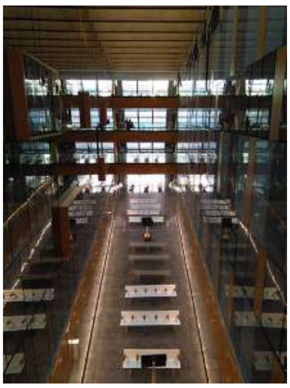


*Fig. 35 Indoor atriums in the out-patient building. HUCA.*

*Fig. 36 Cafeteria in the teaching department. HUCA.*

*Fig. 37 Charging station at basement 2 for robots. HUCA.*

*Fig. 38 Automatised circulation of 12 robots. HUCA.*

*Fig. 39 Close up view of a robot. HUCA.*

*Fig. 40 Lobby lift in basement 2 and robotized lift. HUCA.*


*Fig. 41 Parking area for robots at each in-patient ward. HUCA.*

## "Hospital General Universitario de Ciudad Real" (HGUCR)

The circulation strategy in HGUCR relies on two access points, one for in-patient wards and another for the out-patient departments (Fig. 42-Fig. 44). There are two public galleries connected through the cafeteria to distribute public flow between these two areas. The first public gallery directs people to the three vertical transportation cores that take people to the hospitalization wings. In the second public gallery there are several staircases and lifts to connect the two out-patient floors. Internal circulation is resolved in the inner part of the building. The in-patient access faces a park while the out-patient area and the back of the building contain the outdoor parking areas.

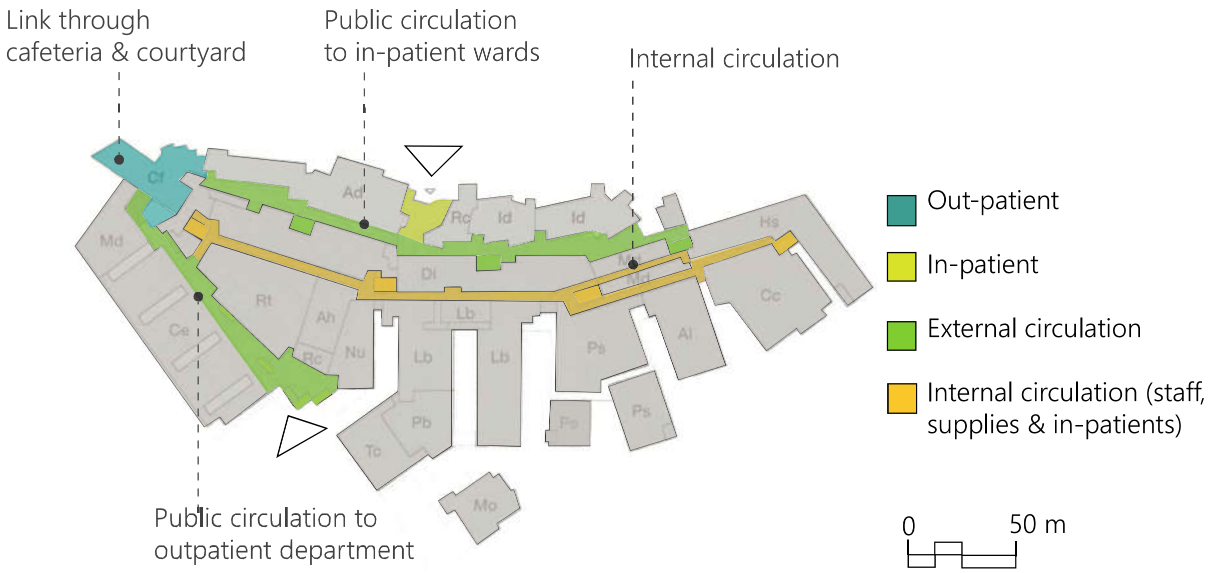



*Fig. 42 Ground floor HGUCR.*

*Fig. 43 Park in the acute-care hospital site. HGUCR.*

*Fig. 44 Piano in the external corridor. HGUCR.*

## "Sahlgrenska Universitetssjukhuset" (SAHLH)

The "Bild och interventionscentrum" at Sahlgrenska Hospital (SAHLH) is an imaging and intervention centre that combines the department of radiodiagnostics and imaging with the operating theatres department (Fig. 45-Fig. 51). This renovated building was placed in an existing facility of the acute-care hospital. Since the floor heights were higher than the adjacent building (for housing operating theatres and their required equipment) a void volume was designed facilitating the transition from the central building of the acute-care hospital to this new building. Thus, there is no horizontal connection to the central building of the acute-care hospital. Two thirds of the building are designated to technical installations mainly in the basement (for data, gases and electricity) and the roof (for ventilation) as well as the needed shafts through all the floors. The location of a magnetic resonance (MR) scanning room next to the operating theatres allows for a scan of the head and neck of the patient during brain surgery so that surgeons may work with updated images during the operation and without moving the patient.

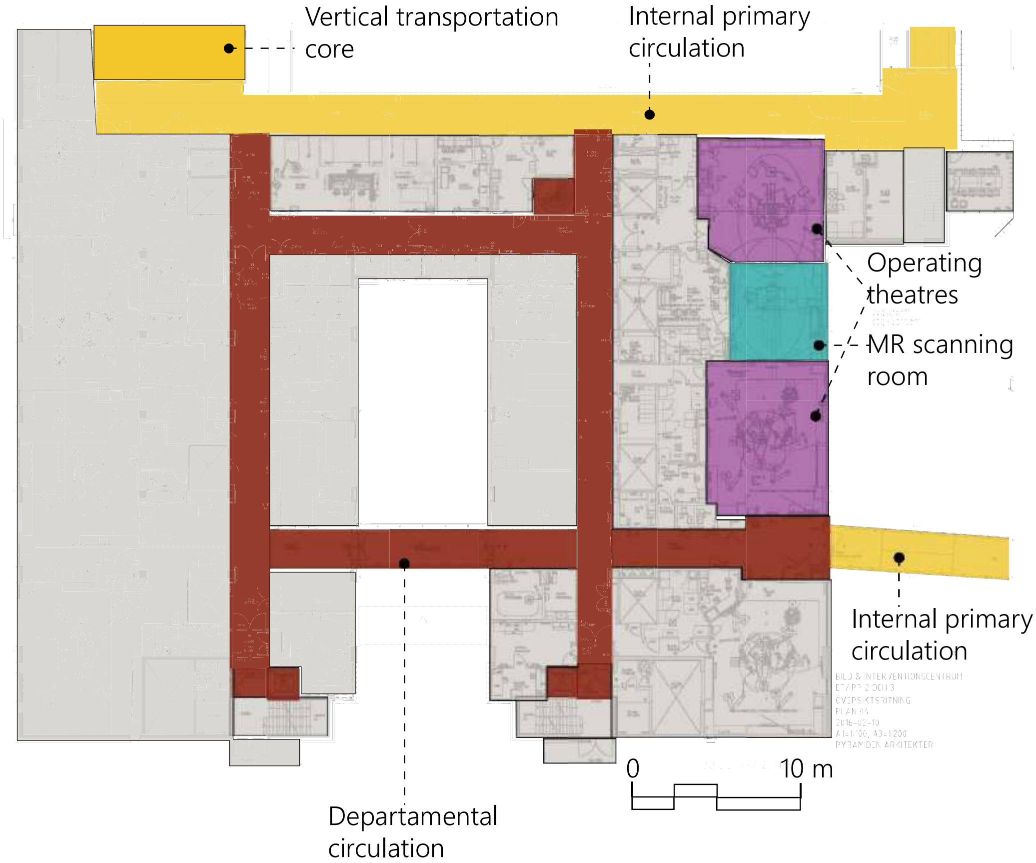



*Fig. 45 Fourth floor of building with departmental circulation. SAHLH.*

*Fig. 46 Goods flow in the basement with resistant finishes, sidewalk (to protect walls from wheel impacts), and suspended ceiling for covering the installations. SAHLH.*

*Fig. 47 Basement level with building services. SAHLH.*

*Fig. 48 Operating theatre of about 100 m² with daylight and workstations in each corner for specialist teams (one for anaesthetists, another for surgeons). Artificial lighting contrast for better visualization of screen images. SAHLH.*

*Fig. 49 Designated parking area in the internal corridor. SAHLH.*

*Fig. 50 Volume of nexus between the two buildings, which had different height levels, with a friendly waiting area. SAHLH.*

*Fig. 51 Internal lift for bed-ridden patients with a specific gases box for patient provision in case of lift failure. SAHLH.*

## "Östra Hospital" (ÖH)

This poliblock acute-care hospital is under a challenging and ambitious upgrading strategic plan with sustainable planning that started in 2011 and will be finished by 2030 (Fig. 52-Fig. 53).

*Fig. 52 Birds-eye view of the whole acute-care hospital. ÖH.*

*Fig. 53 Planned buildings for acute-care hospital remodelation and extension. ÖH.*

## "Angereds Närsjukhus" (AN)

The building has three floors and a basement for car parking (Fig. 54-Fig. 68). The exterior shape is that of a square with four atriums that provide natural light and contain art installations. There are two opposite access points to the building, one in the north for external flow and the another in the south for internal flow. Next to the external access there is the directory, open stairs to encourage their usage, public toilets, café and the reception desk. Public circulation is arranged as a central spine that crosses two atriums. Internal circulation is organised from the public circulation into two clusters. There is only one entrance and reception desk for all external visitors (for primary and specialist care) so that everyone goes directly there and receives the right directions to their final destination. Directly from the external access, there is a view of the stairs to encourage their use but also a sign to the public lifts. The internal lift is close to the internal access.

*Fig. 54 External view of building. AN.*

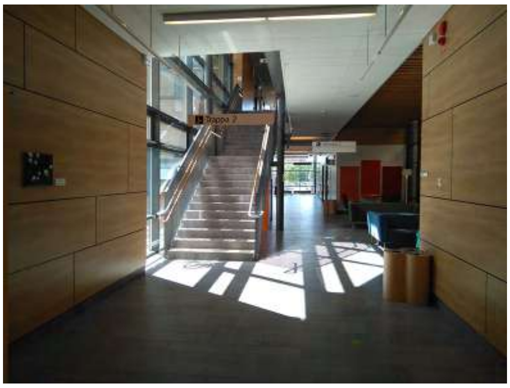


*Fig. 55 Open stairs next to access to promote their use. AN.*

*Fig. 56 Courtyard with artistic installations. AN.*

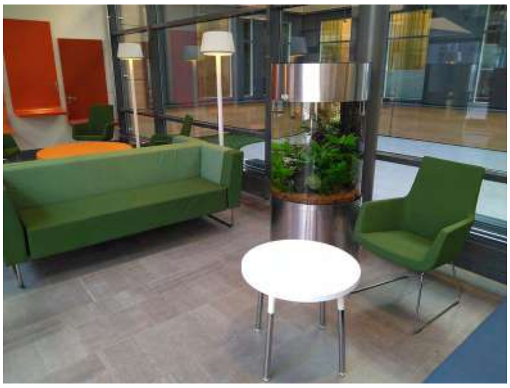


*Fig. 57 Waiting area with comfortable furniture and aquarium. AN.*

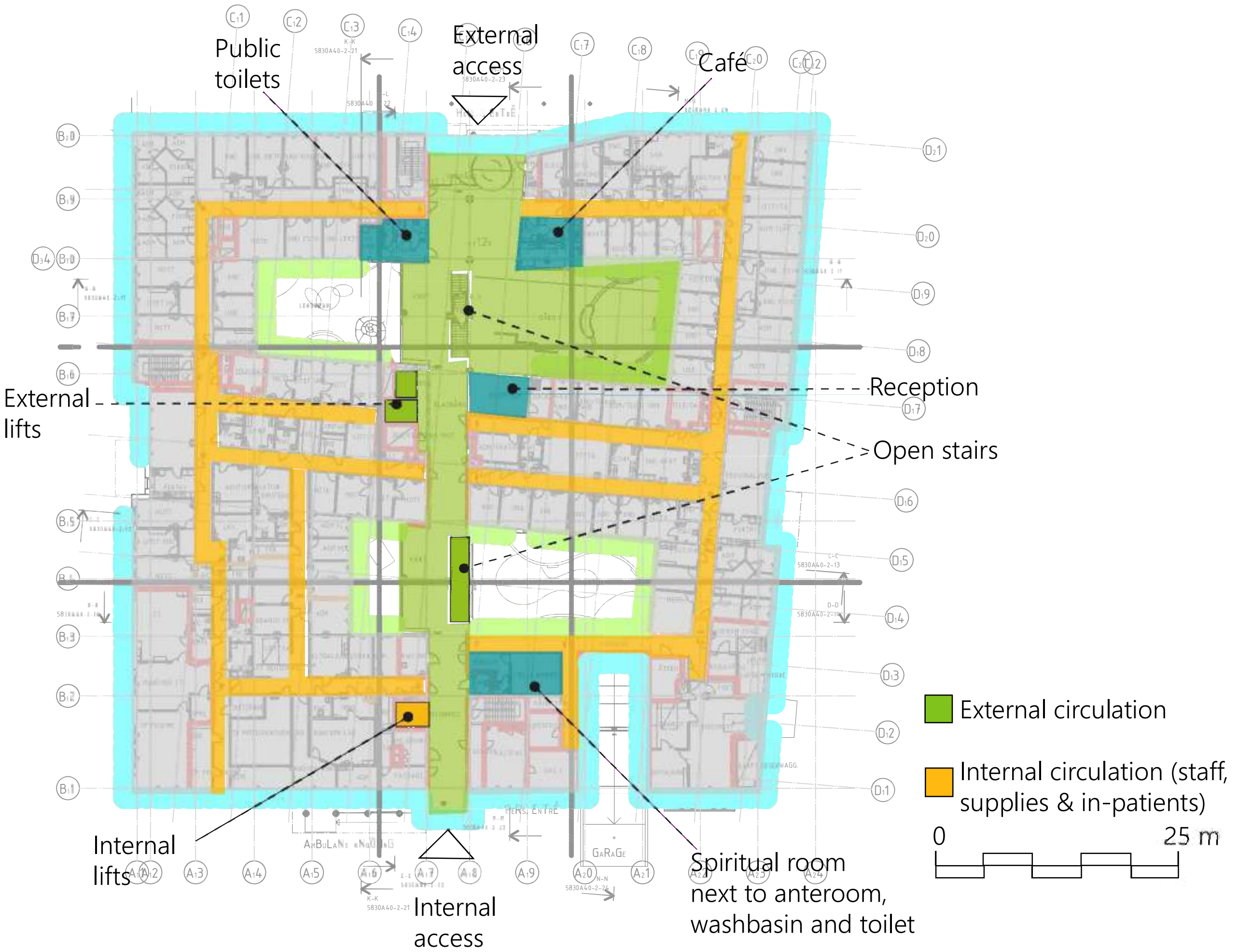



*Fig. 58 Ground floor with two opposite access points. AN.*

*Fig. 59 Furniture in waiting areas with material for children. AN.*

*Fig. 60 Cosy sofas for waiting. AN.*

*Fig. 61 Furniture for children's entretainment. AN.*


Fig. 62 Concealable Information desk. AN.

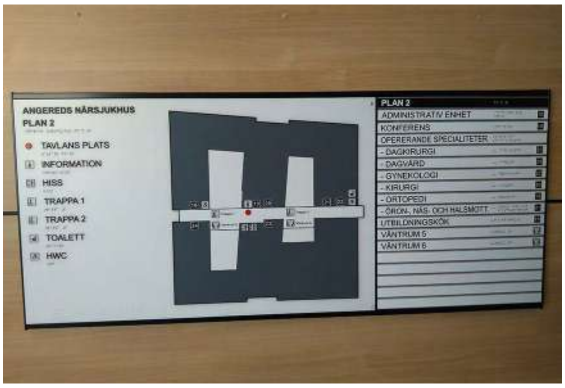



*Fig. 63 Informative panel with basic information, in braille and a display with easy to change lines. AN.*

*Fig. 64 Contrasting colour surface in public toilets. AN.*

*Fig. 65 Drinking water tap. AN.*

*Fig. 66 Neutral spiritual room for all religions. AN.*

*Fig. 67 Cabinet for storage of complements for rituals like sacred books or carpets. AN.*

*Fig. 68 Tap for rituals that need water or water hygiene. AN.*

## "Skånes universitetssjukhus" (SKU)

Due to the whole hospital typology, the primary circulation system of this acute-care hospital is that of urban planning with streets and underpasses that connect several of the departmental buildings (Fig. 69-Fig. 83). However, the interdepartmental circulation spaces of the department of infectious disease are worthy of special attention. This building cares for infectious or immunosuppressed patients, thus the circulation flows have to be as safe as the patient areas. That is why this building uses a quick and short distance route from the ambulance to the in-patient bedroom, outdoor areas for the circulation of patients and visitors, and ante-rooms for the access of visitors and staff to the in-patient room.

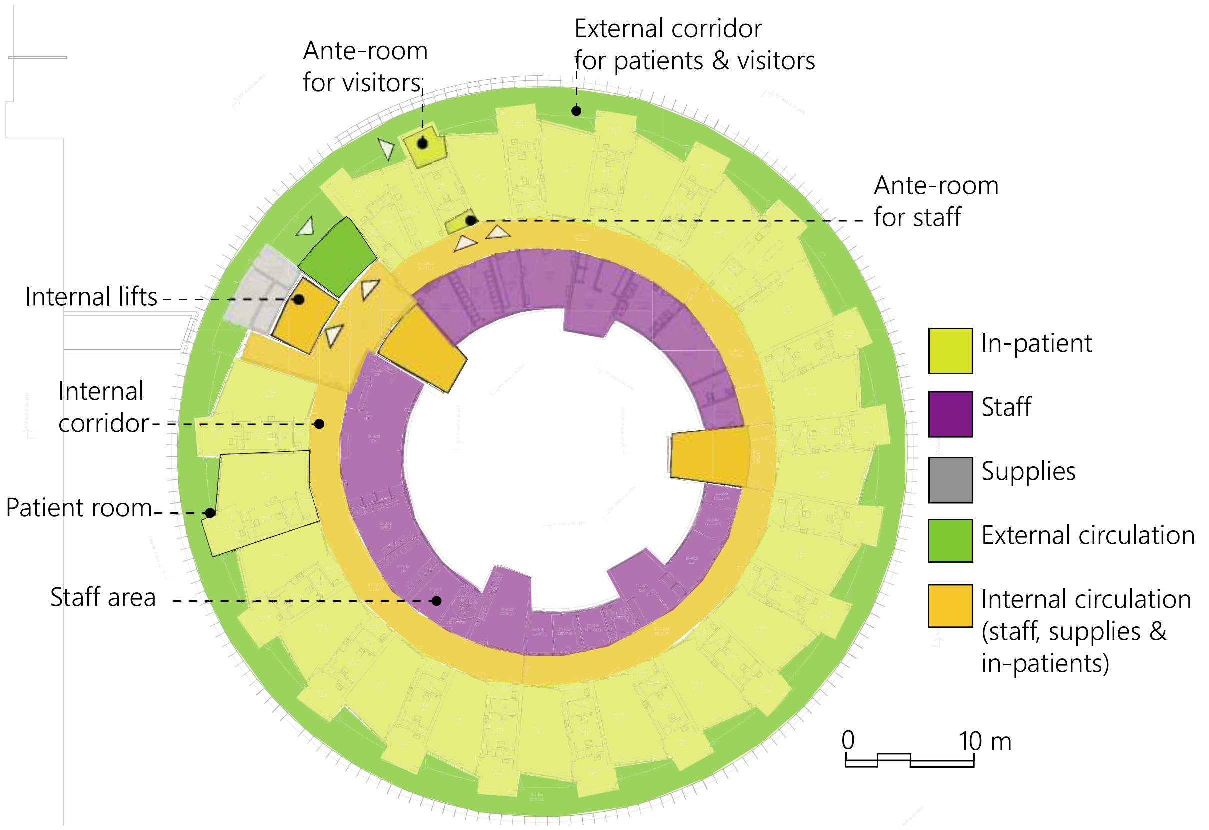



*Fig. 69 In-patient ward floor. SKU.*

*Fig. 70 Infectious disease building. SKU.*

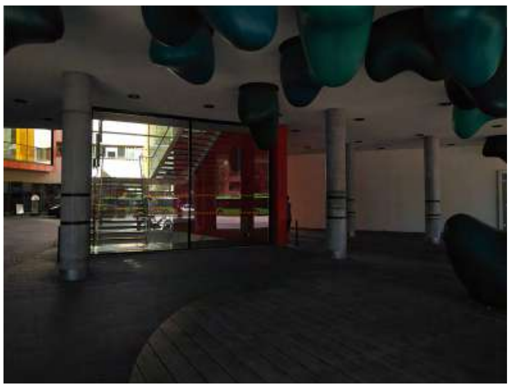


*Fig. 71 Pedestrian access and drop-off area. SKU.*

*Fig. 72 Staircase windows to inner courtyard. SKU.*

*Fig. 73 Artistic installations on lift doors. SKU.*

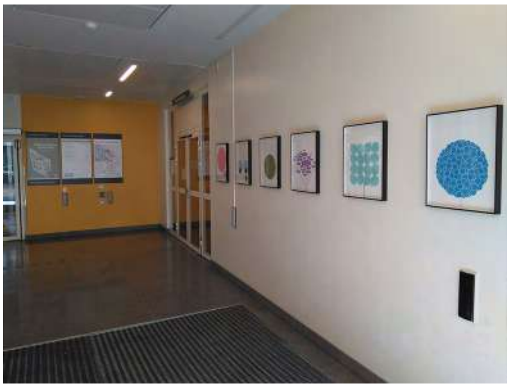


*Fig. 74 Artistic installations in corridors. SKU.*

*Fig. 75 Staff resting area and kitchen. SKU.*

*Fig. 76 Staff balcony with views to acute-care hospital expansion. SKU.*

*Fig. 77 Ambulance bay for infectious patients who are treated separately from their arrival and go directly to the external lifts into the infectious patient rooms. SKU.*


*Fig. 78 External corridor to in-patient bedrooms. SKU.*

*Fig. 79 Ante room from the external corridor. SKU.*

*Fig. 80 In-patient room used individually but with double capacity to reduce costs. SKU.*

*Fig. 81 Staff anteroom with sink, personal protective equipment and patients' protocol information. Staff physical and mental transition to patient's bedroom. SKU.*


*Fig. 82 Air conditioning switches for positive or negative pression, regulable both in the anteroom and the bedroom. Display to show the type of patient: contagious or immunocompromised. SKU.*

*Fig. 83 Internal corridor for staff with two accesses to the patient, one through the anteroom and another one directly to the bedroom for emergency situations. SKU.*

## "Nya Karolinska Solna" (NKS)

The building is designed to improve flexibility and resilience (Fig. 84-Fig. 114). During the pre-design stage, designers carried out research and acute-care hospital visits to other countries. The conclusions they reached were that the acute-care hospital had to be prepared for future infectious outbreaks. Hence, it was designed with double corridors for the segregated flow of internal and external users. It was also important to be able to modify departmental location within the acute-care hospital. The initial intention was to build all floors with enough ceiling height and structural load to house an operating theatre. However, due to the cost reduction during the construction stage, this was not possible at all levels. The main entrance leads to an immense hall area with a hotel type reception, cafeterias, and shops. There are several access points like the independent access to the conference room or the children's access.

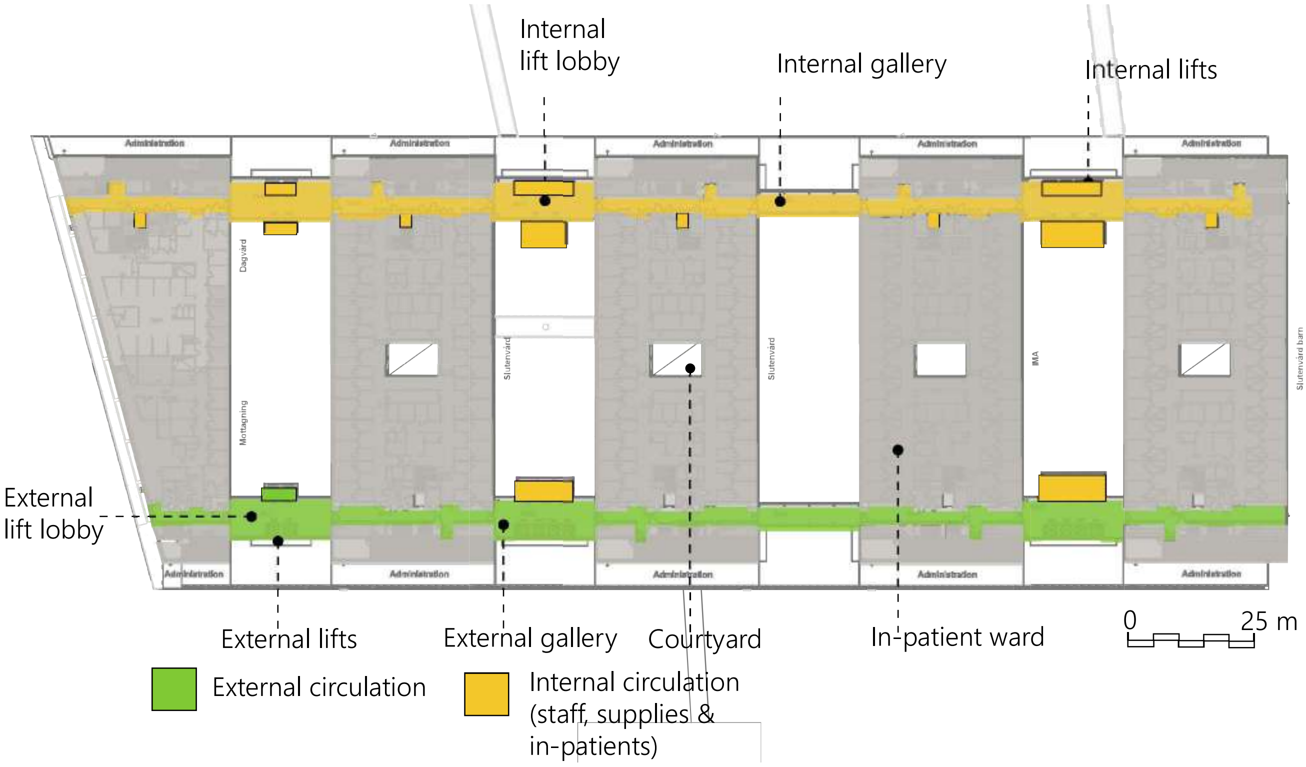



*Fig. 84 Ninth floor NKS.*

*Fig. 85 External view. NKS.*

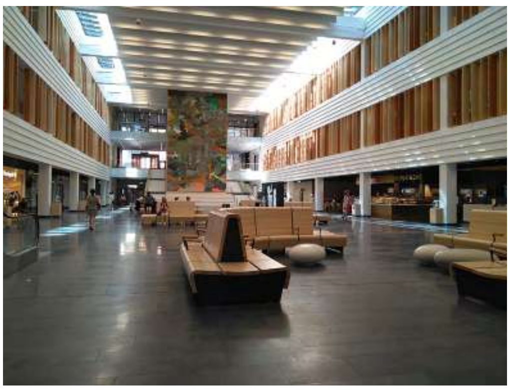


*Fig. 86 Hall. NKS.*

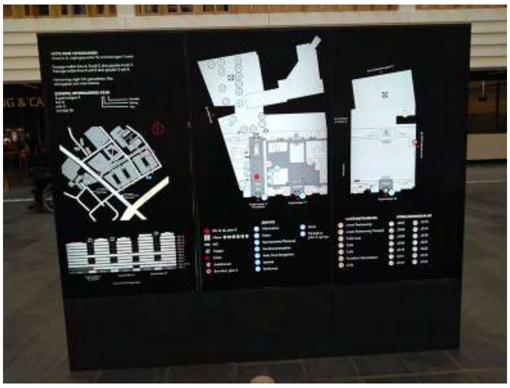


Fig. 87 Main directory in hall. NKS.


Fig. 88 Public cafeteria next to hall. NKS.

Fig. 89 Conference room with public access. NKS.

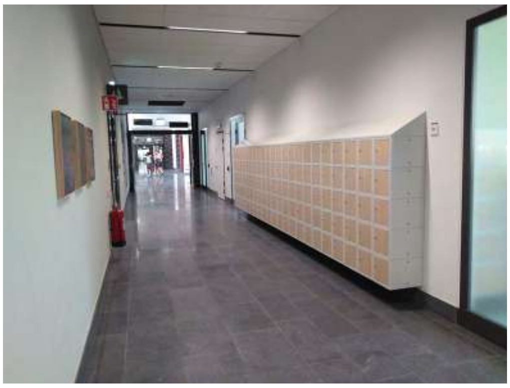


Fig. 90 Corridor with lockers. NKS.

Fig. 91 Concealed fire doors. NKS.

Fig. 92 Staircase with large window to promote its usage. NKS.

*Fig. 93 Concealed goods lift. NKS.*

*Fig. 94 Parking area for goods trolleys in front of goods lift. Trolley bay for goods. NKS.*

*Fig. 95 Pavement signal warning of goods trolley movement from goods lift. NKS.*

*Fig. 96 Parking area for three-wheel scooters. NKS.*

*Fig. 97 Parking area for children's scooters. NKS.*

*Fig. 98 Lift lobby. NKS.*

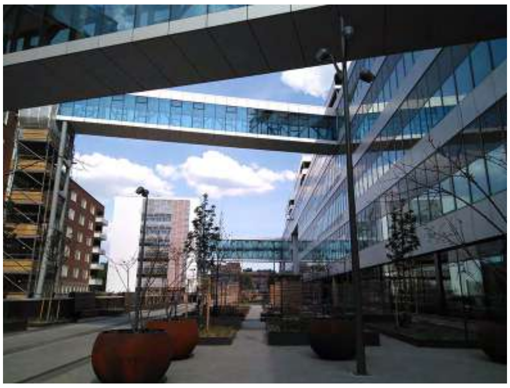


*Fig. 99 Academic mall that connects NKS hospital with research centres and creates a pedestrian urban environment with urban furniture and art. NKS.*

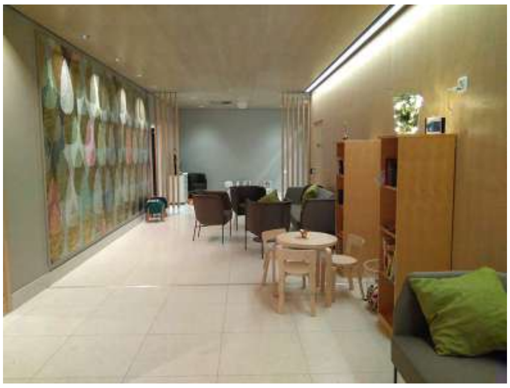


*Fig. 100 Ante room to religious room with furniture for children. NKS.*

*Fig. 101 Rituals room. NKS.*

*Fig. 102 Congregational rituals room. NKS.*

*Fig. 103 Piano in the religious room. NKS.*

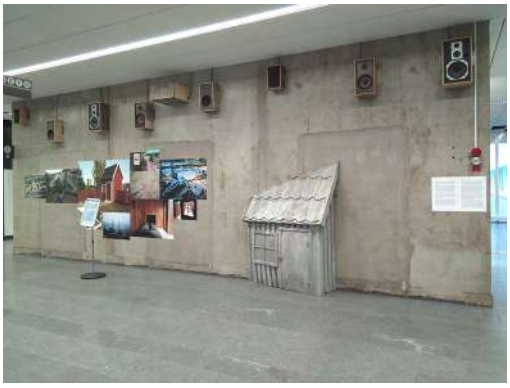


*Fig. 104 Artistic installations in the acute-care hospital. Hospital developers had to invest from 1 to 3% of construction cost on artistic installations. NKS.*

*Fig. 105 Another artistic installation. NKS.*

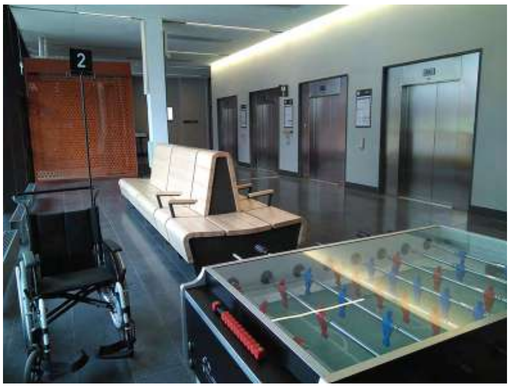


*Fig. 106 Waiting area next to lift lobby with table football. NKS.*

*Fig. 107 Workspace with electrically height adjustable tables. NKS.*

## Biomedicum Laboratory Building, "Karolinska Institutet" (KI NKS)

*Fig. 108 Karolinska Institut external view. KI NKS.*

*Fig. 109 Roof of atrium. KI NKS.*

*Fig. 110 Staircase. KI NKS.*

*Fig. 111 Urban furniture of the atrium. KI NKS.*

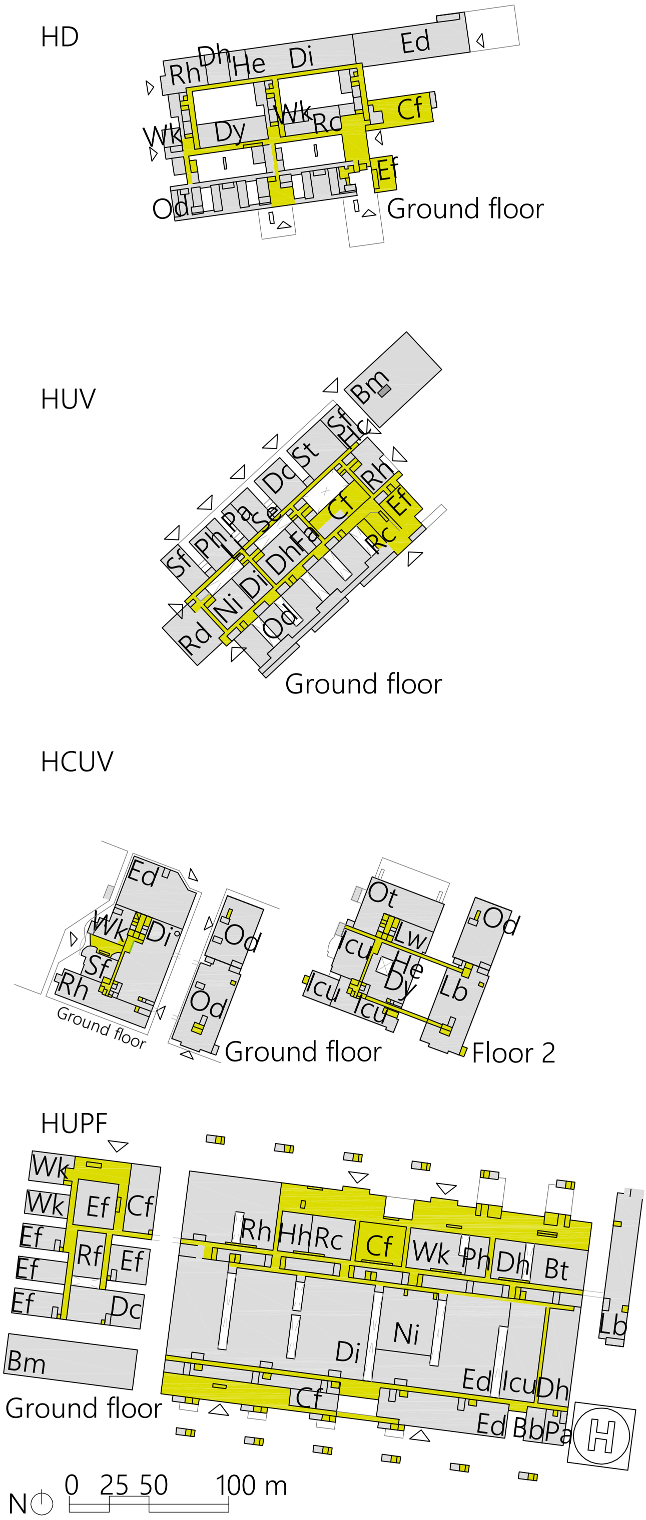
*Fig. 112 Staff kitchen. KI NKS.*

*Fig. 113 Ante room for staff hygiene preparation before entering the laboratory. Flexible fixings for easy redesign. KI NKS.*

*Fig. 114 Laboratory room. Drawers hang from the table to facilitate floor cleaning. KI NKS.*

### 4.2.4 Acute-care Hospital Cases

Fig. 115 shows the location of the evaluated ward within each of the four acute-care hospital floors.

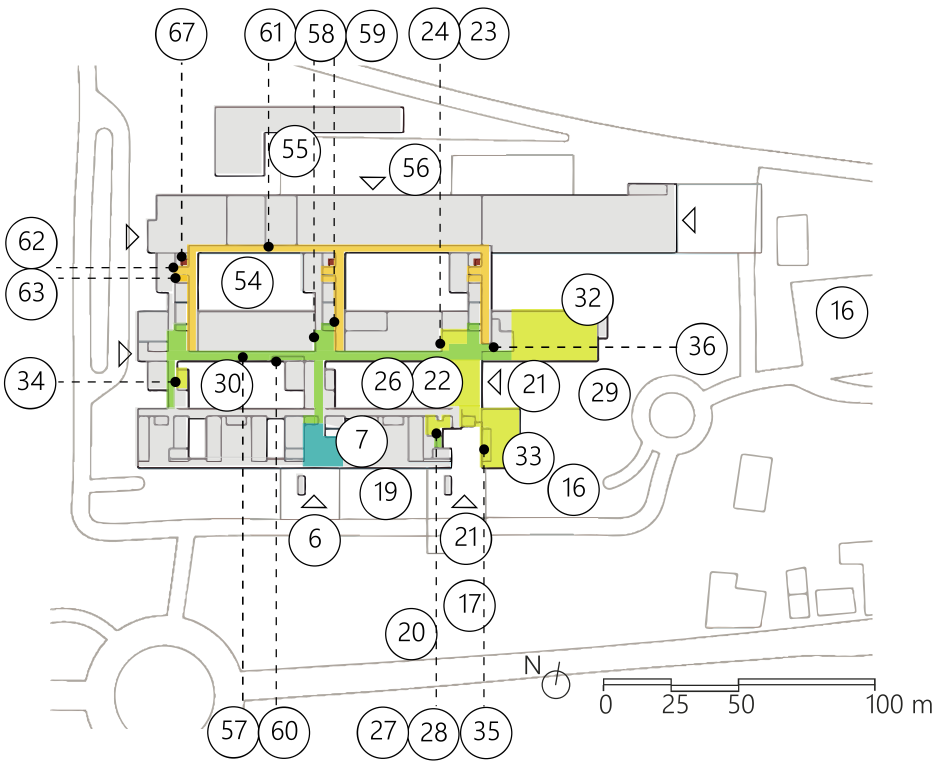



| | |
|---|---|
| O | Out-patient Area |
| Fa | Functional Assessment |
| Bt | Blood Tests |
| Dh | Day Hospital |
| Od | Out-patient Department |
| Dy | Dialysis |
| Rh | Rehabilitation |
| Hh | Home Hospitalisation |
| I | In-patient Area: |
| Rc | Reception |
| Cf | Cafeteria |
| Icu | Intensive Care Unit |
| D | Diagnostic & Treatment Area: |
| Lw | Labour Ward |
| He | Haemodynamic |
| Ni | Nuclear Imaging |
| Ed | Emergency Department |
| Rd | Radiotherapy |
| Di | Diagnostic Imaging |
| Ot | Operating Theatres |
| Ph | Pharmacy |
| Se | Sterilisation |
| Lb | Laboratory |
| Bb | Blood Bank |
| Pa | Pathological Anatomy |
| T | Teaching & Research Area: |
| Ef | Education Facilities |
| Rf | Research Facilities |
| S | Logistical & Medical Supply Area: |
| Wk | Workspaces |
| Sf | Staff Facilities |
| Li | Linen |
| Hc | Housekeeping, Cleaning |
| Dc | Data Centre |
| St | Storage |
| Bm | Building Maintenance |

*Fig. 115 Location of the circulation spaces evaluated.*

## "Hospital de Dénia" (HD)

The circulation spaces in HD were determined by the building's volumetric configuration in three longitudinal blocks of clinical departments and three transversal circulation arteries. There were five access points to the acute-care hospital: hospitalization (with two different doors), out-patient department, emergency, rehabilitation, and personnel (Fig. 116). From the hospitalization access point there was the main hall and a public gallery that connected both horizontally and vertically several departments (including out-patient and staff facilities). This gallery was frequently used for artistic installations that gave the acute-care hospital a cultural touch of personality and differentiation.




Out-patient
6 Entrance
7 Hall

In-patients
16 Car parking area
17 Motorbike parking area
19 Taxi stop
20 Public transportation stop
21 Entrance
22 Hall
23 Reception and information
24 Charity area
26 Waiting area
27 Public toilet
28 Baby feeding & nappy changing room
29 Outdoor
30 Courtyard
32 Cafeteria
33 Conference
34 Spiritual room
35 Shops
36 ATM terminal

Staff
54 Courtyard

Supplies
55 Loading dock
56 Entrance

External circulation
57 Gallery
58 Lift lobby
59 Lift
60 Staircase

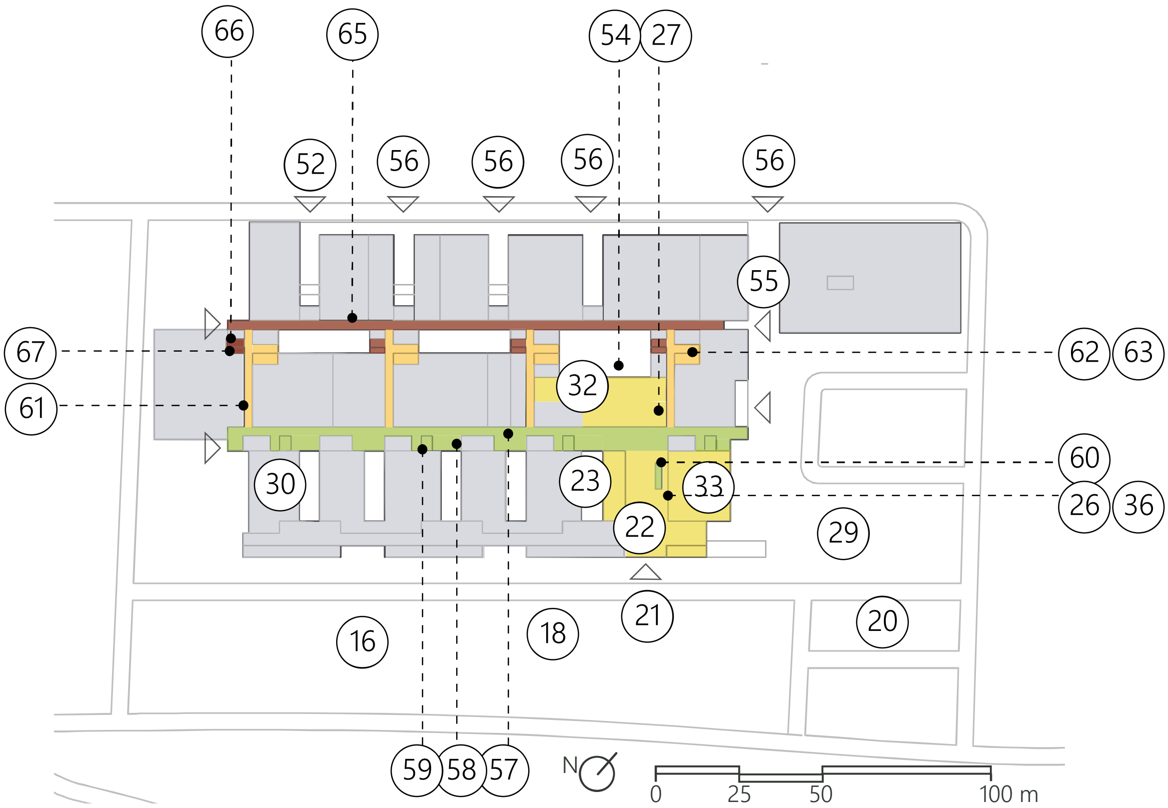
Internal circulation (staff, supplies & in-patients)
61 Gallery
62 Lift lobby
63 Lift

Internal circulation (staff, supplies & in-patients)
67 Lift

*Fig. 116 Evaluated rooms circulation spaces HD.*

## “Hospital Universitario del Vinalopó” (HUV)

HUV had several departmental accesses (emergencies, supplies, rehabilitation) (Fig. 117). The access point for the out-patient patients was shared with the patients and visitors that came to the in-patient wards. There was a double high hall with the information and reception area. The public gallery was a longitudinal corridor that provided access to the four vertical transportation cores that led to the in-patient wards. The internal gallery had a comb-shape for the connection of the diagnostic departments with the public gallery. There were four vertical transportation cores for internal traffic with two pairs of lifts (one for passengers and one for beds) and a staircase.




In-patients
16 Car parking area
18 Bike & scooter parking
20 Public transportation stop
21 Entrance
22 Hall
23 Reception and infomration
26 Waiting area
27 Public toilet
29 Outdoor
30 Courtyard
32 Cafeteria
33 Conference
36 ATM terminal

Staff
52 Entrance
54 Courtyard

Supplies
55 Loading dock
56 Entrance

External circulation
57 Gallery
58 Lift lobby
59 Lift
60 Staircase

Internal circulation (staff, supplies & in-patients)
61 Gallery
62 Lift lobby
63 Lift

Internal circulation (staff, supplies & in-patients)
65 Gallery
66 Lift lobby
67 Lift

*Fig. 117 Evaluated rooms circulation spaces HUV.*

## "Hospital Clínico Universitario del Valencia" (HCUV)

HCUV had different departmental accesses for the emergency department, out-patient department, maternity building, in-patient wards and rehabilitation (Fig. 118). There was no clear separation between external and internal access which produced a merge of flows in the main circulation galleries. The acute-care hospital was divided into two buildings separated by a road and linked by two bridges on the second floor.

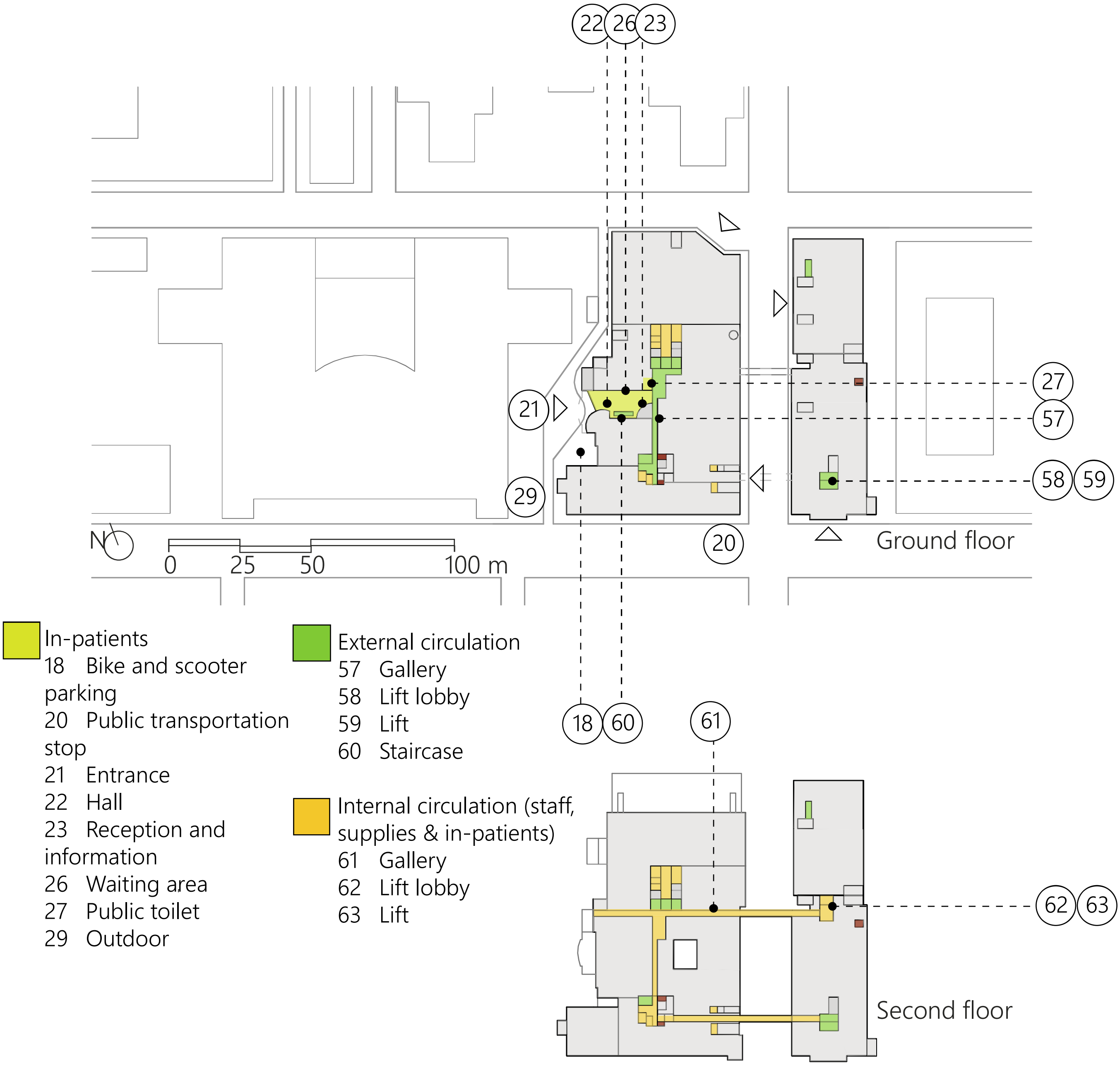
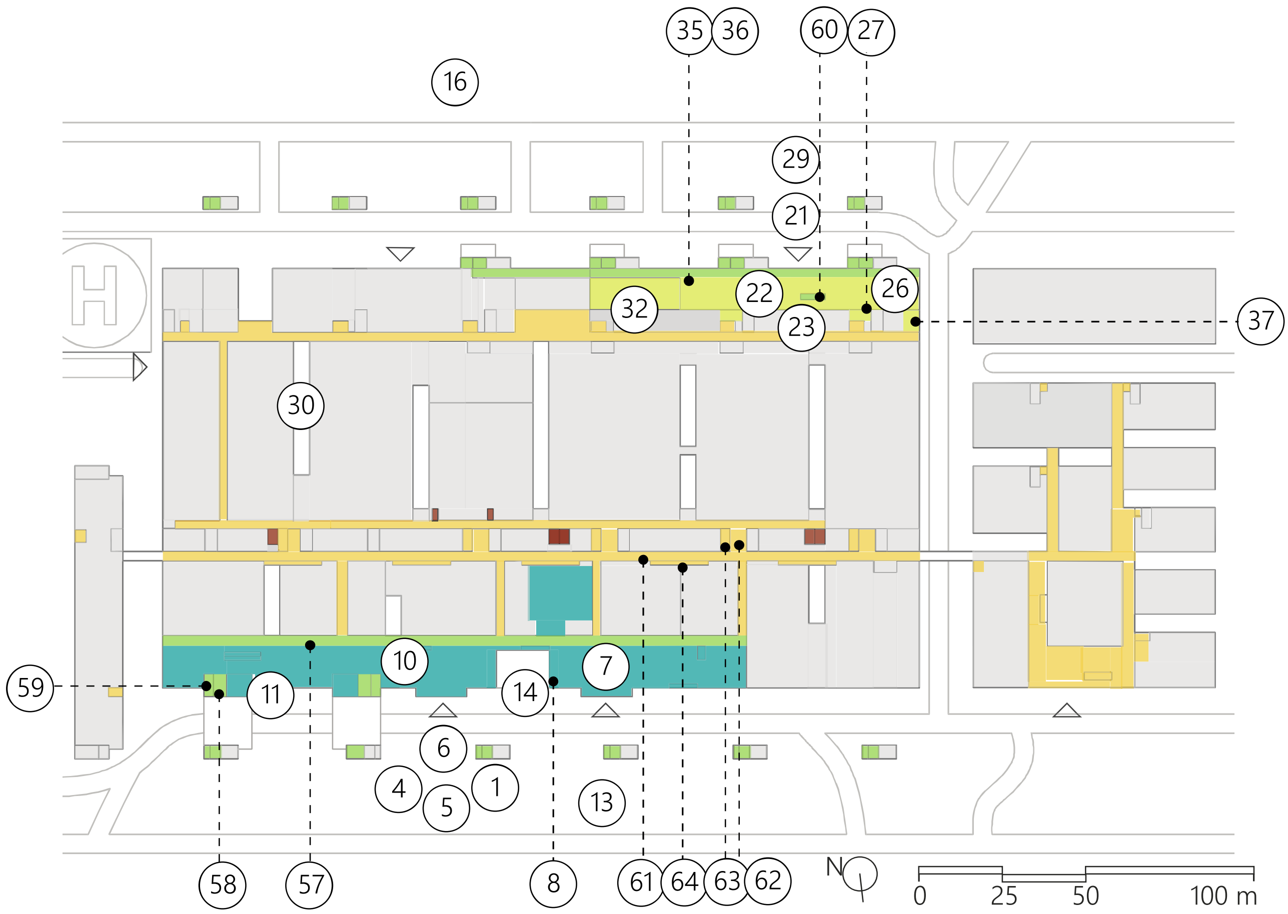



*Fig. 118 Evaluated rooms circulation spaces HCUV.*

## "Hospital Universitari i Politècnic La Fe" (HUPF)

HUPF had several access points. In the main block there were two entrances to the out-patient department, one for in-patient wards and another for the emergency department and the loading bay (Fig. 119). There was an independent tower with access to the laboratory department. A separate block had its own entrance to the teaching and administrative areas. From the out-patient department access there was a huge hall that distributed people flow to the towers (vertical cores B to G) and the vertical out-patient department.




Out-patient
1 Car parking area
4 Taxi stop
5 Public transportation stop
6 Entrance
7 Hall
8 Reception and information
10 Waiting area
11 Public toilet
13 Outdoor
14 Courtyard

In-patients
16 Car parking area
21 Entrance
22 Hall
23 Reception and information
26 Waiting area
27 Public toilet
29 Outdoor
30 Courtyard
32 Cafeteria
35 Shops
36 ATM terminal
37 Library

External circulation
57 Gallery
58 Lift lobby
59 Lift
60 Staircase

Internal circulation (staff, supplies & in-patients)
61 Gallery
62 Lift lobby
63 Lift
64 Staircase

*Fig. 119 Evaluated rooms circulation spaces HUPF.*

## Evaluation Results

Despite the fact that the data was collected in January and February 2018, the final CURARQ-Circ tool had undergone many modifications until its latest version of December 2020 [16]. This meant that many of the items were written after the evaluation, so no data was provided. Originally, only the in-patient arrival, access and support spaces, together with the external circulation and internal circulation (staff, supplies and in-patients) were considered. This is the reason why the results shown do no tackle all the rooms scheduled described in Tab. 2. From the results obtained following the evaluation process described at chapter 4.1.2, the HUV design scored the best results. The percentage of achievement with CURARQ-Circ tool is shown in Fig. 120.

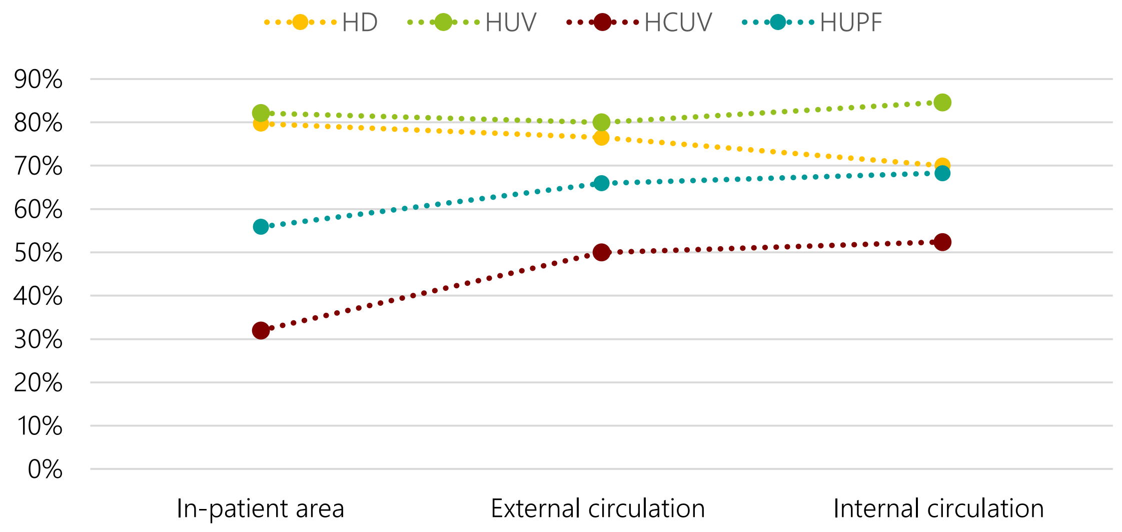



*Fig. 120 CURARQ-Circ results.*

HUV was closely followed by HD, with very similar scores. HUPF got sufficient grades in almost three areas while HCUV scored poor marks. All detailed results are available online [16].

Regarding the in-patient arrival, access and support spaces, HUV and HD got very similar results, both over 80% (Fig. 121-Fig. 124). In contrast HUPF scored just above 50% for several reasons. For example, there was no visual contact from the reception and information desk to the vertical transportation cores to the wards, the waiting area lacked interesting features, there was no playground area for children, nor did the cafeteria have an outdoor terrace. HCUV scored the lowest points as it had a dark and unappealing hall area, a minimal and improvised waiting area, public toilets without accessible cubicles and no allowance for baby changing or feeding areas.

As regards the external circulation area, HUV and HD again got similar scores (Fig. 125-Fig. 128). The requirements that could be improved in both acute-care hospitals had to do with the signage strategy. HD scored slightly lower because at some parts the delimitation between external and internal flows was not clear enough and people became confused.

In the case of HUPF, the flow strategy was not clear and more importantly there was no connection between the out-patient entrance and in-patient entrance, hence visitors crossed the corridors of other units to arrive at the in-patient area. Moreover, the out-patient area was arranged in two towers without sufficient lifts (inadequate handling capacity) that produced long queues and discontent among visitors. HCUV had no separation of external and internal flows, which made circulation chaotic and unorganised.

In terms of internal circulation only the one for staff, supplies and in-patients was evaluated (Fig. 129-Fig. 130). HUV met almost all the requirements except for having small areas for staff to stop and talk or write notes, artistic installations or adequate signage in the lift lobbies. HD scored lower because it had some issues with the internal lifts (such as small lift and door dimensions, gaps between floor and lift cabin or inadequate floor finishes). HUPF had worse scores because in addition to the previous requirements, the corridors and lifts were shared with out-patient flow. Moreover, corridors had no views or natural light. HCUV did not comply with many basic requirements such as flow separation, corridor width, or a sufficient number of lifts.


*Fig. 121 Hall in HD.*

*Fig. 122 Hall in HUV.*


*Fig. 123 Hall in HCUV.*

*Fig. 124 Hall in HUPF.*


Fig. 125 External gallery HD.


Fig. 126 External gallery HUV.


Fig. 127 External gallery HCUV.

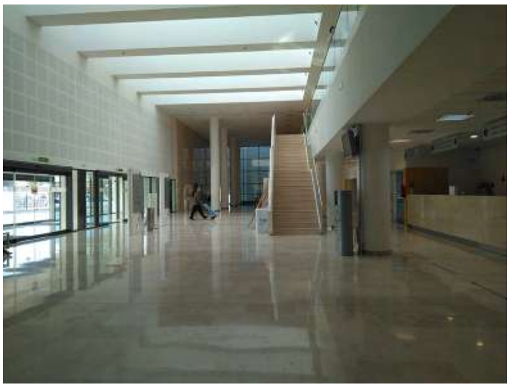


Fig. 128 External gallery HUPF.


Fig. 129 Internal gallery HD.


Fig. 130 Internal gallery HUV.

### 4.2.5 Discussion

The literature analysis revealed that the circulation area is one of the least researched spaces in the acute-care hospital. Probably because the study of those circulation arteries requires the understanding of the whole building, while a ward can be studied almost independently. However it was in the guidelines, reports, white papers and books where the most valuable information was found [5, 8, 11, 15, 17].

From the acute-care hospital visits, the most effective circulation strategies were the ones that had a clear separation between external and internal flow. Only when the circulation strategy was neat and simple in the layout diagram, the acute-care hospital being used performed better. Regarding the separation of flows to avoid infectious disease, it was remarkable to see the Swedish preparedness with "Skånes universitetssjukhus" and the "Nya Karolinska Solna" compared to the improvisation in the region of Madrid with Hospital Zendal construction [18].

Regarding the four case studies, HUV and HD received the highest marks because they both used a similar circulation strategy. HCUV circulation strategy was inefficient as there was no separation of external and internal flows, probably due to its long history and the consequent functional disorder [19]. HUPF got lower grades as it presented several circulation problems. The out-patient department was arranged in two towers with a very poor vertical transportation strategy, an insufficient number of lifts that resulted in out-patients using internal lifts with the consequent merging of internal and external flows. Another main problem of the building was access by public transportation and its only stop in front of the out-patient access together with the fact that the out-patient access was not connected to the in-patient entrance. This meant that visitors and programmed in-patients accessed the building through the wrong access door and had to cross all the ground floor, intruding on other units, to arrive at the in-patient hall. These issues were not justifiable in such a recent design, an acute-care hospital of reference for a wide population, and with a generous ratio of area per bed (238 $m^2$ according to chapter 3.5).

# 4.3 Intensive Care Unit

## 4.3.1 Acute-care Hospital Placement

From the interviews performed in the Intensive Care Unit (ICU) at "Hospital de Dénia", the topics that came up were related to room area, privacy, security, lighting, ergonomics, temperature, views, outdoor contact, cleanliness and noise. Additionally, the interviews allowed for the description of several users scripts as follows (Fig. 131-Fig. 134).

*PATIENTS All patients were naked covered by a sheet and with a sanitary disposable product below them. Most of them were highly sedated. The conscious patients were those who had suffered a coronary disease. They spent all day in bed. When feeling well they spent their time reading, listening to the radio, watching people's movement in the unit, playing games on their smartphones or maintaining videoconferences with their relatives.*

*VISITORS The access to the ICU was limited to two people per patient for 30 minutes twice a day. Visitors did not spend time in the waiting room because they knew the unit schedule. They made acquaintance with other visitors because they saw each other daily. While in the patients' box, they took care of their loved one by talking to him or her, giving some massages or helping with some basic exercise. Relatives had no place to stay or sit in the box.*

*NURSES When nurses arrived at the ICU, they went through the changing rooms to change clothes and to the staff communication base to take over from the previous shift staff. Next, they did the patients' blood tests and sent them to the laboratory. After they washed patients together with the nursing assistants. If a rest was possible, they took a coffee at the staff rest room. After the break, they carried out special techniques and reviewed patients' treatments. During visiting time, they talked to the ones that required it. Next, they received the programmed admissions. Before finishing their shift, they had a small nursing session with the next shift co-workers. Finally, they went to the changing room to get their own clothes and leave the hospital.*

*Fig. 131 Coronary patient A interviewed in HD.*

*Fig. 132 Coronary patient B interviewed in HD.*

*Fig. 133 Wife of ICU patient. HD.*

*Fig. 134 Husband and children of ICU patient. HD.*

## 4.3.2 Literature Analysis

From literature analysis came the organisation of the ICU in five areas, which in turn might contain the rooms described in the next room schedule (Tab. 3). all the CURARQ-UCI tool requirements per each room can be read online.

| | Room | Function |
|---|---|---|
| Circulation | 1. Corridor | To allow for the horizontal movement of people and supplies. |
| Access | 2. External lobby and entrance | To enter the unit, for caregivers and visitors. |
| | 3. Reception desk | To give basic information to external visitors. |
| | 4. Waiting room | To spend time while waiting. |
| | 5. Visitors' changing room | To get appropriate clothing with access to hand hygiene. |
| | 6. Public toilet | To empty the body of urine or solid waste. |
| | 7. Interview room | To provide confidential information in private. |
| Clinical | 8. Staff communication base | To provide workspace and facilitate communication among staff members. |
| | 9. Clean utility room | To prepare and store medication. |
| | 10. Dirty utility room | To store dirty materials. |
| | 11. Patient's room | To receive critical care. |
| | 12. Isolation room | To treat infectious or immunocompromised patients. |
| | 13. Patient's toilet | To empty the body of urine or solid waste. |
| | 14. Staff rest room | To rest and relax. |
| | 15. Staff toilet | To empty the body of urine or solid waste. |

| | | |
|---|---|---|
| Staff | 16. Head nurse's office | To organise and supervise the work of nurses in the unit. |
| | 17. Head doctor's office | To organise and supervise the work of doctors in the unit. |
| | 18. Doctors' office | To provide workspace for doctors. |
| | 19. Seminar room | To gather clinical staff for teaching and communication sessions. |
| | 20. Admin office room | To provide workspace for administrative work. |
| | 21. Staff changing room | To get dressed and leave their personal clothing. |
| | 22. On call doctor's bedroom | To sleep during on call shifts. |
| Support | 23. Treatment room | To deliver complex procedures such as pacemaker implantation. |
| | 24. Laboratory | To examine blood samples and other biochemical analyses. |
| | 25. Internal lobby | To provide access to clinical and non-clinical staff and supplies. |
| | 26. Regeneration kitchen | To keep patient's food at the required temperature. |
| | 27. Cleaners' room | To store cleaning material. |
| | 28. Dirty linen room | To store dirty clothing before its transport to the laundry. |
| | 29. Linen store | To store clean clothing. |
| | 30. Clean supply room | To store small clean items. |
| | 31. Large equipment store | To store larger clean equipment. |
| | 32. Building services room | To store and maintain the needed services. |

*Tab. 3 Areas and rooms in the ICU.*

### 4.3.3 Acute-care Hospital Visits

#### "Hospital del Mar" (HdM)

The intensive care unit at HdM had a circular layout with zenithal natural light (Fig. 135-Fig. 136).

*Fig. 135 ICU at HdM.*

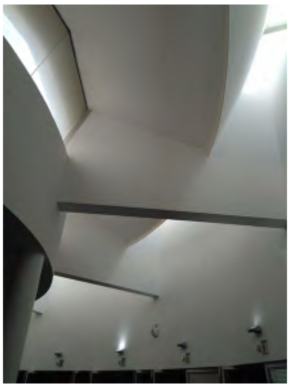


*Fig. 136 Zenithal light design strategy at HdM.*

## **"Hospital General Universitario de Ciudad Real" (HGUCR)**

The ICU at HGUCR had windows in the patient boxes and indirect natural lighting for the whole unit (Fig. 137).

*Fig. 137 Light openings in the ICU at HGUCR. Figure by [50].*

## **"Sahlgrenska Universitetssjukhuset" (SAHLH)**

The thorax intensive care unit at SAHLH was a unit for eight patients arranged in double bedrooms (Fig. 138-Fig. 154). There were control cabinets each pair of bedrooms for patient control and monitoring.

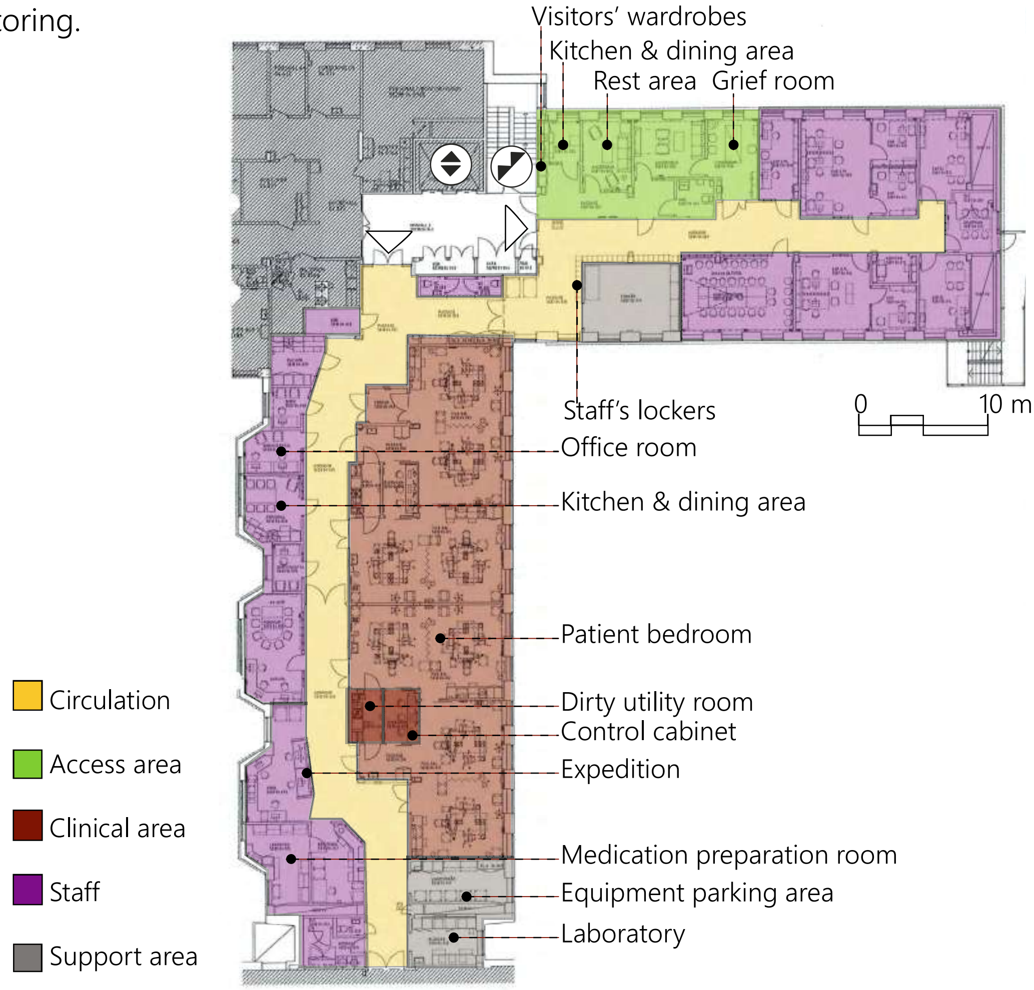



*Fig. 138 Thorax Intensive Care Unit layout at SAHLH.*

*Fig. 139 Double patient room. Folding screens between patients. Equipment hung on the ceiling. Radiators for heating. SAHLH.*

*Fig. 140 Work area and consumables in the patient room. SAHLH.*

*Fig. 141 Hand basin and visitors' chair hung on the wall. Water pipes installation visible. SAHLH.*


*Fig. 142 Environmental conditions control for the patient room. SAHLH.*

*Fig. 143 Access to control cabinet. SAHLH.*

*Fig. 144 Air mattress for patients. SAHLH.*

*Fig. 145 Bed movement control powered by electricity. SAHLH.*

*Fig. 146 Medication preparation ante room with view to corridor. SAHLH.*

*Fig. 147 Medication preparation area for hazardous substances. SAHLH.*

*Fig. 148 Medication preparation room with restricted access. SAHLH.*


*Fig. 149 Expedition. SAHLH.*

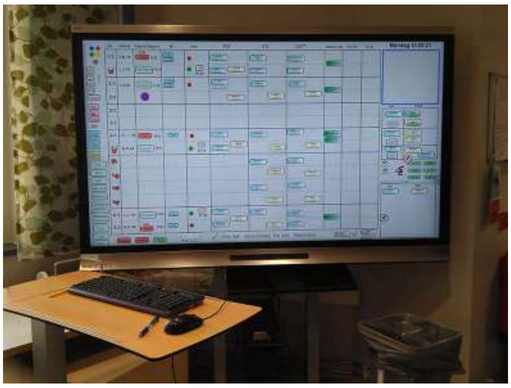


*Fig. 150 Touchscreen for patient coordination. SAHLH.*

*Fig. 151 Office for staff with a casual area. SAHLH.*

*Fig. 152 Interior of staff lockers. An upper compartment for documents and a bigger one for valuable objects. SAHLH.*

*Fig. 153 Lockers for relatives' belongings, next to the relatives' access to the unit and the kitchen and dining area. SAHLH.*

*Fig. 154 Rest room for relatives with direct access to RIP room. SAHLH.*

## Östra Hospital" (ÖH)

The ICU at ÖH had a double-corridor arrangement with the staff and support areas with no day light (Fig. 155-Fig. 167).


*Fig. 155 ICU layout at ÖH.*

*Fig. 156 ICU corridor at ÖH.*

*Fig. 157 Chairs for relatives hung on the corridor wall. ÖH.*

*Fig. 158 Quadruple patient bedrooms. ÖH.*

*Fig. 159 Black skirting and wall-mounted cabinets for storage. ÖH.*

*Fig. 160 Workstation for staff in the patient bedroom. ÖH.*

*Fig. 161 Expedition with high counter as it did not work as a reception desk. ÖH.*

*Fig. 162 Sitting area at the corridor end. ÖH.*

*Fig. 163 Large equipment storage room. ÖH.*

*Fig. 164 Laboratory. ÖH.*

*Fig. 165 Supply room. ÖH.*

*Fig. 166 Dirty utility room. ÖH.*

*Fig. 167 Hidroalcoholic solution dispenser with a dustpan. ÖH.*

## "Skånes Universitetssjukhus" (SKU)

The ICU unit at SKU had control cabinets between the patient bedrooms (Fig. 168-Fig. 181).

*Fig. 168 Mobile equipment parking area. SKU.*

*Fig. 169 Unit corridor. SKU.*

*Fig. 170 Panel with design updates for staff to comment and give feedback. SKU.*

*Fig. 171 Dashboard for patient coordination. SKU.*

*Fig. 172 Patient bedroom with double capacity and ceiling lift. SKU.*

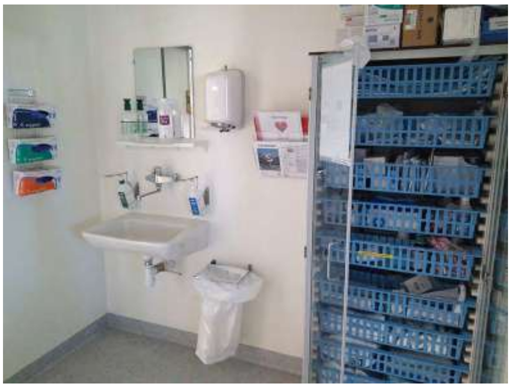


*Fig. 173 Basin and storage in the patient room. SKU.*

*Fig. 174 Laundry trolley for patient pillows and installation for dyalisis treatment. SKU.*

*Fig. 175 Patient equipment for moving arms and legs like on a bicycle from the bed in a lying position. SKU.*

*Fig. 176 Control cabinet for the supervision of two double bedrooms. SKU.*

*Fig. 177 Patient bathroom with toilet and shower. SKU.*

*Fig. 178 Equipment to be hung on patient's bed. SKU.*

*Fig. 179 Linen storage. SKU.*

*Fig. 180 Assisted bathroom. SKU.*

*Fig. 181 Grief room for relatives. SKU.*

## 4.3.4 Acute-care Hospital Cases

Fig. 182 shows the location of the evaluated ward.

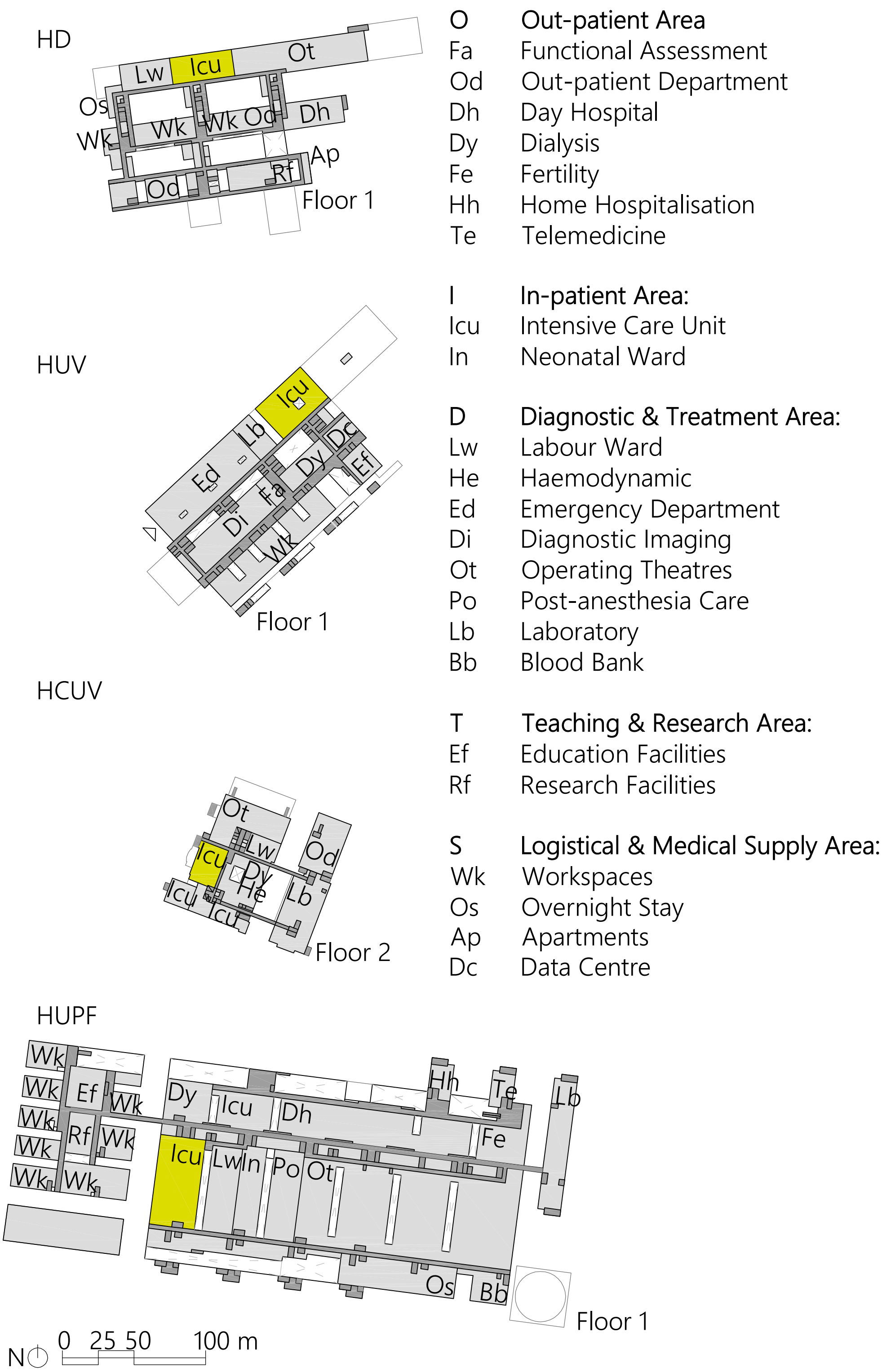



*Fig. 182 Location of the ICU evaluated.*

## "Hospital de Dénia" (HD)

The ICU was located on the first floor between the labour ward and the surgical unit. It had two accesses: one that connected this unit directly to the surgical unit and another both for the internal and external access from the internal corridor (Fig. 183-Fig. 184). The unit had 14 individual boxes, six of them with no natural light.

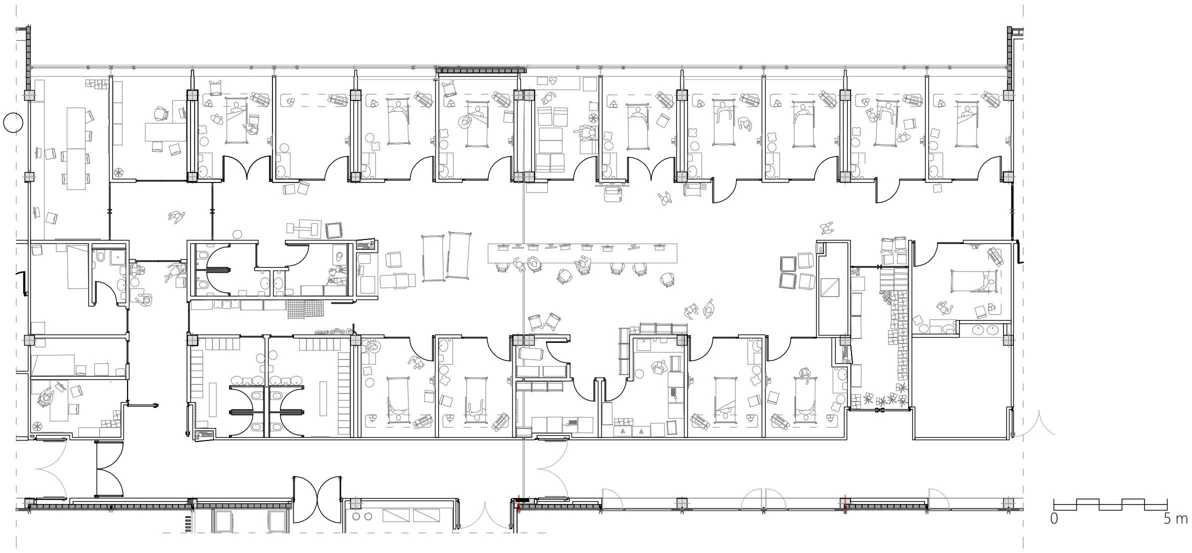



*Fig. 183 ICU layout with furniture at HD.*

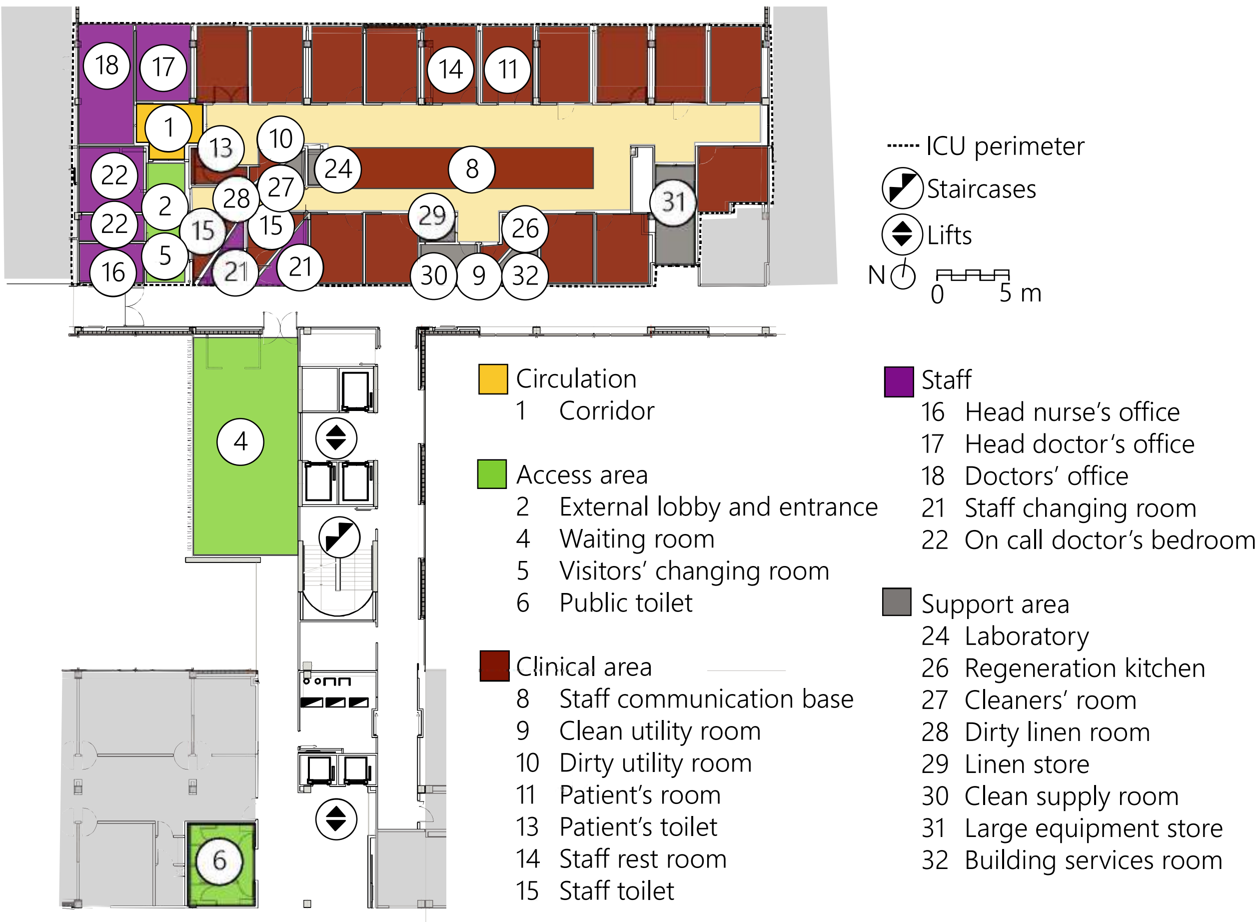



*Fig. 184 Evaluated rooms ICU HD.*

## “Hospital Universitario del Vinalopó” (HUV)

The ICU at HUV was located on the first floor next to the laboratories and the emergency department (Fig. 185). The access to the unit was through the internal circulation of the acute-care hospital. The clinical area had 14 individual boxes and two more boxes with anteroom. All of them had natural lighting.

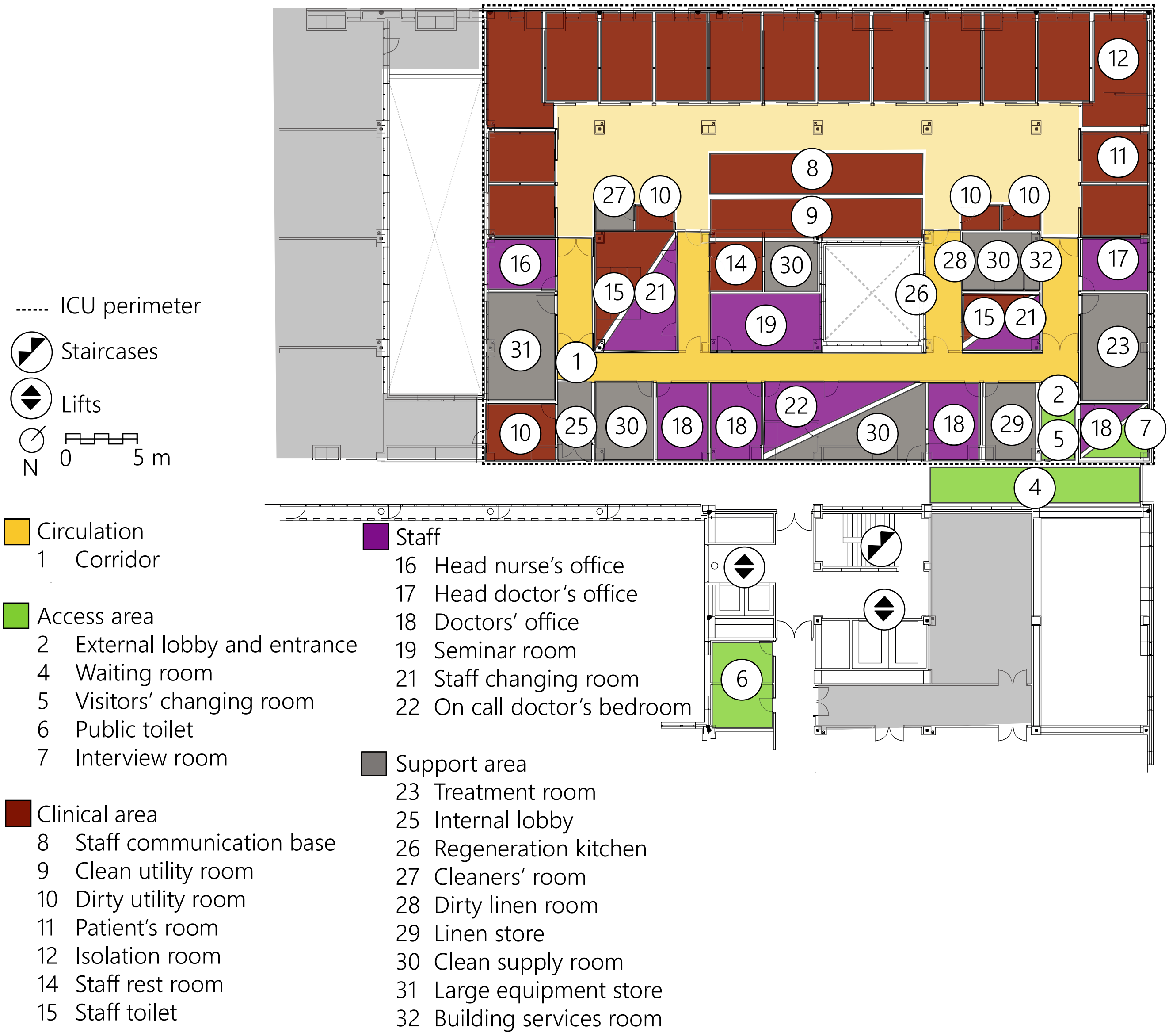
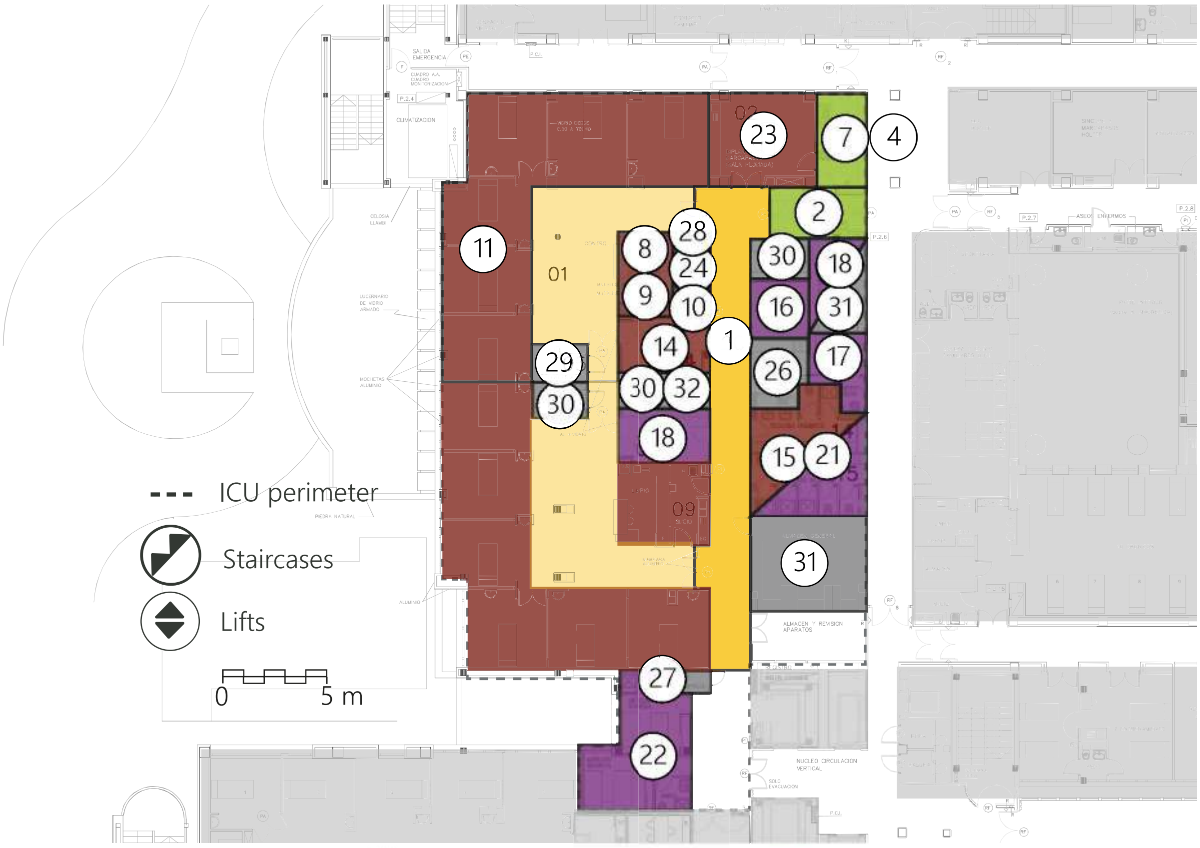



*Fig. 185 Evaluated rooms ICU HUV.*

## "Hospital Clínico Universitario de Valencia" (HCUV)

The evaluation of HCUV was done in the surgical intensive care unit, which had a renovated design (Fig. 186). The unit was located on the second floor of the acute-care hospital, next to two other ICUs (one medical care unit and one coronary care unit), the labour ward, the haemodynamic area and haemodialysis. The ICU had two clinical areas with six individual boxes each one (twelve in all).




**Circulation**
1 Corridor

**Access area**
2 External lobby and entrance
4 Waiting room
7 Interview room

**Clinical area**
8 Staff communication base
9 Clean utility room
10 Dirty utility room
11 Patient's room
14 Staff rest room
15 Staff toilet

**Staff**
16 Head nurse's office
17 Head doctor's office
18 Doctors' office
21 Staff changing room
22 On call doctor's bedroom

**Support area**
23 Treatment room
24 Laboratory
26 Regeneration kitchen
27 Cleaners' room
28 Dirty linen room
29 Linen store
30 Clean supply room
31 Large equipment store
32 Building services room

*Fig. 186 Evaluated rooms ICU HCUV.*

## "Hospital Universitari i Politècnic La Fe" (HUPF)

The ICU at HUPF was located on the second floor next to the labour ward, the neonatal ward, paediatric intensive care unit, post-anaesthetic care unit, haemodialysis and day hospital (Fig. 187). The unit had two opposite accesses, one internal and another external. The unit configuration was of a rectangular shape with a longitudinal corridor that arranged the staff and support rooms at one side and the three clinical areas at the other side. Each clinical area had a maximum capacity of twelve patients (thirty-six in all).

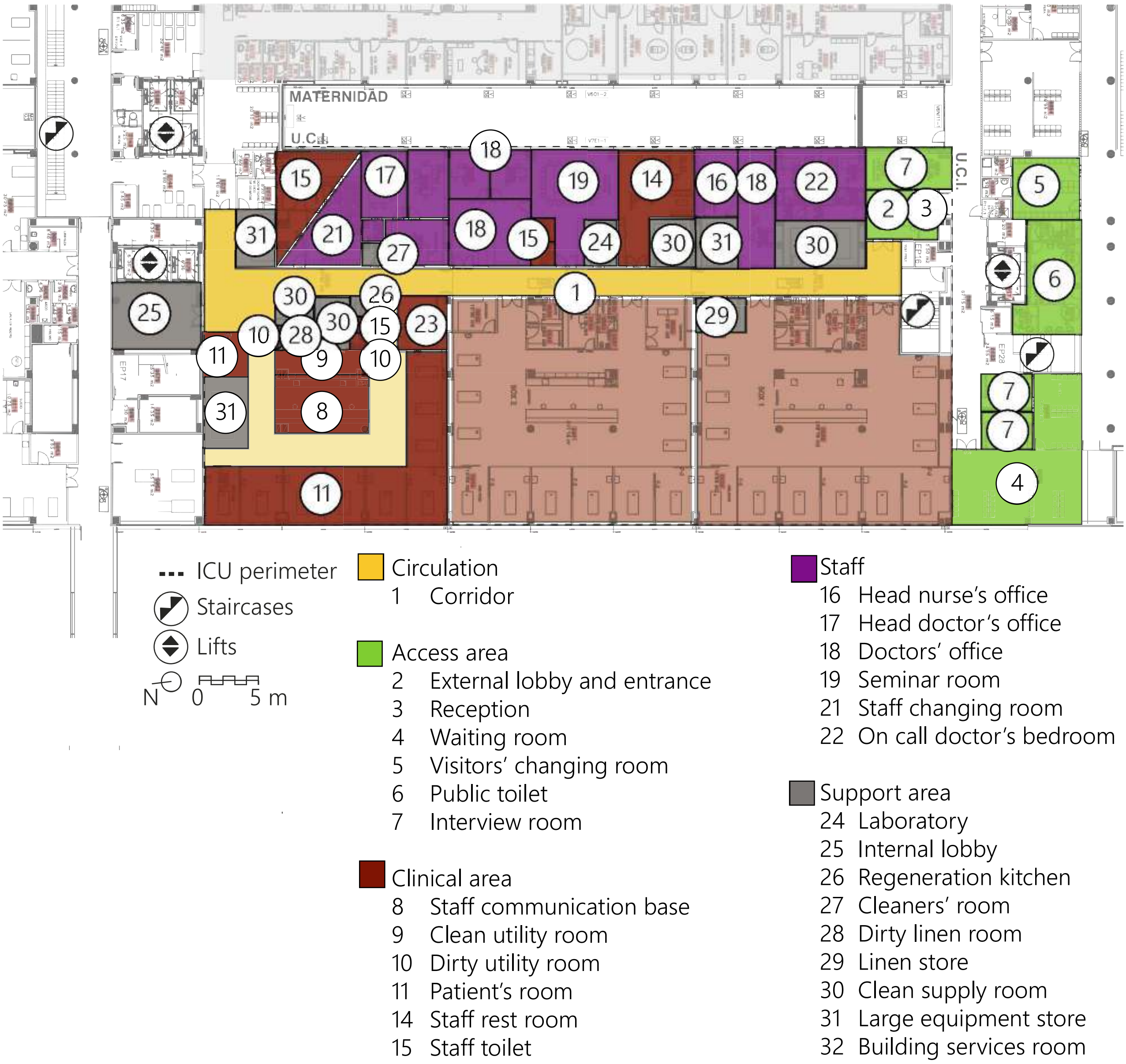



*Fig. 187 Evaluated rooms ICU HUPF.*

## Evaluation Results

Fig. 188 shows the results obtained following the evaluation process described in chapter 4.1.2, with CURARQ-UCI tool. The global scores in each acute-care hospital were over 60%. The acute-care hospital with the highest score was HD, closely followed by HUV, then HUPF and the worst scores went to HCUV. For a detailed analysis of each item, the results are available online [20]. Next, there is a summary of the main findings and some photographs of the rooms evaluated organised by areas.

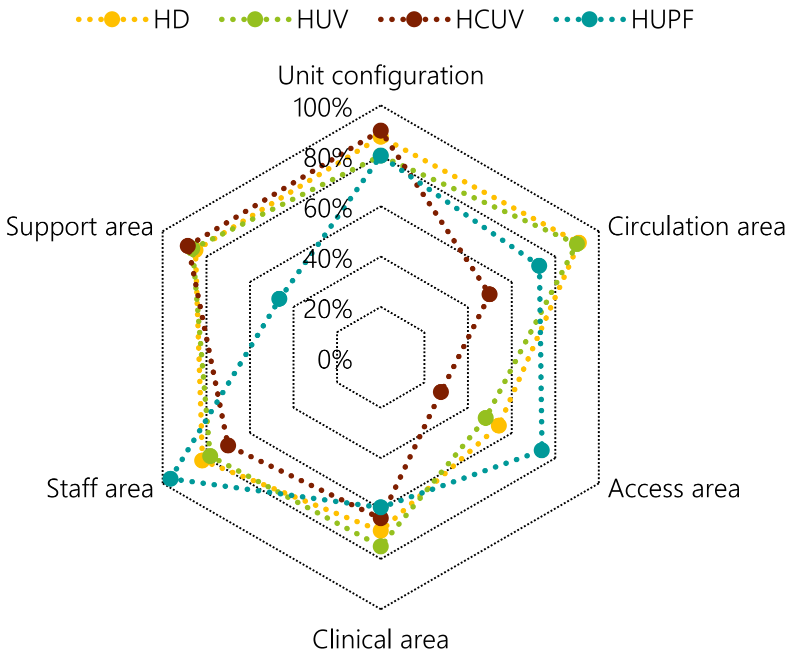



*Fig. 188 CURARQ-UCI results.*

Regarding the unit configuration, the four acute-care hospitals could be arranged in pairs based on the healthcare services provided. While HD and HUV had a smaller unit with only one staff communication base, HCUV and HUPF had higher complexity units with several clinical areas. The requirements analysed in this category were regarding the relationship of the unit with the rest of the acute-care hospital (mainly the operating theatres, emergency department, diagnostic imaging and standard wards), the number of accesses (at least one for internal and another for the external flow), and the presence of artistic installations.

The circulation area referred to the unit corridor. HCUV got the lowest percentage because the corridor width was narrower than 2.4 m and the finishing materials were not resistant enough. In addition to the unit corridor, in some units there was another corridor in the clinical area (between the staff communication base and the patients' boxes).

Very few rooms were found in the access area of the ICUs. The units in HD and HUV shared the access hall with the visitors' changing area (Fig. 189). Only HUPF had a reception desk (Fig. 190). The waiting area for HD and HUPF units was outside the perimeter of the unit and in HD it was shared with the labour ward. The waiting room in HUV and HCUV was in a corner of the corridor without proper amenities for visitors.

In all four acute-care hospitals, the staff communication base was an open area in the centre of the clinical room to facilitate visual control of patients' boxes (Fig. 191-Fig. 193).

All the patients' boxes had a square area smaller than the recommended 25 m$^2$ and only HUV had two isolation rooms with ante room for infectious patients (air system with negative pressure) or immunocompromised patients (air system with positive pressure) (Fig. 194-Fig. 197). Only in HUV all patients' boxes had natural light and in HCUV boxes the bed's relative position allowed for patients to see through the windows (Fig. 196). Moreover, the initial design of HD and HUV had two patients' toilets (one for each gender). In HD only one was left and the other one was converted into a dirty utility room and cleaning room. In HUV none of them was left.

In the staff area, the on-call bedroom at HUV was improvised in the area originally designed for the visitors' waiting room. Thus, the room was excessively big and was also used as a storage area. Additionally, the toilets were designed for public use and on-call doctors did not have showers. Regarding the staff changing room, it was seen that at HD the available floor area for women and men was the same but at HUV, HCUV and HUPF there was more floor area for women than for men as it was more adjusted to the current staff gender proportion.

Regarding the support area (Fig. 198-Fig. 201), because of the healthcare services provided, HCUV and HUPF had a treatment room which was similar to a small operating theatre. Furthermore, in the support area of HD, one of the original accesses had been reconverted into a room for large equipment storage (Fig. 198). Additional storage area was also needed at HUPF, and some equipment was found in corridors. The scores of HUPF are the lowest because the storage rooms were too small, for example the cleaning room did not fit the cleaner's trolley. In other cases, several functions (such as dirty linen, food trolleys or building services) were combined in the same room without adding extra floor area.

*Fig. 189 Access to ICU at HUV.*

*Fig. 190 Reception desk to ICU at HUPF.*

*Fig. 191 Staff communication base at HD.*

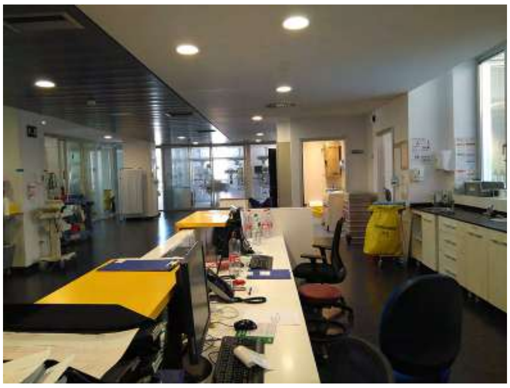


*Fig. 192 Staff communication base at HUV.*

*Fig. 193 Staff communication base at HCUV.*

*Fig. 194 Patient's box at HD.*

*Fig. 195 Patient's box at HUV.*

*Fig. 196 Patient's box at HCUV.*

*Fig. 197 Patient's box at HUPF.*

*Fig. 198 Large equipment store at HD.*

*Fig. 199 Large equipment store at HUV.*

*Fig. 200 Large equipment store at HCUV.*

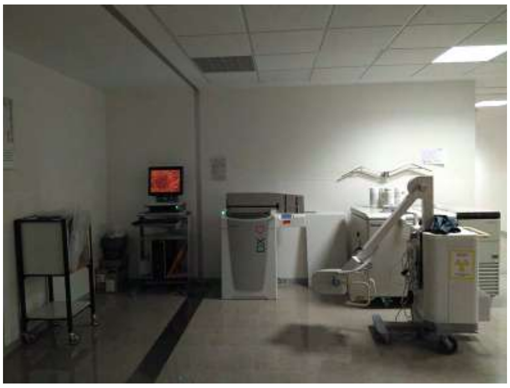


*Fig. 201 Large equipment store at HUPF.*

### 4.3.5 Discussion

During the three-month acute-care hospital placement, it was difficult to perform interviews. Staff had an intense workload, and they were hard to meet. Additionally, there were few conscious patients and caregivers had restricted visiting hours. All these factors resulted in more time invested in this unit than in other less complex wards.

In all the Spanish acute-care hospital visits, the unit configuration was very similar, with a centralised staff communication base almost open and located in the middle of the clinical area. The Swedish ICUs however, showed a segregation of patient bedrooms (single, double, or quadruple) with smaller control cabinets for clinical staff.

Regarding the results of the acute-care hospital cases, the worst scores went to the access area. When the functional needs of healthcare staff were not resolved, staff incorporated rooms originally designated for relatives for their own usage. The scarcity of floor area per patient together with the lack of support rooms for relatives does not encourage the involvement of relatives in the care of patients which may hinder family satisfaction and end of life care [21-23].

The current tendency towards the humanisation of ICU will need a reconfiguration of the unit rooms [24]. For example, if the units are open all day to relatives, there will be no need for waiting rooms but other amenities for visitors (toilets, showers and dining areas) will be required. It will be necessary for the ICU to offer a less clinical environment, with bigger floor areas in the patient bedrooms (to promote relatives' engagement and ease staff work) and more support rooms for relatives.

# 4.4 Standard Ward

## 4.4.1 Acute-care Hospital Placement

From the interviews performed in the internal medicine ward at "Hospital de Dénia", the main issues that came up were: noise, lighting, views, ventilation, hygiene, privacy, ergonomics, security, and room area. Additionally, the interviews allowed for the description of several users' scripts as follows (Fig. 202-Fig. 204).

*Fig. 202 Room interview with caregiver and patient. HD.*

*Fig. 203 Caregiver interviewed during a room interview. HD.*

*Fig. 204 Interviewing a nurse. HD.*

*PATIENTS: They had very limited functional and cognitive activity, some of them were unconscious. In the case of a conscious women, she could not move by herself; the porters sat her on the sofa so that she was not always lying on the bed. She wore diapers and the assistant nurses washed and changed her.*

*RELATIVES: Given that the hospital was in a very touristic area for international retired people, many patients stayed at the hospital without any relatives. There were less caregivers available and less visitors to interview. The script for two of the caregivers interviewed was:*

> *Testimony A. In the morning, about 6 am the nurse came into the room. At 8 am she went downstairs with her new hospital mate (a caregiver from a neighbouring room) to have breakfast at the café. After that, they went to the bus station so that her friend could smoke and came back to her mother's bedroom. Housekeeping staff cleaned the room, and the assistant nurse washed her mother. Next, the doctor saw her mother. There was a lot of movement in the mornings. Staff brought the food and she served it to her mother. After that, she went downstairs to the café for her food. When she was done, she came back to the room, sat on the sofa to watch TV. In the evening she fed her mother and kept herself entertained (reading, watching TV or playing with her smartphone). She did not use the ward's waiting room because she did not know how to prepare coffee in the coffee machine and she preferred to stay with her mother, she did not walk too far away from her room. She did not use the nurse's call system because she preferred to walk to the nursing control and have personal contact with them.*

> *Testimony B. When she woke up, she took a painkiller because sleeping on the sofa was very uncomfortable. In the morning she went downstairs to have breakfast at the café. The assistant nurses washed her husband*

> *while she stayed outside the room. The porters sat her husband on the armchair so that he changed his body posture. She sat on the sofa and read. She fed him when they brought the food and went to the café for her lunch. She bought a sandwich for dinner while in the café so that she did not have to go again. She spent the whole evening in the room. When moving from the room to the café she always chose the same route so that she did not get lost. She made a new friend while in the hospital and kept herself entertained reading, talking to her friend and watching TV.*

*NURSES: Nurses arrived at the hospital by car and parked at the car park. Then, they either went to the centralised staff changing room in the basement or to an improvised changing room in the staff toilet room next to the control station, it depended on if they had a locker assigned in the basement or on the time available, as the distance from the basement to the ward was long. Once changed, they went to the staff rest room to safe keep their handbag and to the nursing counter for the handover from the previous shift. Next, they reviewed the medication prepared in the medication trolley, printed patients' diets and went to the patients' bedrooms and corridors for the ward round. They did the blood test and took vital signs as needed. Once finished, they went back to the medication preparation room to prepare the next medication in the trolley. They attended patients' admissions from the intensive care unit and the emergency unit. They updated the monitoring information of each patient at the counter and did all the administrative work on the counter computers. For resting and eating they used the staff rest room.*

## 4.4.2 Literature Analysis

From the literature analysis came the organisation of a standard ward that can be arranged according to six areas which in turn might contain the rooms shown in Tab. 4. All the CURARQ-H tool requirements per each room can be read online.

| | Room | Function |
|---|---|---|
| Circulation | 1. Corridor | To allow for the horizontal movement of people and supplies. |
| Access | 2. External lobby and entrance | To enter the unit, for caregivers and visitors. |
| | 3. Waiting room | To spend time while waiting. |
| | 4. Public toilet | To empty the body of urine or solid waste. |
| | 5. Interview room | To provide confidential information in private. |
| Patient and family care | 6. Patient's bedroom | To receive in-patient care. |
| | 7. Patient's toilet | To empty the body of urine or solid waste. |
| | 8. Patients' rest room | To spend time outside their bedroom. |

| | | |
|---|---|---|
| Nursing control | 9. Counter | To visually control the whole ward. |
| | 10. Nurses' office room | To provide workspaces for nurses. |
| | 11. Staff rest room | To rest and relax. |
| | 12. Clean utility room | To prepare and store medication. |
| | 13. Head nurse's office | To organise and supervise the work of nurses in the unit. |
| | 14. Staff toilet | To empty the body of urine or solid waste. |
| | 15. Treatment room | To provide special treatment when bedrooms are not appropriate. |
| | 16. Assisted bathroom | To wash patients when toilet is not appropriate (e.g., bariatric). |
| Staff | 17. Doctors' office | To provide workspaces for doctors. |
| | 18. Staff changing room | To get dressed and leave their personal clothing. |
| Support | 19. Internal lobby | To provide access to clinical and non-clinical staff and supplies. |
| | 20. Regeneration kitchen | To store patients' food at the required temperature. |
| | 21. Dirty utility room | To store dirty materials. |
| | 22. Cleaners' room | To store cleaning material. |
| | 23. Dirty linen room | To store dirty clothing before transport to the laundry. |
| | 24. Linen store | To store clean clothing. |
| | 25. Clean supply room | To store small clean items. |
| | 26. Large equipment store | To store larger clean equipment. |

*Tab. 4 Areas and rooms in the standard ward.*

## 4.4.3 Acute-care Hospital Visits

### "Hospital de la Santa Creu i Sant Pau" (HSCSP)

The four wings of the HSCSP had a similar layout arrangement for the wards with a central corridor, the staff area next to the access, patients' bedrooms at both sides of the corridor and a rest room for patients at the end of the unit (Fig. 205-Fig. 208).

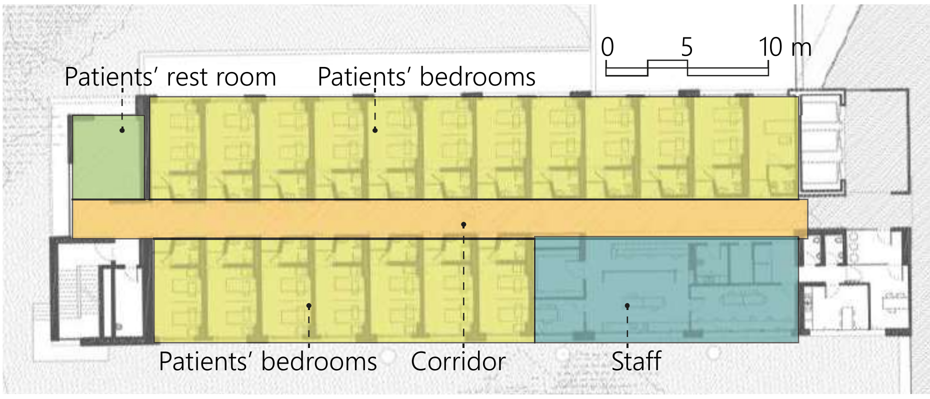



*Fig. 205 Ward diagram. HSCSP.*

*Fig. 206 Regeneration kitchen next to the service lifts. HSCSP.*

*Fig. 207 Ward corridor. HSCSP.*


*Fig. 208 Patients' rest room. HSCSP.*

## "Hospital Sant Joan Despí Moisès Broggi" (HSJDMB)

The acute-care hospital had "L" shaped wards with the nursing control in the vertex (Fig. 209-Fig. 213). One wing of the ward had natural light for the corridor and the other had patient bedrooms on one side and the staff and support area on the other side. Each ward had 19 double patient bedrooms. All patient bedrooms faced an open courtyard with vegetation.

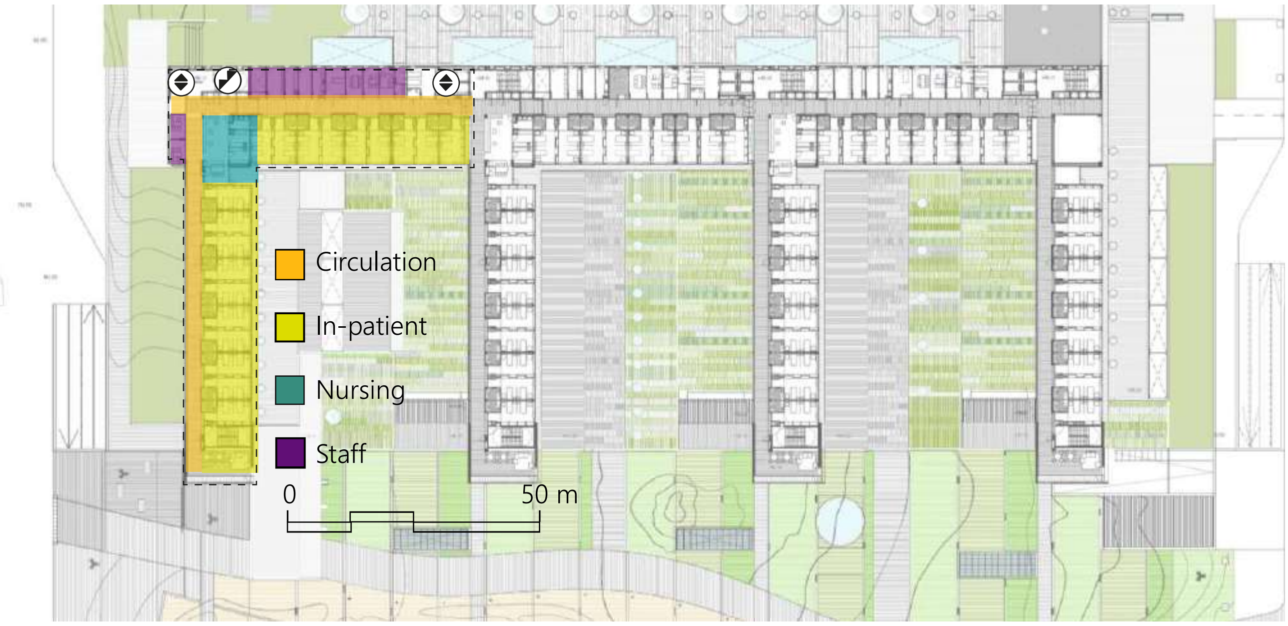



*Fig. 209 Second floor. HSJDMB.*

*Fig. 210 Outdoor vegetation surrounding the wards. HSJDMB.*

*Fig. 211 Internal view of nursing control counter. Zenithal natural light. HSJDMB.*

*Fig. 212 Ward corridor with side openings at a lower height to avoid views to the next wards. HSJDMB.*

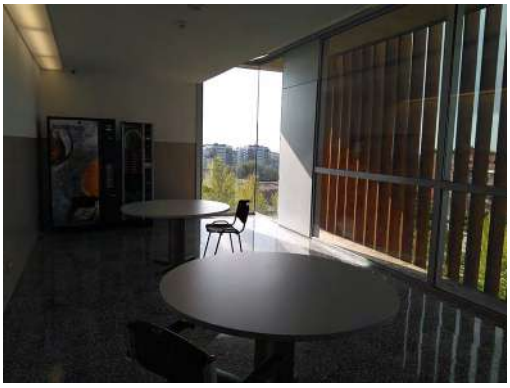


*Fig. 213 Sitting area and external views at the end of the ward corridor. HSJDMB.*

## "Hospital Universitario Central de Asturias" (HUCA)

The in-patient wards at HUCA were in a longitudinal block (Fig. 214-Fig. 219). There were three wards per floor and each unit had a central corridor with one side dedicated to patients' bedrooms and the other side to the staff area. Thus, all patients' bedrooms were facing the south. There was also an internal staff and services corridor in the staff area facing the north.

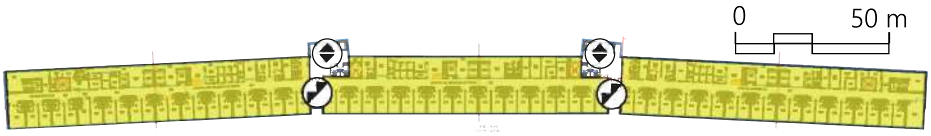



*Fig. 214 Layout arrangement of the sixth floor. HUCA.*

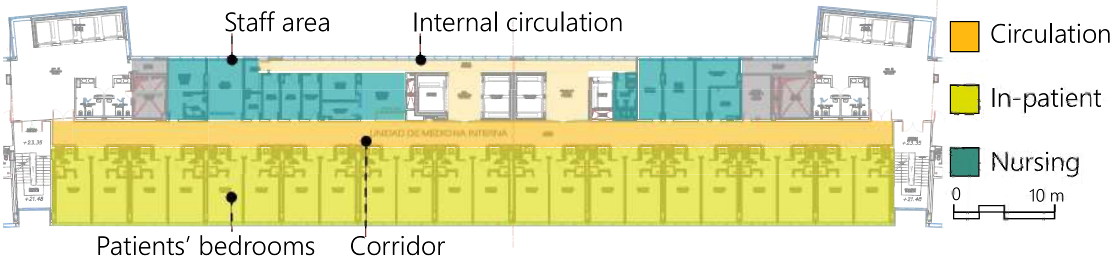



*Fig. 215 Ward layout. HUCA.*

*Fig. 216 Ward corridor in the in-patient unit. HUCA.*

*Fig. 217 Service lift lobby with service robot parking area. HUCA.*

*Fig. 218 Counter and nurses' office room. HUCA.*

*Fig. 219 Outdoor views from the in-patient's bed. HUCA.*

## "Sahlgrenska Universitetssjukhuset" (SAHLH)

The internal medicine ward at SAHLH was located in a designated building block for in-patients that had two F-shape nursing units, mirroring each other, per floor (Fig. 220-Fig. 232). The lifts core was located in the middle of the two units' intersection, dividing an internal courtyard in two. The staff area faced the internal courtyard while the patient area had views to the outdoors. There was a reception desk and a kitchen and dining/living room for patients to encourage their stay outside their rooms. The dining room even had a terrace for being outdoors.

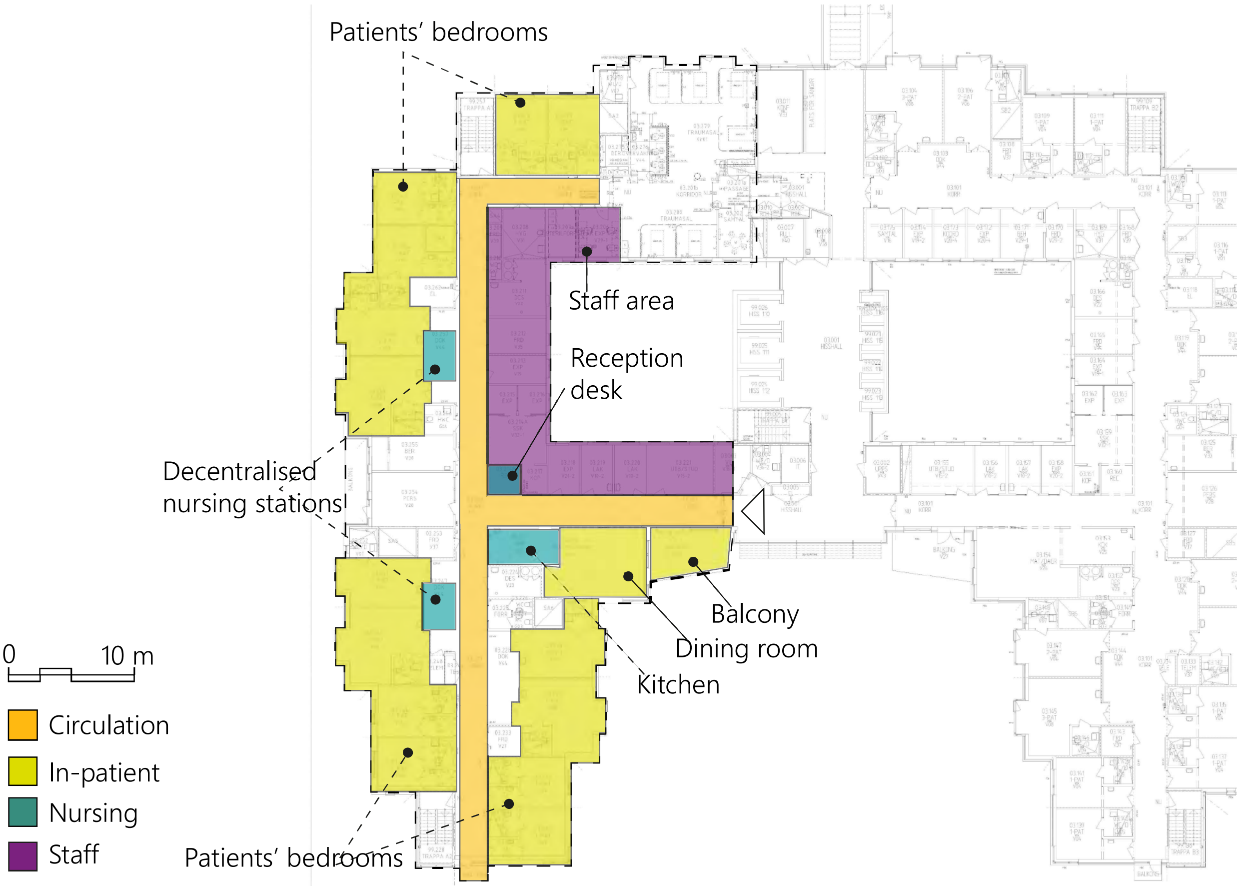



*Fig. 220 Ward layout at SAHLH.*

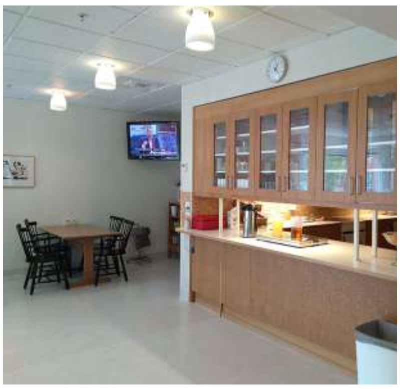


*Fig. 221 Kitchen for patients' food. SAHLH.*

*Fig. 222 Interior of kitchen. SAHLH.*

*Fig. 223 Dining and living area for patients. SAHLH.*

*Fig. 224 Medication room with restricted access for nurses only and a window to the corridor. SAHLH.*

*Fig. 225 Patient's bathroom with contrasting colours for walls and floor, wall hung toilet and flat shower. SAHLH.*

*Fig. 226 Staff preparation area before patient bedroom. SAHLH.*

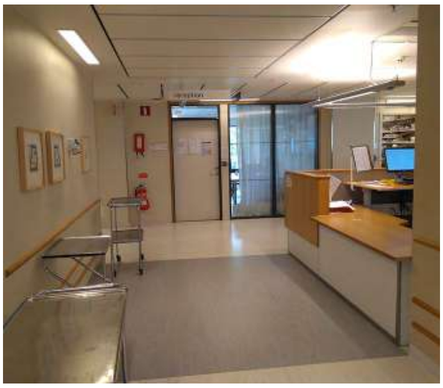


*Fig. 227 Reception desk for administrative tasks. SAHLH.*

*Fig. 228 Ward corridor with art, handrails, bump rails, a designated floor area for equipment and natural views. SAHLH.*

*Fig. 229 Designated area for parking mobile equipment. SAHLH.*

*Fig. 230 Decentralised nursing station. SAHLH.*

*Fig. 231 Interior of the decentralised nursing station. SAHLH.*

*Fig. 232. Hall call device for nurses. They receive calls from designated patients with the room number. SAHLH.*

## "Skåne Universitetssjukhus" (SKU)

The in-patient wards of the department of internal medicine at SKU was located in an independent block with a rectangular shape (Fig. 233-Fig. 251). This building had four ward floors with the same layout configuration. The ward was organised in a double corridor strategy with the vertical circulation at one extreme of the block. Patients' bedrooms were located at both longitudinal façades (with opposite orientation) and the staff area was mainly located in the middle of the rectangle with some rooms also at the façades. There was a reception desk next to the access point to the unit and decentralised nursing stations.

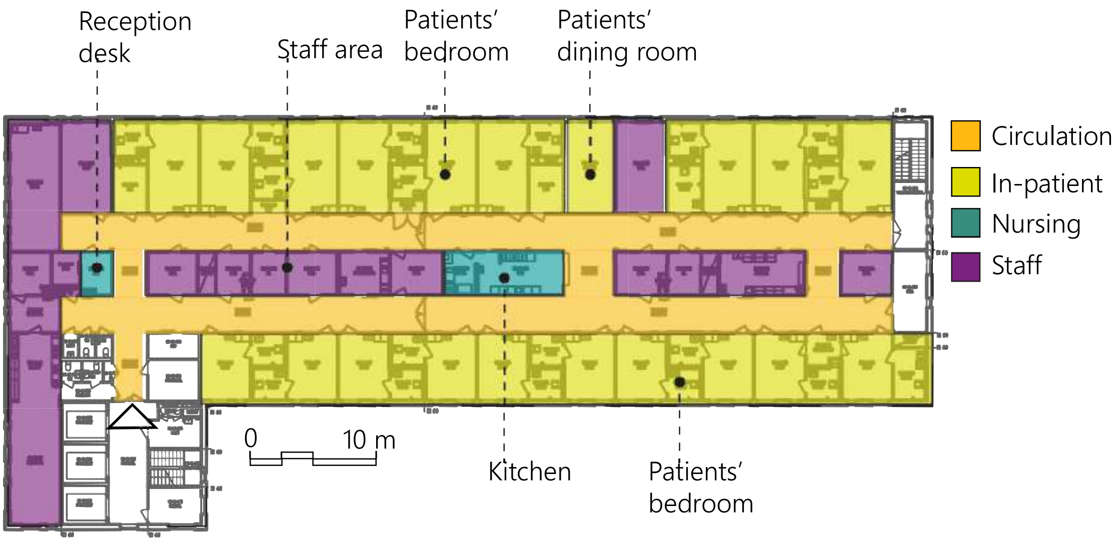



*Fig. 233 Ward layout at SKU.*

*Fig. 234 Patient's bedroom with ceiling lift, heaters, and lighting. SKU.*

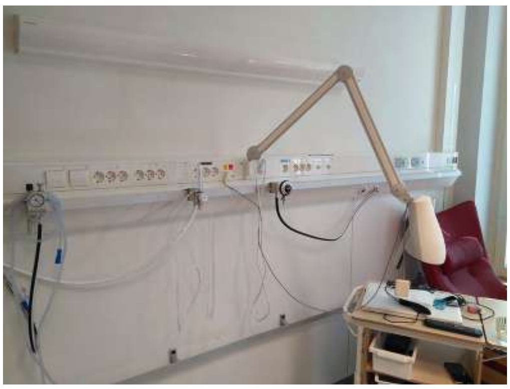


*Fig. 235 Detail of headboard equipment with rail to move gas tubes. SKU.*

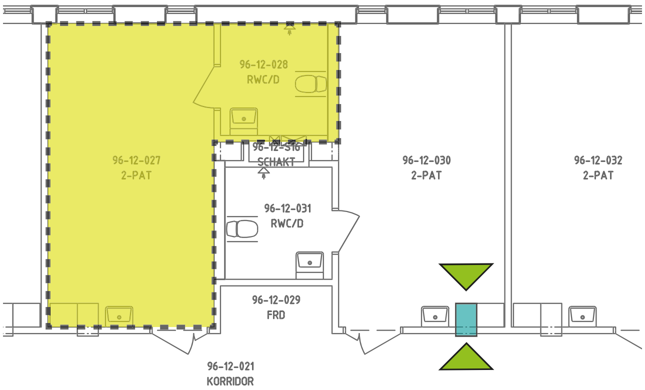



*Fig. 236 Patient's bedroom cupboard with dual access so that staff did not need to enter the bedroom for replacing supplies. SKU.*

*Fig. 237 View of the dual access cupboard from the patient's bedroom. SKU.*

*Fig. 238 Security system for patient's personal belongings. SKU.*

*Fig. 239 Patient's bathroom with flat shower and contrasting colours. SKU.*

*Fig. 240 Continuation of patient's bathroom SKU.*

*Fig. 241 Assisted bathroom next to dining room. SKU.*

*Fig. 242 Regeneration kitchen for patients' food. SKU.*

*Fig. 243 Dining area for patients. SKU.*

*Fig. 244 Continuation of patients' dining room with whiteboard displaying the menu. SKU.*

*Fig. 245 Clean supply room SKU.*

*Fig. 246 Storage cupboards along the corridors. SKU.*

*Fig. 247 Rest area for patients and visitors. SKU.*

*Fig. 248 Staff kitchen and dining area. SKU.*


*Fig. 249 Reception desk. Counter with an area recessed for placing walking aids. SKU.*

*Fig. 250 Ward corridor with indirect artificial light, handrails and art pieces. SKU.*


*Fig. 251 Nurses' hall call system on the corridor ceiling. SKU.*

## "Universitetssjukhuset i Linköping" (ULKÖ)

The ward analysed was that for orthopaedic patients (Fig. 252-Fig. 263). Recent rehabilitation had been done over a pre-existing pavilion. The ward was arranged with a double corridor with staff area in the middle of the rectangle (with no natural light). Patients' bedrooms were located in both sides of the pavilion. There was a dining and sitting area for patients and a kitchen for staff preparation of patients' meals. There were four nursing stations between the patients' bedrooms.


*Fig. 252 Ward layout at ULKÖ.*

*Fig. 253 Reception desk at the ward entrance. ULKÖ.*

*Fig. 254 Sitting area at the end of the ward corridor for visitors and patients. ULKÖ.*

*Fig. 255 Patient bedrooms with vertical headboard equipment. ULKÖ.*

*Fig. 256 Handrail from bed to toilet. ULKÖ.*

*Fig. 257 Patient toilet with flushed shower (it is possible to shower a patient lying on a stretcher. ULKÖ.*

*Fig. 258 Ante room and access to the patient toilet. ULKÖ.*

*Fig. 259 Staff preparation area. ULKÖ.*

*Fig. 260 Ceiling equipment for artificial lighting, air conditioning and fire detection. ULKÖ.*


*Fig. 261 Light switch for different options: day, evening, night and exploration. ULKÖ.*

*Fig. 262 Regeneration kitchen for patients' food preparation. ULKÖ.*

*Fig. 263 Patients' and visitors' dining and resting area. ULKÖ.*

## "Nya Karolinska Solna" (NKS)

The in-patient wards at NKS were arranged in rectangular pavilions with two accesses from both extremes, one for public and one for internal flows (Fig. 264-Fig. 266). The ward had a double corridor with the staff area in the middle of the unit (with no natural light).

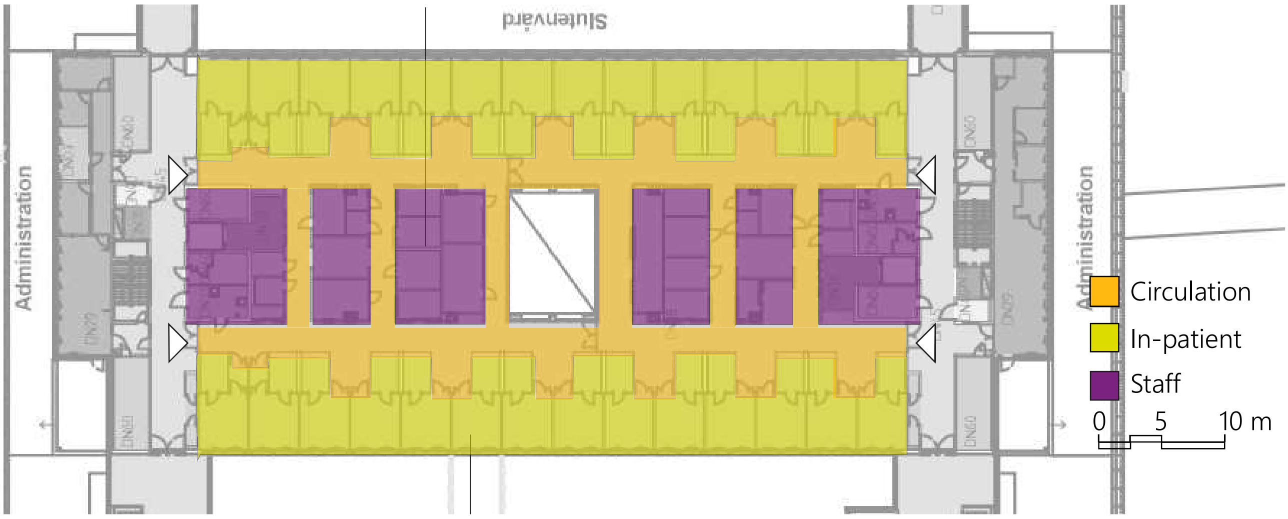



*Fig. 264 Ward layout at NKS.*

*Fig. 265 Designated ward for staff training NKS.*

*Fig. 266 Layout annotations for staff training NKS.*

## 4.4.4 Acute-care Hospital Cases

Fig. 267 shows the location of the evaluated ward within each of the four acute-care hospitals.

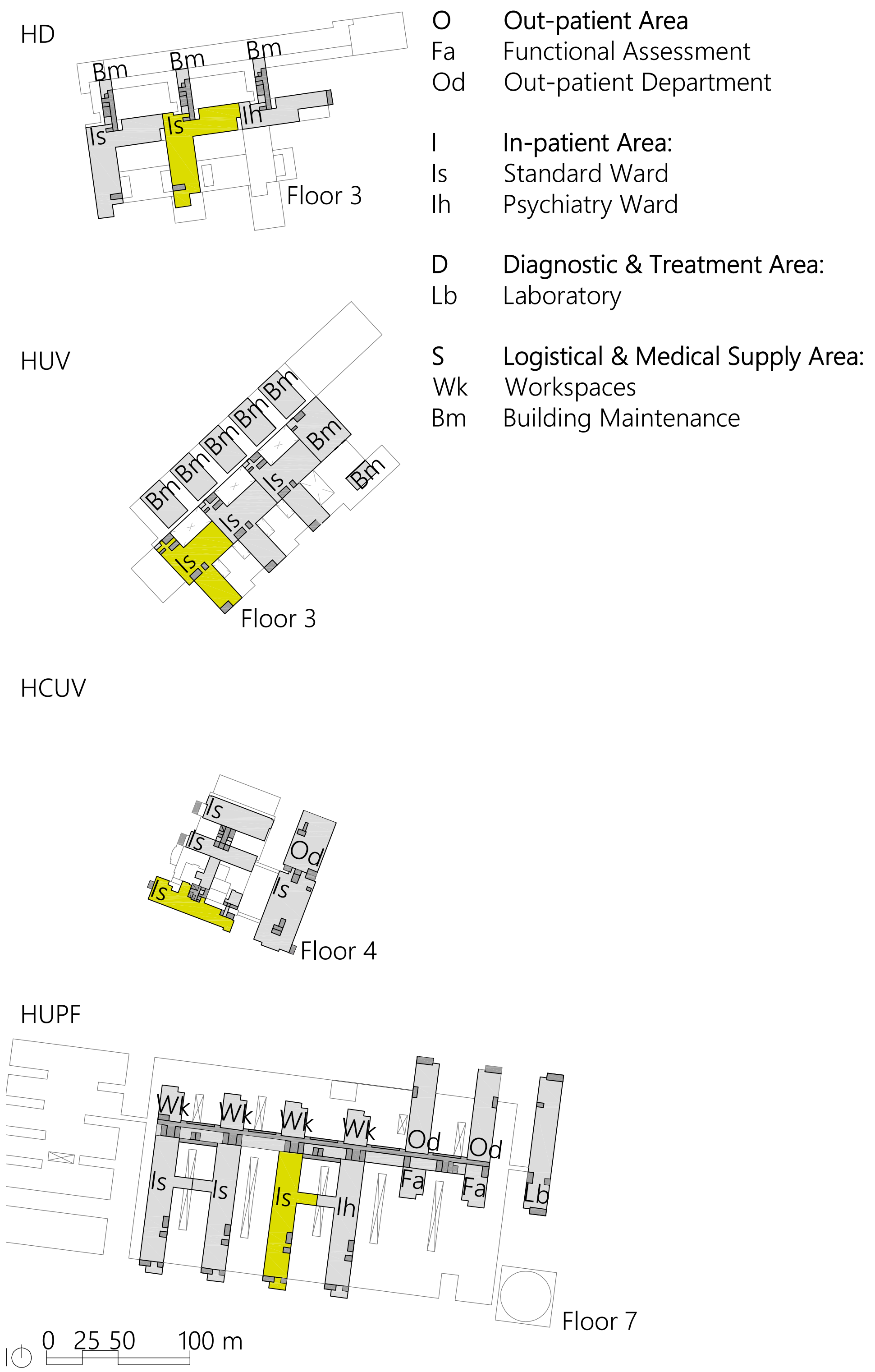



*Fig. 267 Location of the standard ward evaluated.*

## "Hospital de Dénia" (HD)

The ward is located on the third floor of the B hospitalization wing, next to another internal medicine ward and the psychiatric ward (Fig. 268-Fig. 269). Two lift cores (one for public access and one for private access) serve the unit, which has an L shape with patient bedrooms on both sides of the corridor. There are 36 patient bedrooms that have double capacity but are normally used individually (except at peak periods).


*Fig. 268 Standard ward. Furniture and equipment in use. HD.*

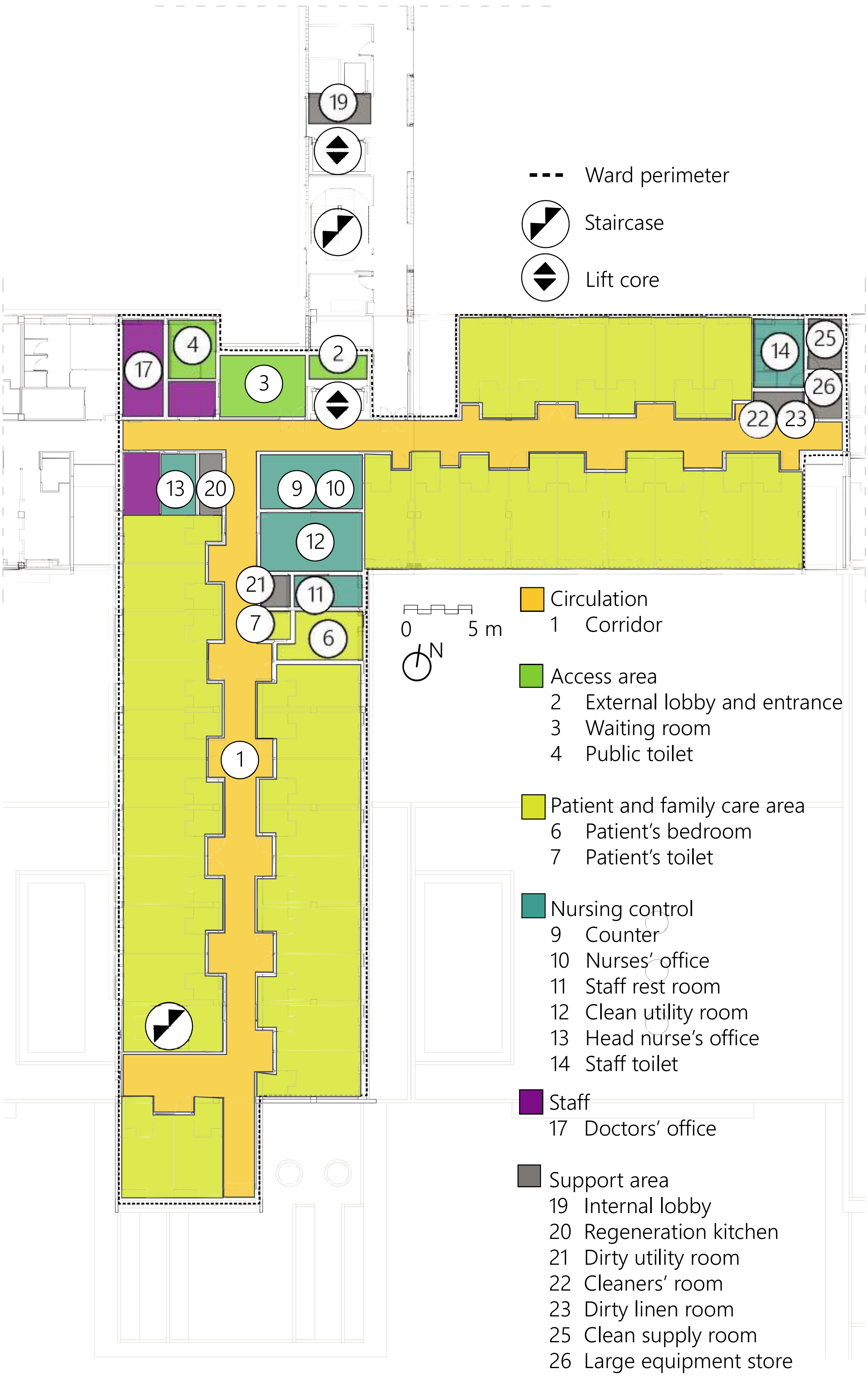



*Fig. 269 Evaluated rooms in standard ward HD.*

## "Hospital Universitario del Vinalopó" (HUV)

The internal medicine ward in HUV is located on the second floor of the blue hospitalization wing, next to more standard wards, the operating theatres and the labour ward (Fig. 270). Three lift cores (one for public access and two for private access) serve the unit which has a Y shape with patient bedrooms on both sides of the corridor. There are 29 patient bedrooms that have double capacity but are normally used individually (except at peak periods).

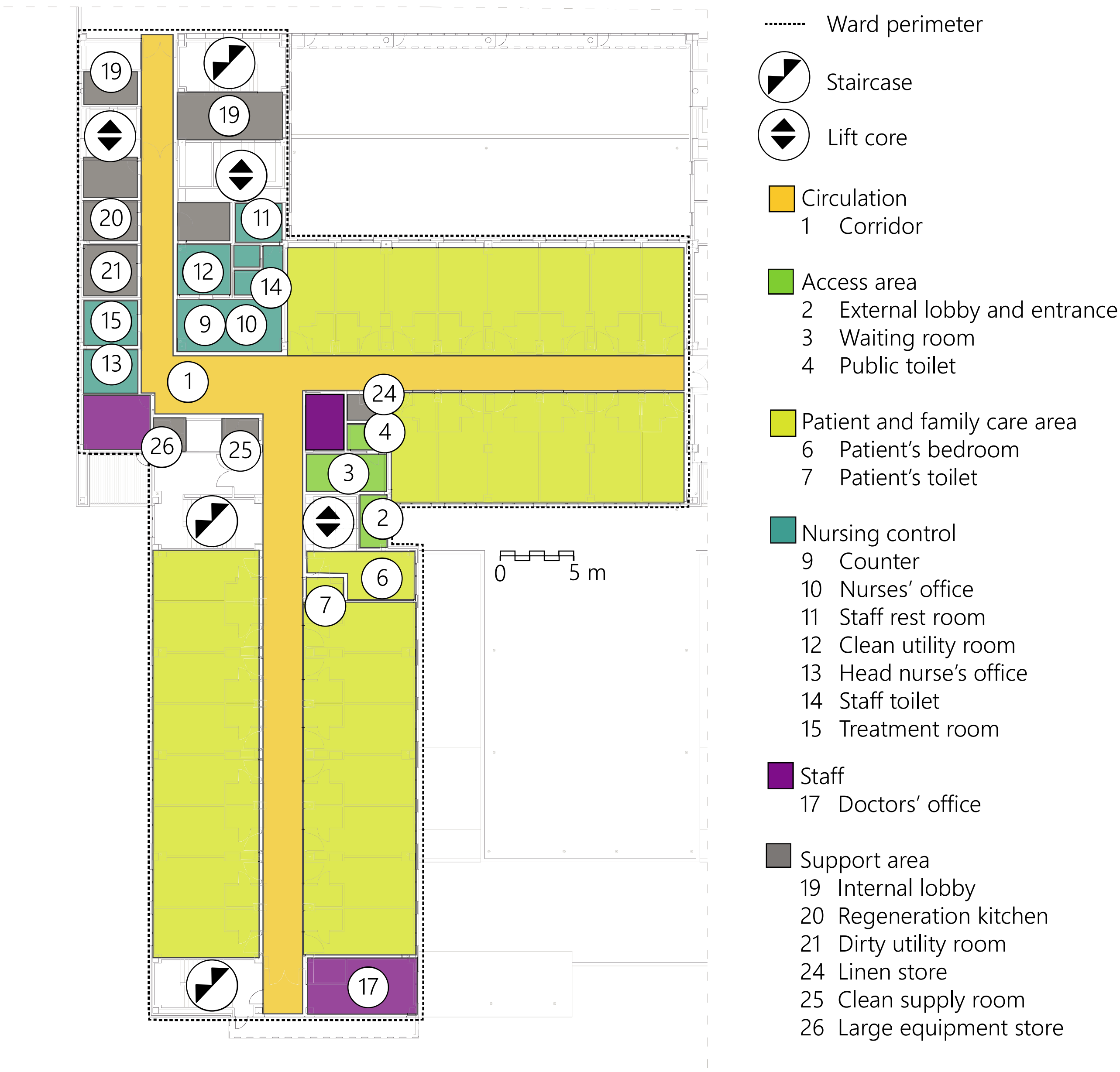



*Fig. 270 Evaluated rooms in standard ward HUV.*

## "Hospital Clínico Universitario de Valencia" (HCUV)

The ward is located on the fourth floor of pavilion B, together with three standard wards and out-patient care at pavilion D (Fig. 271). Three lift cores serve the unit. One of them is used both by public and private users, there is another one that opens directly onto the ward corridor (with no lobby) and the third core is used for the treatment area. The unit has an F shape with patient bedrooms on both sides of the corridor. There are 19 patient bedrooms with different capacity (triple, double and individual).

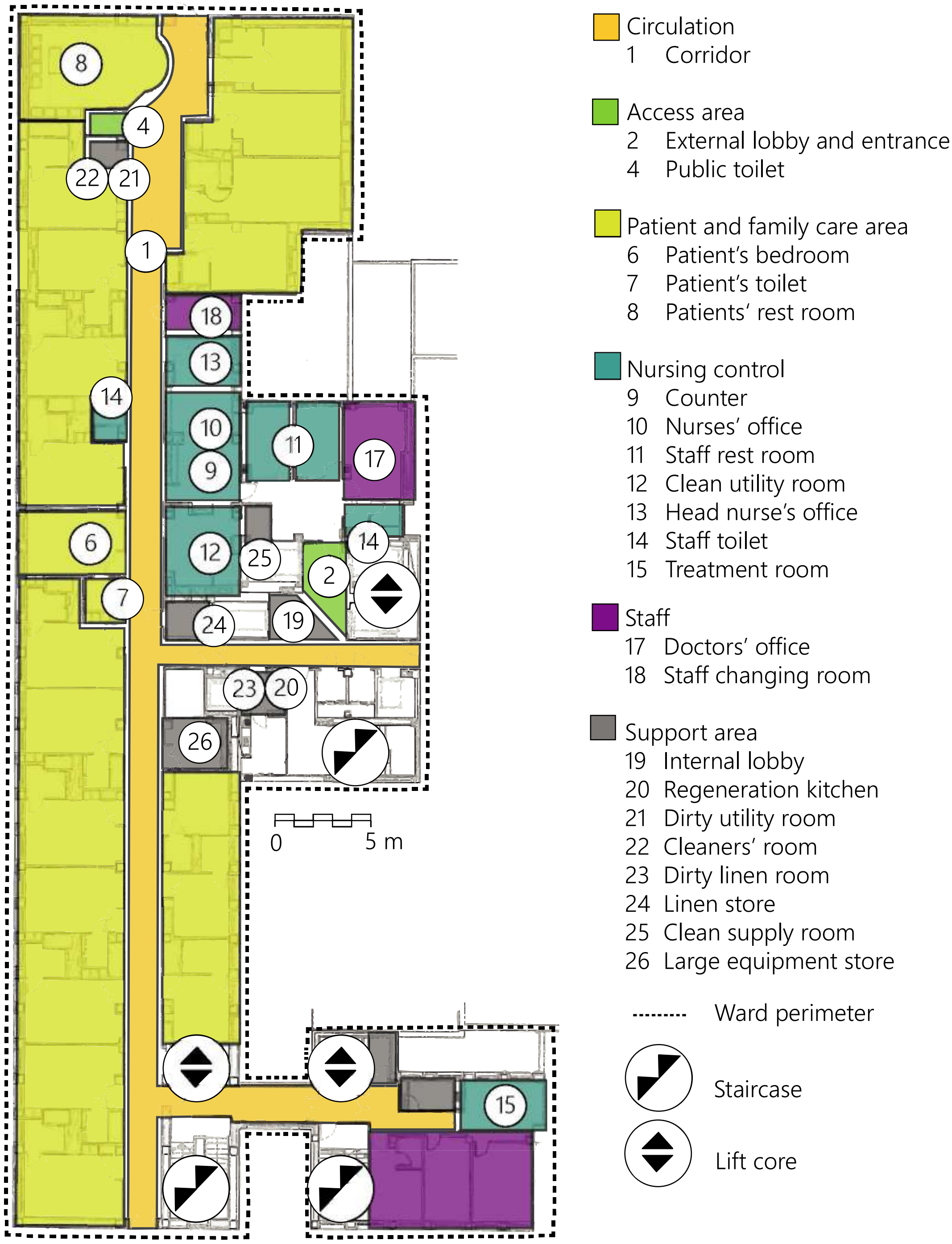



*Fig. 271 Evaluated rooms in standard ward HCUV.*

## "Hospital Universitari i Politècnic La Fe" (HUPF)

The ward is located on the seventh floor of tower E, next to another three wings for in-patient care and two wings for out-patient care. It has four lift cores (one for public access and three for private access) (Fig. 272). The unit has an F shape, and the corridor has one part double-loaded with patient bedrooms and another part with patient bedrooms on one side and staff rooms on the other side. There are 35 individual patient bedrooms and 20 of them can be used for infectious patients.

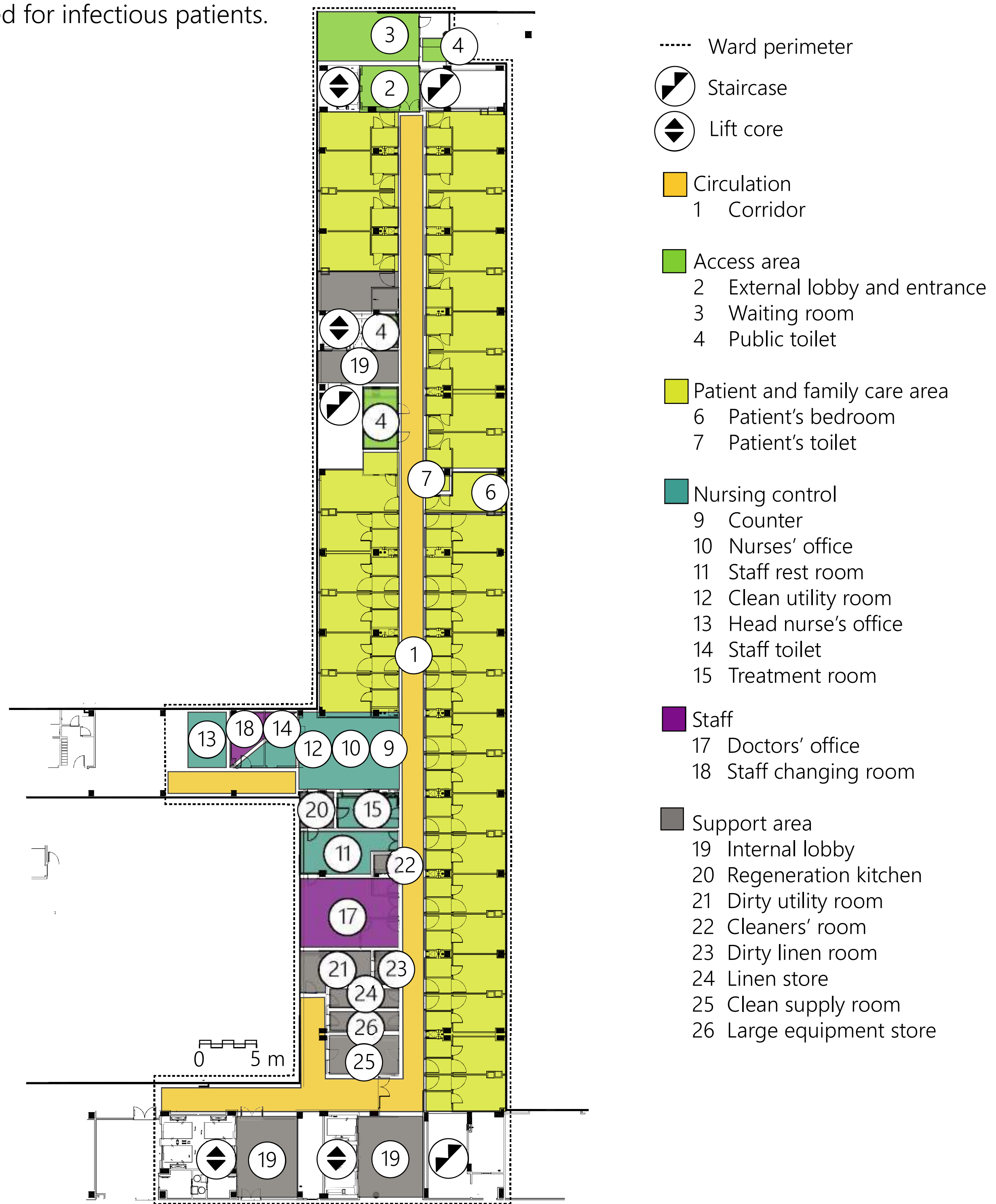



*Fig. 272 Evaluated rooms in standard ward HUPF.*

## Evaluation Results

From the results obtained following the evaluation process described in chapter 4.1.2, the HD ward design scored the best results. The percentage of achievement with CURARQ-H tool is shown in Fig. 273. HD had the highest marks in almost all areas, next came HUV with slightly lower percentages for the circulation and access areas. HUPF scored similarly, but with weaker grades for the nursing and staff areas. The lowest percentages in almost all areas went to HCUV. All detailed results are available online [25].

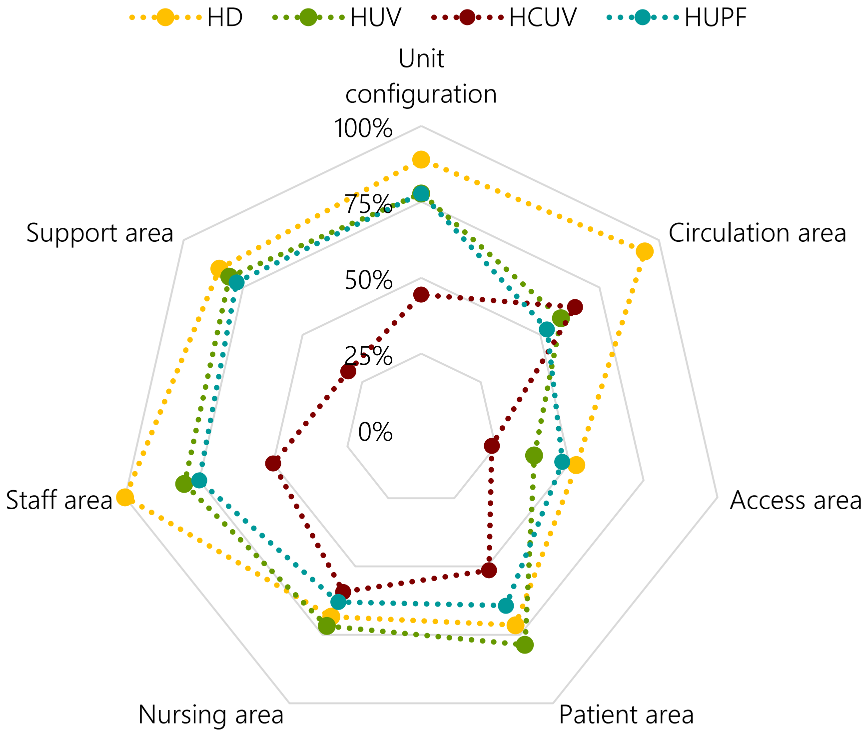



*Fig. 273 CURARQ-H results for the wards evaluated.*

The requirements associated with the unit configuration tackled the relationship of this unit with the other acute-care hospital units and the features of the ward as a whole. While HD, HUV and HUPF graded over 75%, the unit configuration of HCUV was weaker. This unit did not have different access points for external and internal flows. Moreover, in-patient wards in this acute-care hospital had different layout arrangements which made it more challenging for staff to get familiarised. The unit had no art exhibitions, and the signage system was poorly maintained.

For the internal corridor, the following design elements were analysed: layout, light openings, installations, equipment, floor, ceiling, walls and doors (Fig. 274-Fig. 277). While three of the wards got a mark around 60%, HD exceeded 90%. This was because its internal corridor did not use direct artificial light from the ceiling, had natural light, handrails on the walls and a widening of the corridor in front of any pair of patient bedrooms. This corridor widening was useful for the manoeuvrability of the bed and provided a smooth transition between the ward corridor and the patient's bedroom.

It was in the access area where all four acute-care hospitals got the lowest scores (Fig. 278-Fig. 280). None of them had an interview room for confidential conversations. HCUV got the lowest mark as it did not have a waiting room for relatives and visitors and for the other three, even though they did have one, their design features did not comply with all the recommendations.

The patient and family area, together with the staff area, got on average the highest grades (Fig. 281-Fig. 283). Despite the fact that HCUV was the only one with an in-patient rest room, the quality of that room and the patients' bedrooms was lower than in the other acute-care hospitals. In HD, HUV and HUPF patients shared the waiting room in the access area. HUV got the highest marks as its patients' bedrooms complied with almost all the recommendations. The design features to be improved in these rooms were: a larger floor area, higher switches, secure locker for personal belongings and a quiet closing system for the door.

In the nursing control area, the four acute-care hospitals got similar scores (Fig. 284-Fig. 287). They all had the nurses' office and counter sharing the same space. Only HUV and HCUV had a dedicated room in an independent location for medicine preparation. HD and HUPF combined the clean supply room for medicine preparation with the counter and the nurses' office, which increased the number of interruptions and hence the chances of medical errors.

Only two rooms were evaluated in the support area: staff changing room and the doctors' office. In the four acute-care hospitals, the doctors' office fulfilled almost all the recommendations. However, the staff changing room was more controversial. Only HUPF had a designated changing room in the ward. In HCUV there was none but due to staff demands, a small room was adapted for this use. HD and HUV had a centralised staff changing room but, in practice, staff used the toilets as improvised changing rooms.

The support area included all the service rooms that supported the health care activity. HCUV scored the lowest marks as the rooms were too small. This lack of space resulted in several functions being combined in the same room without adding extra space.

*Fig. 274 Corridor at HD.*

*Fig. 275 Corridor at HUV.*

*Fig. 276 Corridor at HCUV.*

*Fig. 277 Corridor at HUPF.*

*Fig. 278 Waiting room for relatives and visitors at HD.*

*Fig. 279 Waiting room for relatives and visitors at HUV.*

*Fig. 280 Waiting room for relatives and visitors at HUPF.*

*Fig. 281 Patient's bedroom at HD.*

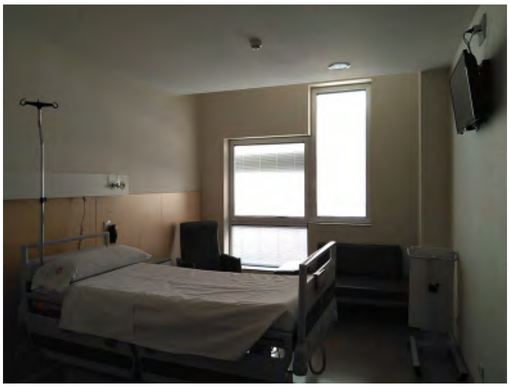


*Fig. 282 Patient's bedroom at HUV.*

*Fig. 283 Patient's bedroom at HUPF.*

*Fig. 284 Clean utility room at HD.*

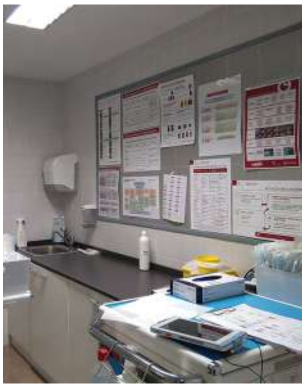


*Fig. 285 Clean utility room at HUV.*

*Fig. 286 Clean utility room at HCUV.*

*Fig. 287 Clean utility room at HUPF.*

### 4.4.5 Discussion

During the acute-care hospital placement, it was noticeable that in the internal medicine ward there were fewer caregivers than in the obstetric or paediatric ward. Moreover, those caregivers were old and eager to chat, which turn interviews into long conversations with very little design content. On the contrary, experienced nurses were the most useful participants for the study, contributing with a large amount of information regarding their concerns as well as the patients' point of view.

From the acute-care hospital visits it was seen that while in Spain a variety of configurations were found (L-shape, Y-shape, rectangular, single-loaded corridors and double-loaded corridors) in Sweden there was a predominance of the rectangular ward with double corridor and internal staff areas with no day-light. Another main difference between the two countries was the centralized workstation for nurses in Spain versus the reception desk and decentralized workstations in Sweden [26].

Regarding the four units evaluated, not surprisingly, the HCUV received the lowest grades in almost all areas, which could be due to its age (about 15 years older than any other acute-care hospital). In all four wards, the patient area got the highest grades. This could be because the patient's bedroom and the patient's toilet are the most researched rooms nowadays. On the contrary, the access area scored lower than any other area. Space for relatives was scarce and the functional and emotional demands of family members were usually overlooked [7]. Family presence and engagement in the care of dependent patients could be promoted by design and hence improve the patient's hospital experience and the efficiency of healthcare staff.

# 4.5 Obstetric Ward

## 4.5.1 Acute-care Hospital Placement

From the interviews performed in the obstetric ward at “Hospital de Dénia”, the topics that came up were related to privacy, lighting, noise, room area, ergonomics, hygiene and security. Additionally, the interviews allowed for the description of several users’ scripts as follows (Fig. 288-Fig. 290).

*PATIENTS*

> *Family A: They came to the hospital for a programmed consultation, and it was detected that the mother was losing amniotic fluid. She was taken to the consulting room in the labour ward and there the gynaecologist decided to admit her to the obstetric ward where she was to be in complete rest as her baby was still in week 36. When the level of amniotic fluid was insufficient for her baby, staff tried to induce labour in a labour-delivery-recovery (LDR) room where the couple stayed for a whole day. As it did not succeed, the doctors performed a caesarean section in the labour ward operating room. Then the new family of three stayed in the recovery room. The father and the baby went to the neonatal ward. After a couple of hours, the mother was moved to the obstetric ward and prior to going to her bedroom, she was able to see her daughter in the neonatal ward. The mother and father stayed in the obstetric ward. The father slept in the sofa/bed. For their entertainment, they watched TV, read journals and received visits. They had up to five relatives visiting at the same time and preferred not to have more amenities for them so that they would not stay very long.*

> *Family B: They came to the hospital hall for a programmed caesarean section. A porter took them to the labour ward where they waited in a LDR room. Next, the mother was taken to the operating theatre for the operation. Once it was over, all three stayed in the recovery room and later went to the obstetric ward. The father slept in the armchair. They did not have a dim light to see their son at night. They had several relatives’ visits (up to six people at a time).*

*NURSES: In the HD the nurses from the obstetric ward also worked in the paediatric ward and neonatal ward. The daily activity of nurses was summarised from the information gathered during interviews. They came to the hospital, parked their car, entered the building and went to the improvised changing room in the staff area behind the nursing control station. Then they carried out their clinical session with the on-call nurses in the nursing control station, did the round with the gynaecologist or paediatrician checking vital constants and administering medication. They attended to neonates in the neonatal ward, children in the paediatric ward or mothers in the obstetric ward. The nursing control room also worked as a reception for many visitors asking for directions or hospital information. They ate in the staff rest room but as its design was open, some relatives interrupted them even there. Staff required more spaces for cots and an outdoor playing area for children as they got very bored shut in their rooms.*

*Fig. 288 Family A at HD.*

*Fig. 289 Family B at HD.*

*Fig. 290 Interviewing a nurse in the obstetric ward. HD.*

## 4.5.2 Literature Analysis

From the literature analysis came the organisation of the obstetric ward in six areas, which in turn might contain the rooms described in the next room schedule (Tab. 5). all the CURARQ-Hobste tool requirements per each room can be read online.

| | Room | Function |
|---|---|---|
| Circulation | 1. Corridor | To allow for the horizontal movement of people and supplies. |
| Access | 2. External lobby and entrance | To enter the unit, for caregivers and visitors. |
| | 3. Waiting room | To spend time while waiting. |
| | 4. Public toilet | To empty the body of urine or solid waste. |
| | 5. Interview room | To provide confidential information in private. |

| | | |
|---|---|---|
| Patient and family care | 6. Patient's bedroom | To receive in-patient care. |
| | 7. Patient's toilet | To empty the body of urine or solid waste. |
| | 8. Patients' rest room | To spend time outside their bedroom, to gather mothers and new-borns. |
| Nursing control | 9. Counter | To visually control the whole ward. |
| | 10. Nurses' office | To provide workspace for nurses. |
| | 11. Staff rest room | To rest and relax. |
| | 12. Clean utility room | To prepare and store medication. |
| | 13. Head nurse's office | To organise and supervise the work of nurses in the unit. |
| | 14. Staff toilet | To empty the body of urine or solid waste. |
| | 15. Mothers' treatment room | To provide special treatment to mothers when bedrooms are not appropriate. |
| | 16. Neonates' treatment room | To provide special treatment to neonates when bedrooms are not appropriate. |
| | 17. Milk kitchen/store | To store human milk or prepare make-up formula. To support mothers who are expressing. |
| Staff | 18. Doctors' office | To provide workspaces for doctors. |
| | 19. Staff changing room | To get dressed and leave their personal clothing. |
| Support | 20. Internal lobby | To provide access to clinical and non-clinical staff and supplies. |
| | 21. Regeneration kitchen | To store patients' food at the required temperature. |
| | 22. Dirty utility room | To store dirty materials. |
| | 23. Cleaners' room | To store cleaning material. |
| | 24. Dirty linen room | To store dirty clothing before its transport to the laundry. |
| | 25. Linen store | To store clean clothing. |
| | 26. Clean supply room | To store small clean items. |
| | 27. Large equipment store | To store larger clean equipment. |

*Tab. 5 Areas and rooms in the obstetric ward.*

## 4.5.3 Acute-care Hospital Visits

### "Hospital Sant Joan de Déu" (HSJD)

The obstetric ward was located on two different floors (Fig. 291-Fig. 296). Almost all rooms were individually used. The staff, support and nursing control area were centralised in the floor plan. There was one corridor with patients' bedrooms at both sides.

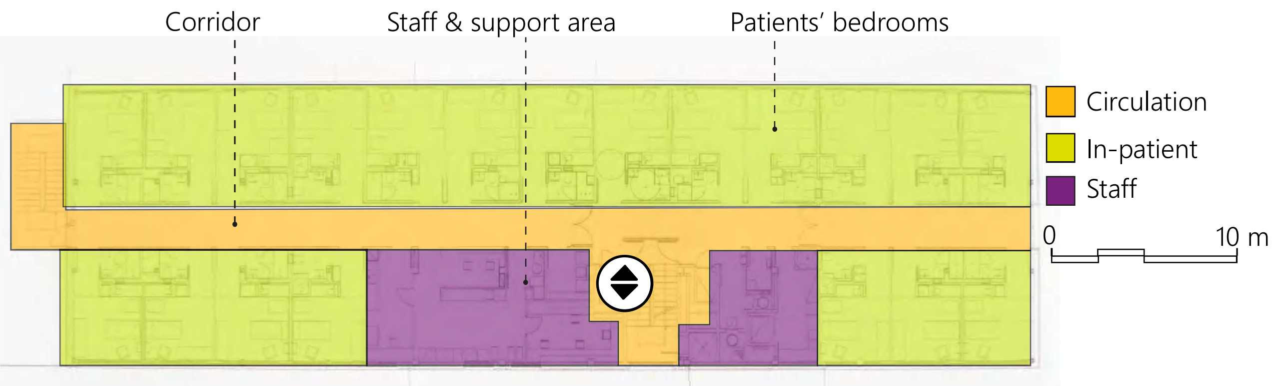



*Fig. 291 Obstetric ward at HSJD.*

*Fig. 292 Sofa/bed for partner in the patient's bedroom at HSJD.*

*Fig. 293 Mother's bed, next to portable cot and integrated furniture for bathing and diaper change (cushion, basin, bin, paper and soap dispenser). HSJD.*

*Fig. 294 Patient's bathroom with shower. HSJD.*

*Fig. 295 Support room in the obstetric ward. HSJD.*

*Fig. 296 Medication preparation room in the obstetric ward. HSJD.*

## "Maternidad Gregorio Marañón" (MGM)

The obstetric wards were located on the fourth and fifth floors of the acute-care hospital, together with the gynaecological wards (Fig. 297-Fig. 308. They had an L shape with a centralised staff and support area.

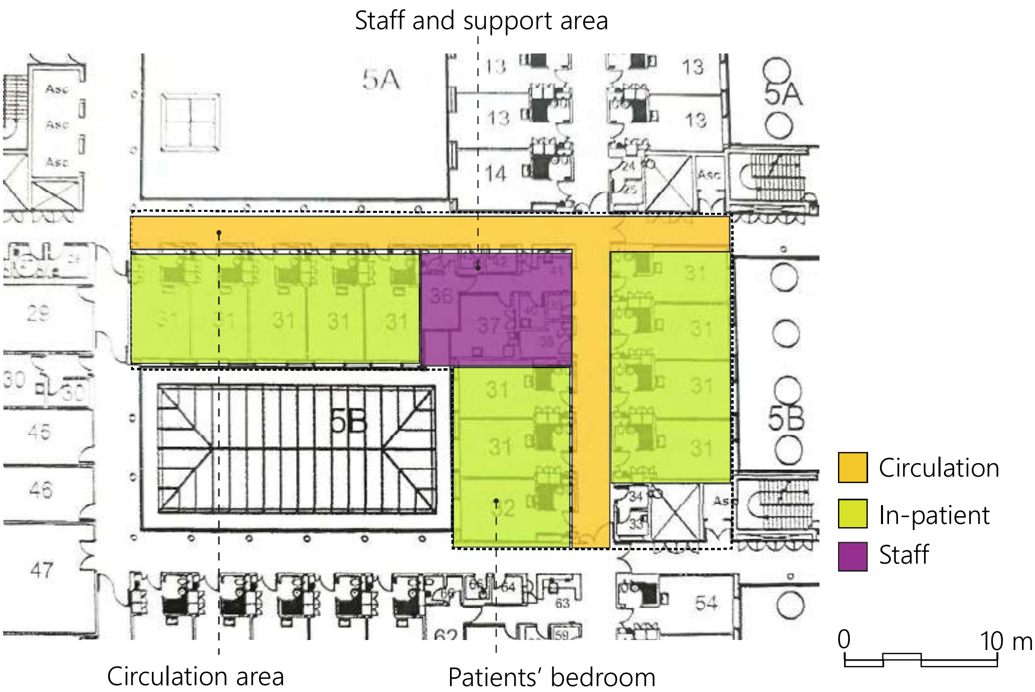



*Fig. 297 Obstetric ward at MGM.*

*Fig. 298 Basin for neonatal bath in the patient's bedroom. MGM.*

*Fig. 299 Sofa, cot and mother's bed. Usage marks on the floor. MGM.*

*Fig. 300 Window and views to the courtyard. MGM.*

*Fig. 301 Hand basin for staff in the small access hall to bathroom and bedroom. Wardrobe for Patient. MGM.*

*Fig. 302 Patient's bathroom with small tiles. Joints coordinated in the three dimensions. MGM.*

*Fig. 303 Flushed shower in the patient's bathroom. MGM.*

*Fig. 304 Counter and nurses' working area with no visual control of rooms. MGM.*

*Fig. 305 Medication preparation room. MGM.*

*Fig. 306 Dirty utility room and garbage disposal. MGM.*

*Fig. 307 Cleaners' room. MGM.*

*Fig. 308 Linen room. MGM.*

## 4.5.4 Acute-care Hospital Cases

Fig. 309 shows the location of the evaluated ward within each of the four acute-care hospitals.

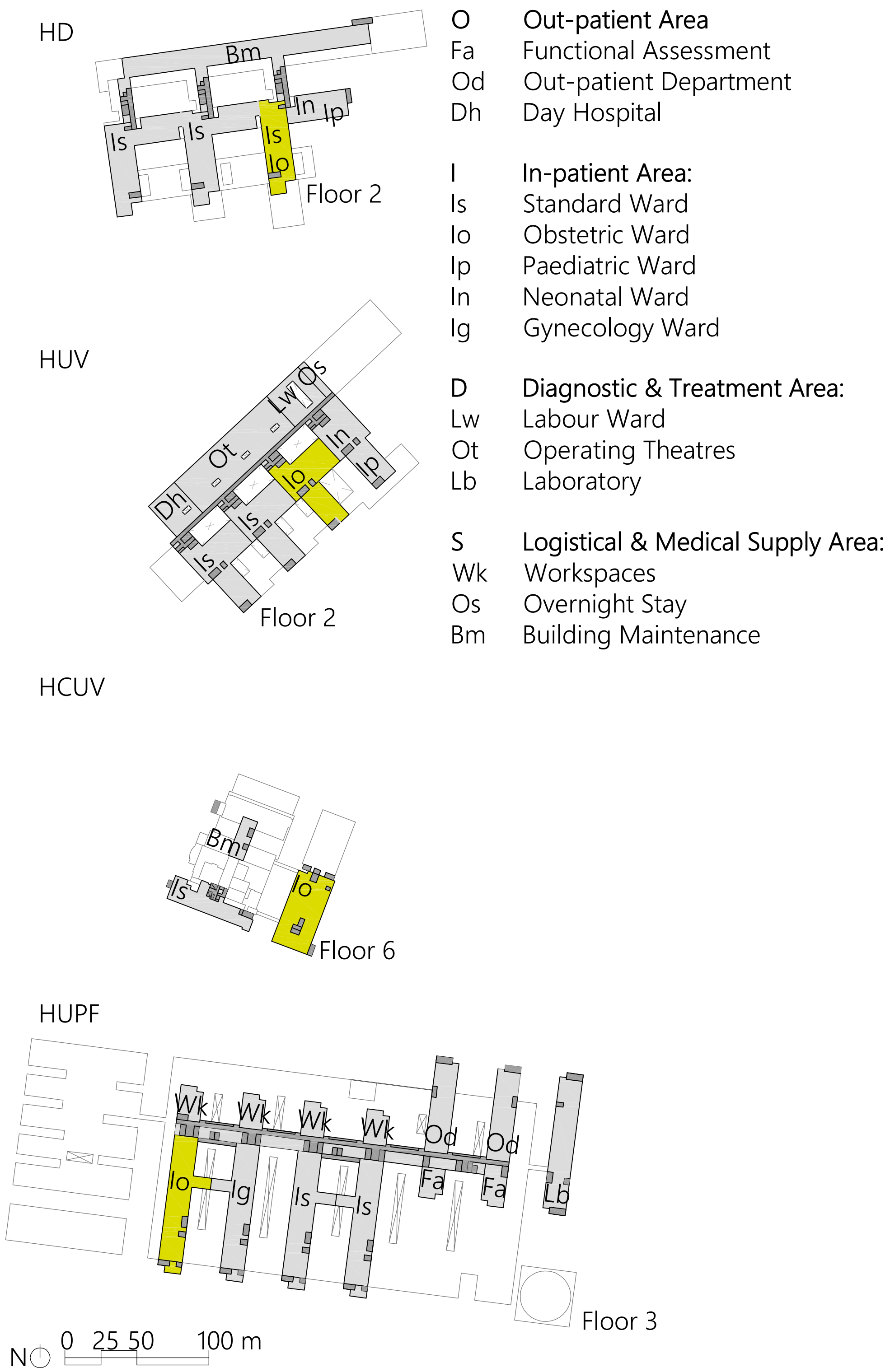



*Fig. 309 Location of the obstetric ward evaluated.*

## "Hospital de Dénia" (HD)

The obstetric ward was located on the second floor of the C hospitalization wing, next to the paediatric ward (see chapter 4.6.4), neonatal ward (see chapter 4.7.4), and other internal medicine wards (Fig. 310-Fig. 311). Two lift cores (one for public access and one for private access) served the unit, which had a rectangular shape with patient bedrooms on both sides of the corridor. The obstetric ward shared staff and support resources with the units in the same wing, i.e. the neonatal, paediatric and standard ward. All mothers' bedrooms (12 in total) were for individual use.


*Fig. 310 Obstetric ward. Furniture and equipment in use. HD.*

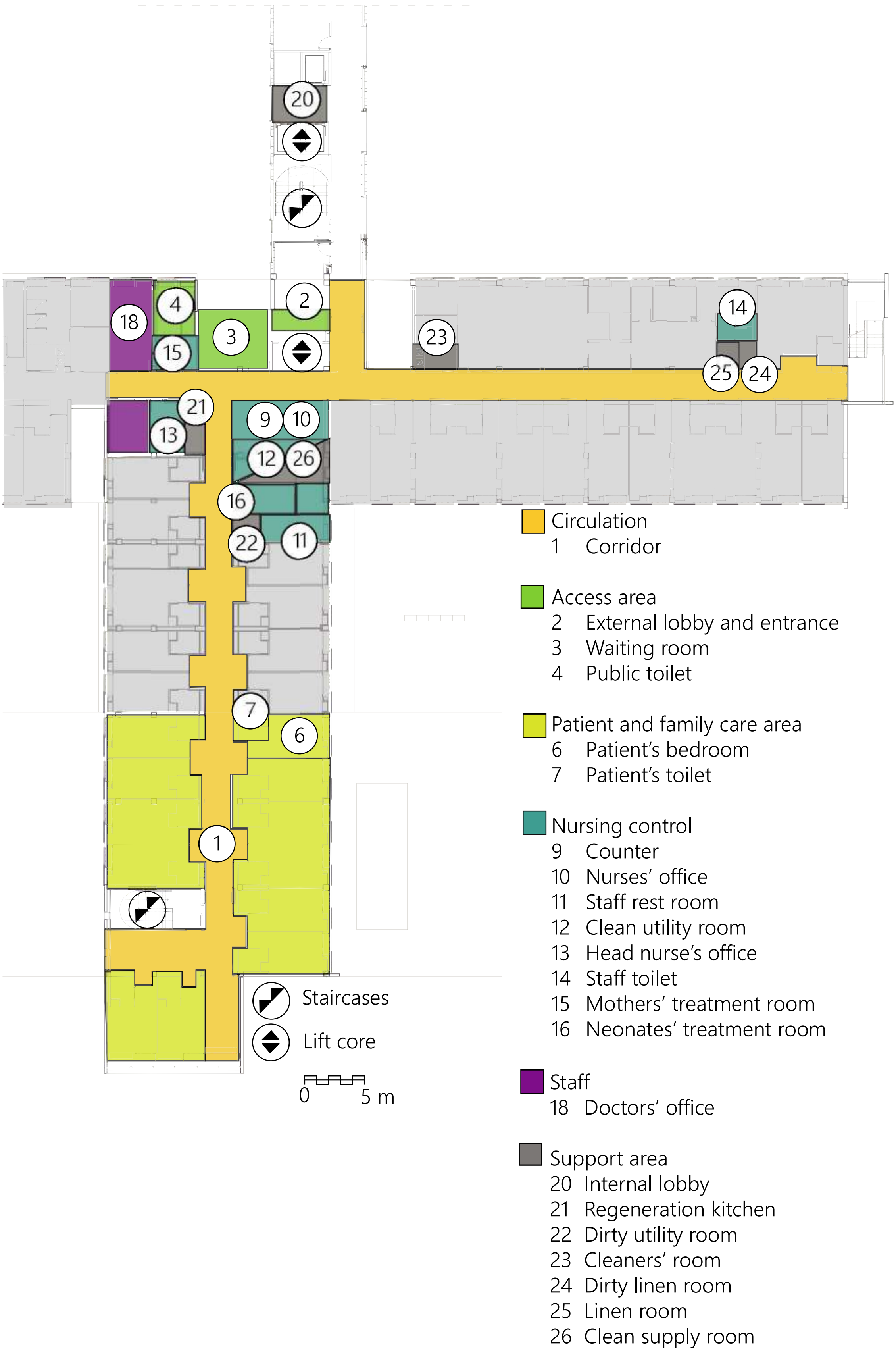



*Fig. 311 Evaluated rooms obstetric ward HD.*

## "Hospital Universitario del Vinalopó" (HUV)

The obstetric ward in HUV was located on the second floor of the blue hospitalization wing, next to the neonatal ward, paediatric ward, labour ward, operating theatres, and an in-patient ward (Fig. 312). Three lift cores (one for public access and two for private access) served the unit which had a Y shape with patient bedrooms on both sides of the corridor. There were 30 patient bedrooms that were used individually. When there was higher demand for rooms, mothers were also located in the paediatric ward.

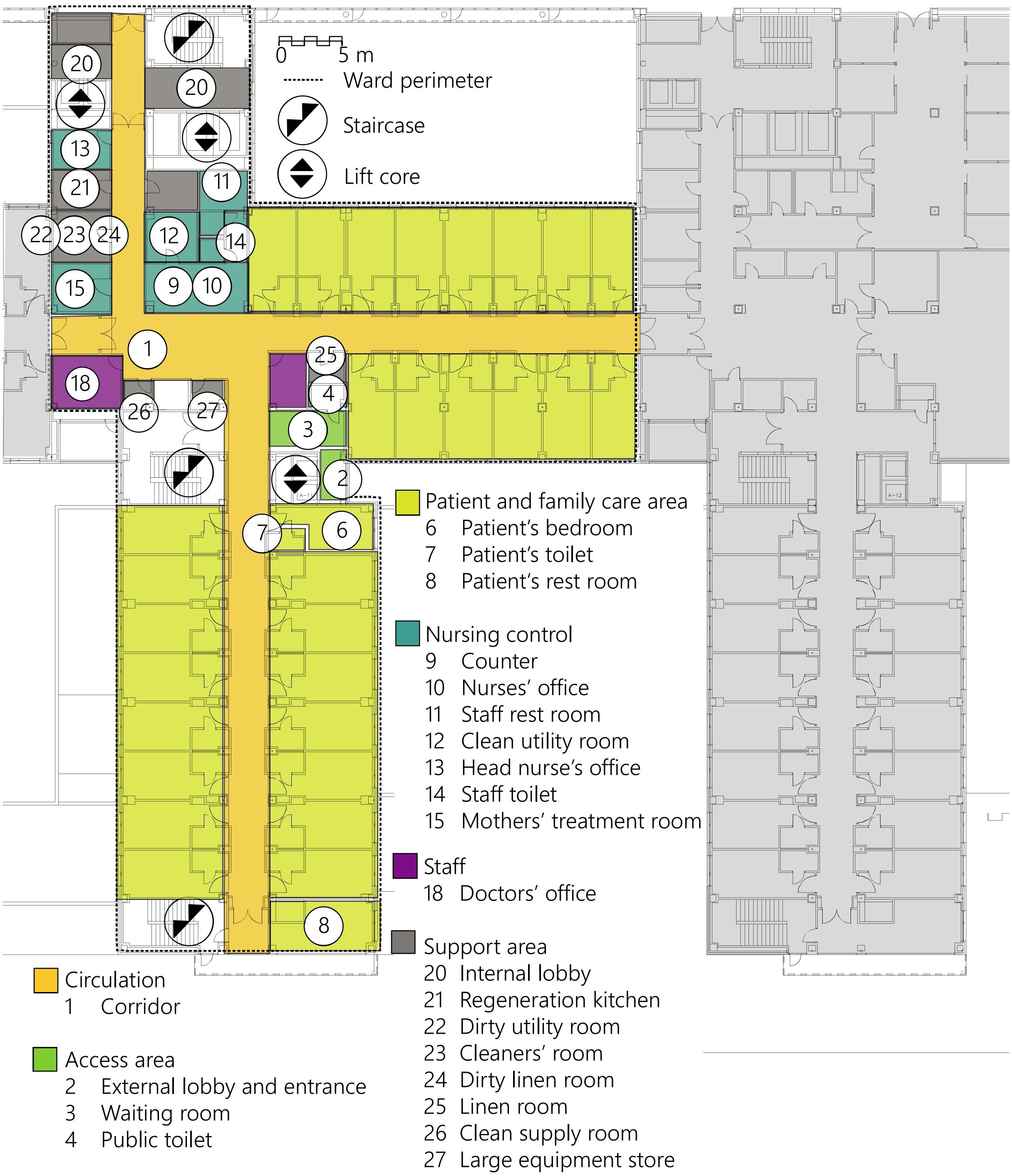
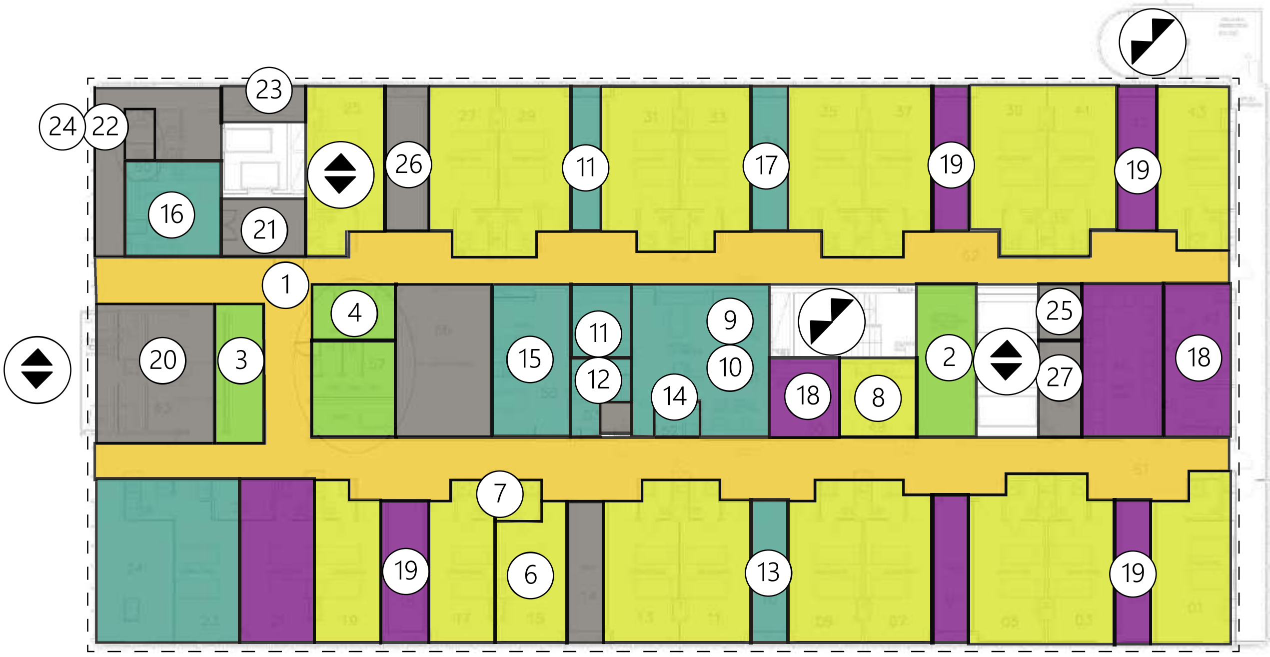



*Fig. 312 Evaluated rooms obstetric ward HUV.*

## "Hospital Clínico Universitario de Valencia" (HCUV)

The ward was located on the sixth floor of pavilion A (Fig. 313). Three lift cores served the unit: one for supplies, another for staff and the last one for the public. The unit had a rectangular shape with a double corridor. The area between the corridors (with no daylight) was used for staff, support, and nursing rooms while the patient bedrooms faced the façades. There were outdated "nest" rooms each two mother's bedrooms on account of the previous mother-infant separation. These narrow rooms were reconverted for a variety of staff and support functions. There were double bedrooms and individual bedrooms as some part of the unit had been renovated to individual designs. The maximum capacity of the ward was of 32 beds.



Circulation
1 Corridor

Access area
2 External lobby and entrance
3 Waiting room
4 Public toilet

Patient and family care area
6 Patient's bedroom
7 Patient's toilet
8 Patient's rest room

0 5 m
Ward perimeter
Staircase
Lift core

Nursing control
9 Counter
10 Nurses' office
11 Staff rest room
12 Clean utility room
13 Head nurse's office
14 Staff toilet
15 Mothers' treatment room
16 Neonates' treatment room
17 Milk kitchen/store

Staff
18 Doctors' office
19 Staff changing room

Support area
20 Internal lobby
21 Regeneration kitchen
22 Dirty utility room
23 Cleaners' room
24 Dirty linen room
25 Linen room
26 Clean supply room
27 Large equipment store

*Fig. 313 Evaluated rooms obstetric ward HCUV.*

## "Hospital Universitari i Politècnic La Fe" (HUPF)

The ward was located on the third floor of tower G, next to a gynaecological wing, two other wings for in-patient care, and two wings for out-patient care (Fig. 314). It had four lift cores (one for public access and three for private access). The unit had an F shape and the corridor had one part double-loaded of patient bedrooms and another part with patient bedrooms on one side and staff rooms on the other side. There were 35 individual patient bedrooms.

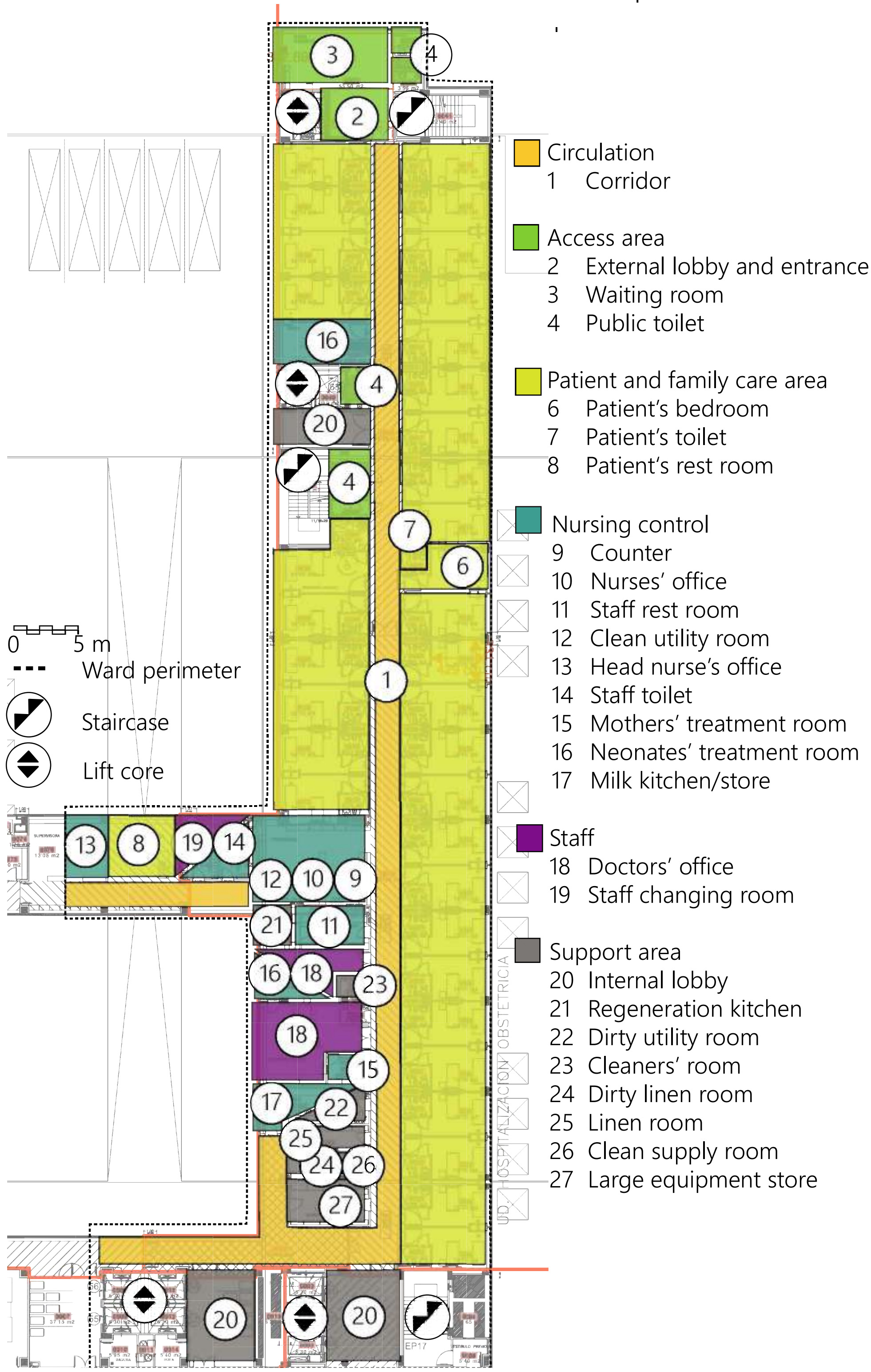



*Fig. 314 Evaluated rooms obstetric ward HUPF.*

## Evaluation Results

According to the results obtained following the evaluation process described in chapter 4.1.2, the HD ward design scored the best results. The percentage of achievement with CURARQ-Hobste tool is shown in Fig. 315 and all acute-care hospitals had a global grade of over 60%. HD had the highest marks in almost all areas, next came HUV with slightly lower percentages for the circulation and access area. HUPF scored similarly to HUV and the lowest global percentages went to HCUV. All detailed results are available online [27].

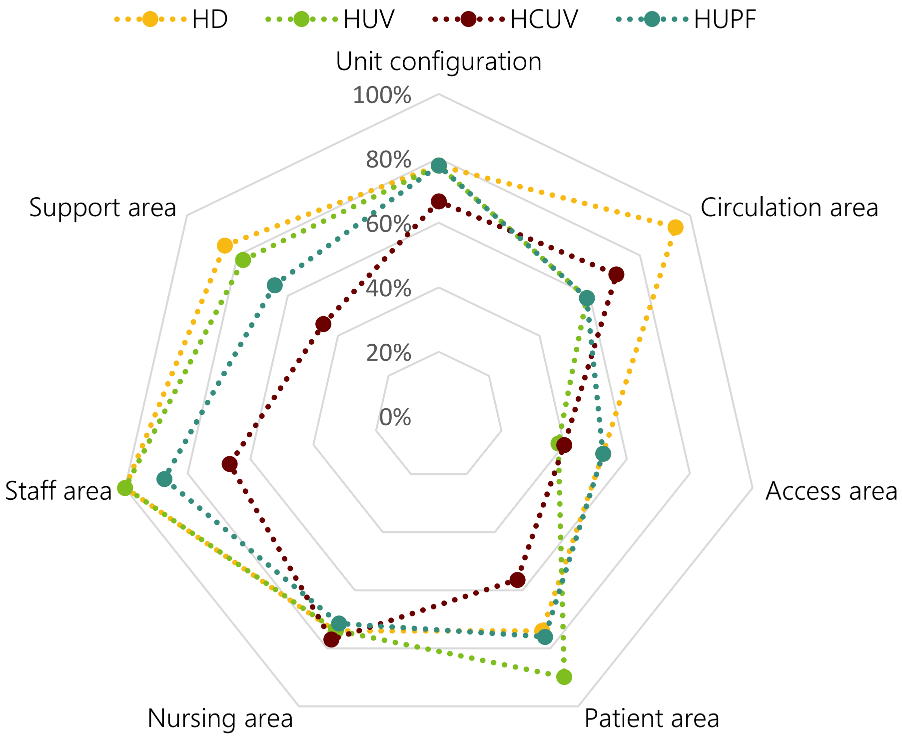



*Fig. 315 CURARQ-Hobste results for the wards evaluated.*

The requirements associated with the unit configuration tackled the relationship of this unit with the labour ward and neonatal ward. Another requirement evaluated whether it had two access points (one for internal and another for external flow) and other features like the signage system or the presence of art. HD, HUV and HUPF scored the same results. HCUV got a lower grade because, among other requirements, it was located in a different pavilion than the labour ward and the circulation flows were mixed. HD even had artistic installations with maternity topics such as breastfeeding.

The internal corridor that scored the best results was that of the HD (Fig. 316-Fig. 318). This was because it had enough width, remarkable elements to aid wayfinding, no direct artificial lighting and even natural light.

The access area got the lowest scores of all areas for the four acute-care hospitals. This was due to the fact that the floor area of the rooms was smaller than recommended and some requirements were missing in all acute-care hospitals like the information room.

The patient and family area had the same requirements as the standard ward except for the fact that all rooms should be individual, have soft lighting for night time, a cot for the baby (able to be attached to the mother's bed), a nappy changer and an additional rest room for mothers (Fig. 319-Fig. 321). HCUV was the one that scored lowest even when only the renovated mother's bedroom was evaluated, because it had direct artificial light to the bed, a smaller floor area than the recommended, and finishing materials difficult to clean.

The nursing control area had the same requirements as the standard ward with the addition of a treatment room for mothers, a treatment room for babies and a kitchen for breastfeeding and formula milk. In this area, all acute-care hospitals got a similar score and, regarding the counter for nurses, it was shared as an open room with the nurses' office (Fig. 322-Fig. 324).

Likewise, in the standard ward, only two rooms were evaluated in the staff area: staff changing room and doctors' office. HD and HUV had a centralised service for staff changing so there were no changing rooms in the ward. In the HCUV staff had redesigned one of the outdated rooms for babies only and used it as a changing room. The HUPF initial design did have changing rooms in the ward.

The support area included all the service rooms that support the health care activity. HCUV scored the lowest because almost all the outdated rooms for babies only were being used for storage and their dimensions were inadequate (too narrow and small). In almost all acute-care hospitals there was an urgent need for more storage space for bulky equipment such as cots, wheelchairs and beds (Fig. 325-Fig. 326).

*Fig. 316 Ward corridor at HD.*

*Fig. 317 Ward corridor at HCUV.*

*Fig. 318 Ward corridor at HUPF.*

*Fig. 319 Mother's bedroom at HD.*

*Fig. 320 Mother's bedroom at HCUV.*

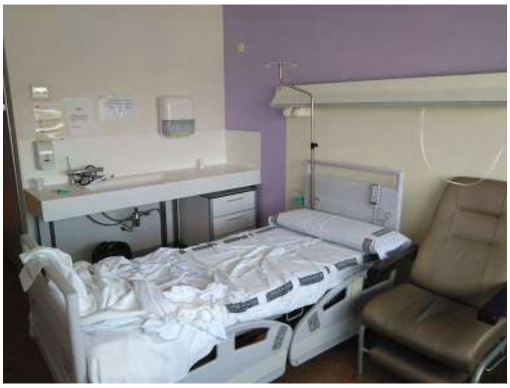


*Fig. 321 Mother's bedroom at HUPF.*

*Fig. 322 Nurses' working area at HD.*

*Fig. 323 Nurses' working area at HCUV.*

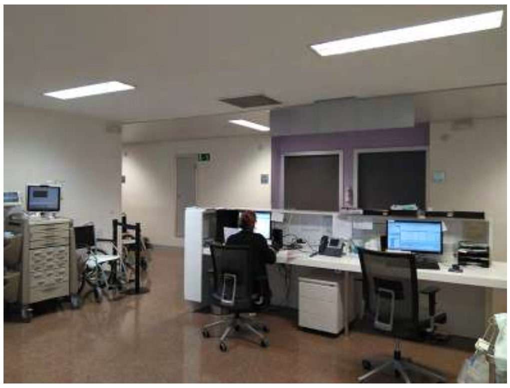


*Fig. 324 Nurses' working area at HUPF.*

*Fig. 325 Need for parking bulky equipment at HD.*

*Fig. 326 Need for parking bulky equipment at HCUV.*

## 4.5.5 Discussion

The obstetric ward is very similar to the standard ward with the particularity that it attends to two patients: the mother and the newborn infant. The room schedule of this ward is the same of a standard ward but with the incorporation of some additional rooms (patients' rest room, treatment room for newborn infants, treatment room for mother or the kitchen room for milk preparation). Regarding the four acute-care hospital cases, as was the case in the standard ward, the area with the lowest results was the access area. Additional floor area for mothers and partners in the ward is particularly important in the obstetric ward to advocate informational support for the father's involvement [28-30], as well as social support to avoid postnatal depression [31] and education for breastfeeding support [32]. Additionally, there were some rooms that could be reconsidered such as the interview room (when almost all patient bedrooms are individual) and the treatment rooms for mother and baby (when in addition to using individual patient bedrooms, the recommendations are directed towards the non-separation of this dyad). Moreover, the need of bathing the newborn infant is questionable so there might be no need for extra basins in the room.

# 4.6 Paediatric Ward

## 4.6.1 Acute-care Hospital Placement

From the interviews performed in the paediatric ward at "Hospital de Dénia", the following topics came up: ergonomics, lighting, views, room size, art, socializing, playing, finishes, security and maintenance. Additionally, the interviews allowed for the description of several users' scripts as follows (Fig. 327-Fig. 328).

*Fig. 327 Two-year old patient. HD.*

*Fig. 328 Ten-year old patient. HD.*

*CAREGIVER They arrived at the emergency department and the child was admitted to the paediatric ward. As the patient was two years old, he wore a diaper and did not use the toilet in the bedroom. Both parents stayed with him and only left to work, buy food, walk their dog, or take care of their other child. For sleeping, the mother laid on the bed with her son and the father slept on a mattress he brought from their house over the bed/sofa because the bed/sofa was extremely uncomfortable. The child loved the clown's visits. During their visits, relatives brought many toys to entertain the child, but the parents took them home as there were too many things in the bedroom. The patient could not attend school as he was under three so there was no place in the ward where he could stay outside his bedroom and interact with other children. From time to time, the parents took him for a ride in a wheelchair around the ground floor. There he liked to see other people at the cafeteria and specially the big yellow bear at the kiosk. Sometimes the parents bought him some sweets from the shop.*

*PATIENT She came for a programmed consultation and was admitted to the paediatric ward. She liked the wall decoration in her bedroom and sent photos from her smartphone to her friends. She went to the school room with the hospital teacher where she met other children. In the bedroom she spent time looking through the window, reading, playing with a tablet or receiving visits.*

*TEACHER She was responsible for patients of school age (from 3 to 18 years old). The school mission was not to follow the school curriculum but to improve the children's experience at the hospital by giving them a regular routine and the possibility to interact with other children. The teacher attended to the children either in the patient bedroom or in the school room. She mentioned that an extra room for indoor games was needed for children of all ages that should be open during the evenings and at the weekends or bank holidays.*

*PAEDIATRICIAN When she arrived at the hospital, she parked her car in the basement carpark, and went to the doctors' office for the clinical session and the relief with the previous doctor's shift. Then she changed her clothes in the on-call doctor's bedroom and took a coffee at the hospital cafeteria. After that, she did the rounds in the patient bedrooms, took notes on the clinical evolution of patients, whether they needed additional tests and prescribed their medication. She also helped at the out-patient department consultancy. In case of high-risk deliveries or caesarean sections, she attended births at the labour ward.*

## 4.6.2 Literature Analysis

From the literature analysis came the organisation of the paediatric ward in six areas, which in turn might contain the rooms described in the next room schedule (Tab. 6). All the CURARQ-Hpedi tool requirements per each room can be read online.

| | Room | Function |
|---|---|---|
| Circulation | 1. Corridor | To allow for the horizontal movement of people and supplies. |
| Access | 2. External lobby and entrance | To enter the unit, for caregivers and visitors. |
| | 3. Waiting room | To spend time while waiting. |
| | 4. Public toilet | To empty the body of urine or solid waste. |
| | 5. Interview room | To provide confidential information in private. |
| | 6. Lactation room | To feed babies. |
| Patient and family care | 7. Patient's bedroom | To receive in-patient care. |
| | 8. Patient's toilet | To empty the body of urine or solid waste. |
| | 9. Patients' rest room | To spend time outside their bedroom, for mothers and new-borns to be together. |
| | 10. School room | To provide school services to in-patients. |
| | 11. Indoor play area | To allow for indoor games. |
| | 12. Outdoor play area | To allow for outdoor games. |
| Nursing control | 13. Counter | To visually control the whole ward. |
| | 14. Nurses' office | To provide workspace for nurses. |
| | 15. Clean utility room | To rest and relax. |
| | 16. Staff rest room | To prepare and store medication. |
| | 17. Head nurse's office | To organise and supervise the work of nurses in the unit. |
| | 18. Staff toilet | To empty the body of urine or solid waste. |
| | 19. Treatment room | To provide special treatment to patients when bedrooms are not appropriate. |
| | 20. Support for unsupervised infants | To supervise infants with no caregivers. |

| | | |
|---|---|---|
| Staff | 21. Doctors' office | To provide workspaces for doctors. |
| | 22. Staff changing room | To get dressed and leave their personal clothing. |
| Support | 23. Internal lobby | To provide access to clinical and non-clinical staff and supplies. |
| | 24. Regeneration kitchen | To store patients' food at the required temperature. |
| | 25. Dirty utility room | To store dirty materials. |
| | 26. Cleaners' room | To store cleaning material. |
| | 27. Dirty linen room | To store dirty clothing before its transport to the laundry. |
| | 28. Linen store | To store clean clothing. |
| | 29. Clean supply room | To store small clean items. |
| | 30. Large equipment store | To store larger clean equipment. |

*Tab. 6 Areas and rooms in the paediatric ward.*

### 4.6.3 Acute-care Hospital Visits

#### "Hospital de la Santa Creu i Sant Pau" (HSCSP)

The paediatric ward was similar to the standard wards of the acute-care hospital with more cheerful interior decoration and access to an outdoor play area (Fig. 329-Fig. 330).

*Fig. 329 Ward corridor with colourful decoration at HSCSP.*

*Fig. 330 Outdoor play area for children at HSCSP.*

#### "Hospital Sant Joan de Déu" (HSJD)

This acute-care hospital had several paediatric wards for different treatments and with different architectural designs (Fig. 331-Fig. 336). During the visit, three different arrangements were observed: the oldest ward, the renovated ward and another renovated ward for international patients. All three had a layout arrangement similar to the obstetric ward (see chapter 4.5.3).


*Fig. 331 Hall area at HSJD.*

*Fig. 332 Renovated ward corridor at HSJD.*

*Fig. 333 Renovated patient bedroom at HSJD.*

*Fig. 334 Renovated patient bedroom with bed for a parent at HSJD.*


*Fig. 335 Corridor at the paediatric ward for international patients at HSJD.*

*Fig. 336 Patient bedroom at the paediatric ward for international patients at HSJD.*

## "Maternidad Gregorio Marañón" (MGM)

The paediatric wards at MGM had the same layout arrangement as the obstetric and gynaecological wards (see chapter 4.5.3) with more support rooms for teaching and recreational activities with infants (Fig. 337-Fig. 342).

*Fig. 337 Children's room with double capacity at MGM.*

*Fig. 338 Outdoor terrace for each children's bedroom at MGM.*

*Fig. 339 School room with mobile library and school material at MGM.*

*Fig. 340 General view of school room decorated for Halloween at MGM.*

*Fig. 341 Rest room called "Como en casa" for families at MGM.*


*Fig. 342 Courtyard with artistic intervention by Boa Mistura: "To live is not only to exist" MGM.*

## "Östra Hospital" (ÖH)

The Queen Silvia Children Hospital was a new building under construction connected to the existing children's acute-care hospital (Fig. 343-Fig. 353). The building had two basement levels and six floors. On the ground floor, there was the external access. From there patients could go directly to the existing or the new building. The first area when entering the new building was the school and playrooms, so that it did give a friendly and relaxing environment to children. On this floor there was a central atrium that gave the U shape to the whole building. The rehabilitation area with a gym and a swimming pool was also at this level. The first floor housed the operating theatres and ICU. The second and third floors contained the staff areas and ventilation equipment for the operating theatres. The fourth floor had the in-patient units. There were terraces to the atrium for the bedrooms at this level. Floors number five and six were very similar but without terraces.

*Fig. 343 External view of new and existing buildings at ÖH.*

*Fig. 344 "Ronald McDonald Hus" for family accomodation at ÖH.*

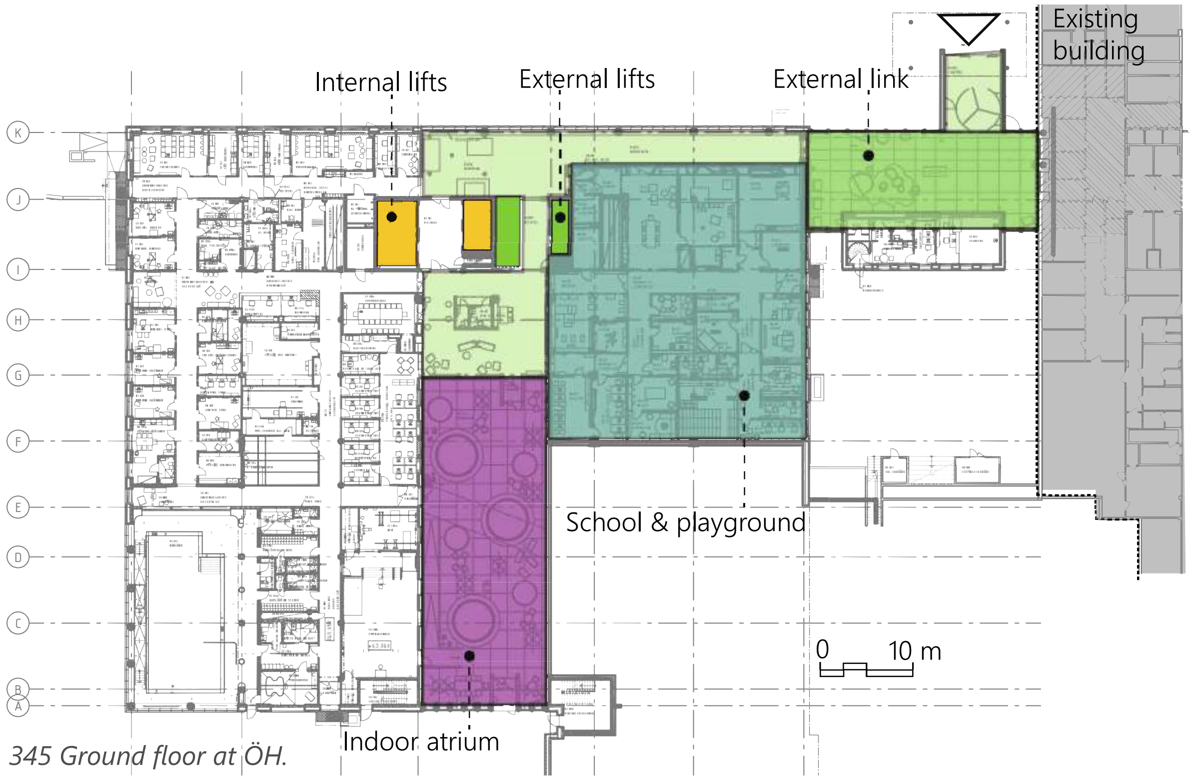



*Fig. 345 Ground floor at ÖH.*

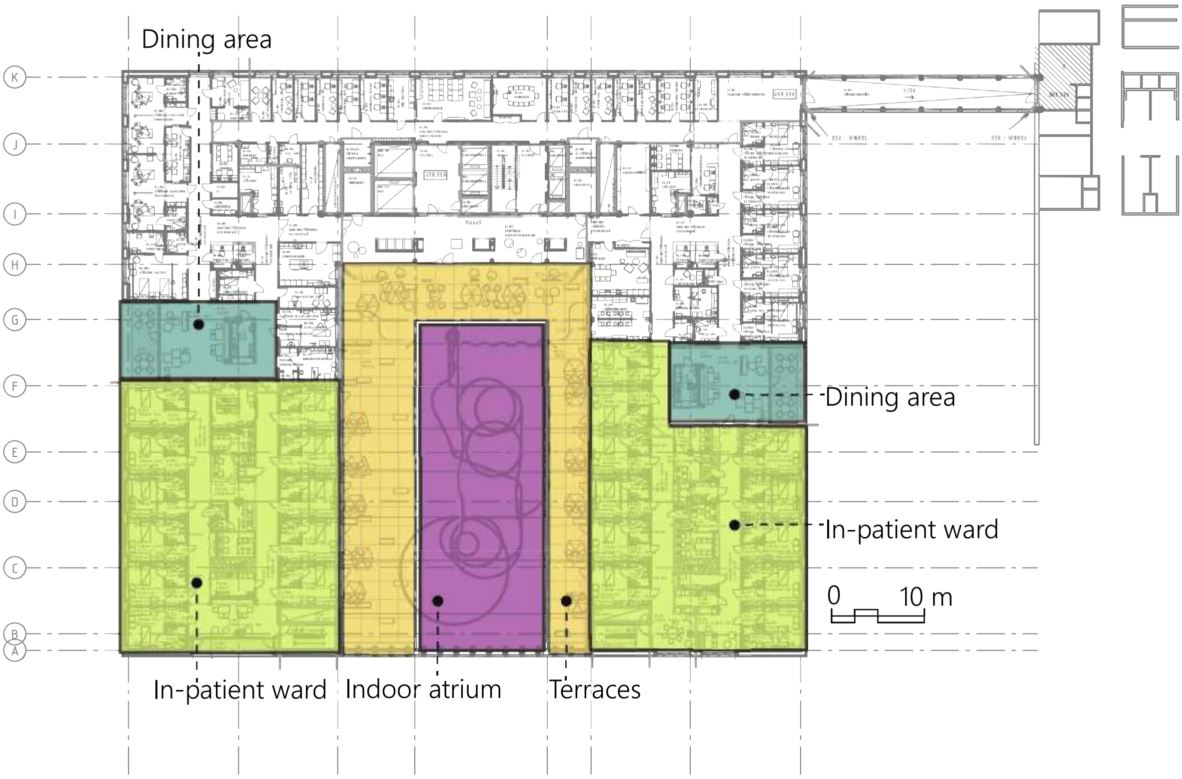



*Fig. 346 Fourth floor at ÖH.*

*Fig. 347 View to the forest at the end of the corridor at ÖH.*

*Fig. 348 External link to the existing building at ÖH.*

*Fig. 349 Dining area for staff on the second floor at ÖH.*

*Fig. 350 Operating theatre installation on the second floor at ÖH.*

*Fig. 351 Internal façade to the atrium at ÖH.*

*Fig. 352 View of the atrium from the fourth floor at ÖH.*

*Fig. 353 Auxiliar structure for hanging ceiling equipment at ÖH.*

## St. Olav's Hospital (OLAV)

The paediatric wards were located within the women and children centre of the acute-care hospital (Fig. 354-Fig. 367).

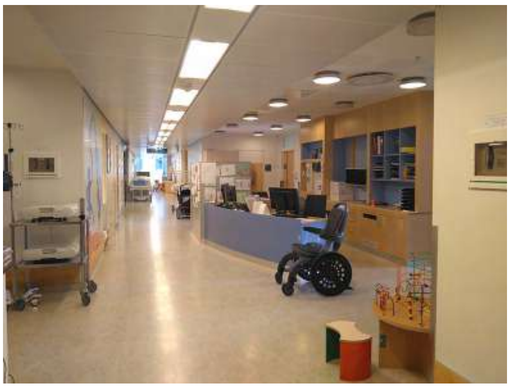


*Fig. 354 View from the ward counter and corridor at OLAV.*

*Fig. 355 Open counter with no separation from patients and visitors. Toys and material for children's entertainment at OLAV.*

*Fig. 356 Hand sanitation station between the storage area. OLAV.*

*Fig. 357 Integrated storage area before entering the child's bedroom. OLAV.*

*Fig. 358 Patient's bedroom with furniture for parent. OLAV.*

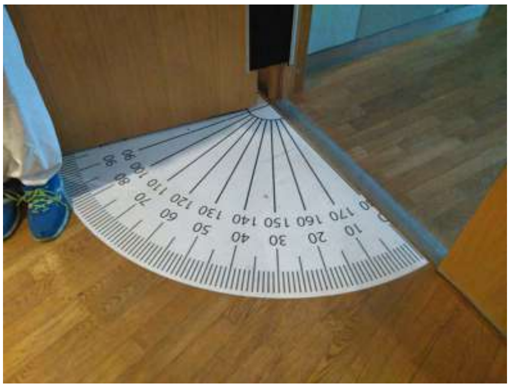


*Fig. 359 Detail of door opening. OLAV.*

*Fig. 360 Aquarium next to a cosy sitting place. OLAV.*

*Fig. 361 Playroom for imitation games where children can represent doctors and nurses. OLAV.*

*Fig. 362 Dining area for families. OLAV.*

*Fig. 363 Outdoor play area with a sandbox. OLAV.*

*Fig. 364 Outdoor sitting area for staff, families and children. OLAV.*

*Fig. 365 "Frirom" for parents who need a private space to be. OLAV.*

*Fig. 366 "Frirom" ceiling view. OLAV.*

*Fig. 367 "Frirom" place to keep your shoes and hang your coat. OLAV.*

## 4.6.4 Acute-care Hospital Cases

Fig. 368 shows the location of the evaluated wards.

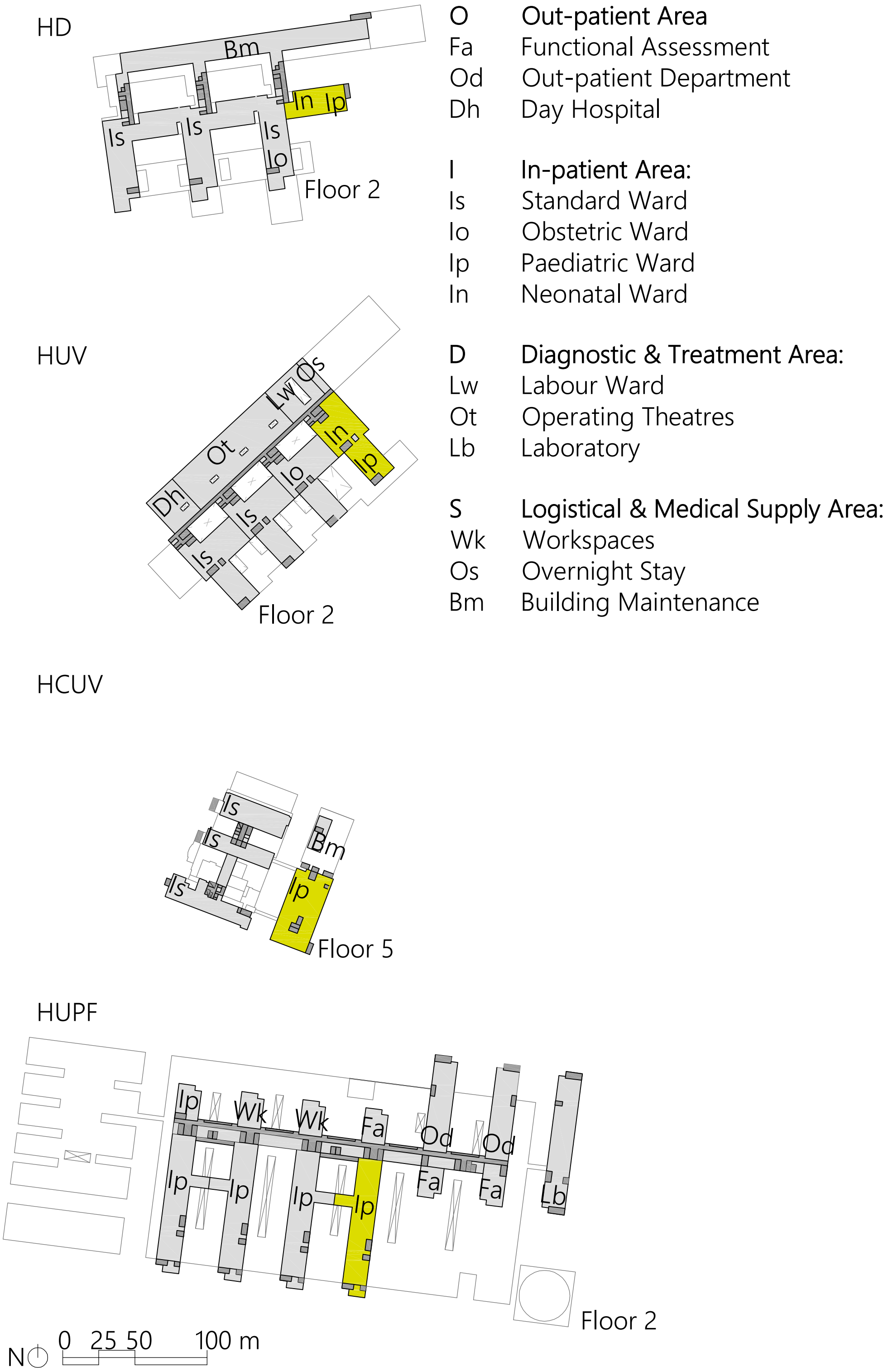



*Fig. 368 Location of the paediatric ward evaluated.*

## "Hospital de Dénia" (HD)

The paediatric ward was located on the second floor of the C hospitalization wing, next to the obstetric ward (see chapter 4.5.4), neonatal ward (see chapter 4.7.4) and other internal medicine wards (Fig. 369). Two lift cores (one for public access and one for private access) served the unit. Two double bedrooms were used for day hospital treatment and there were nine bedrooms used individually but with double capacity.

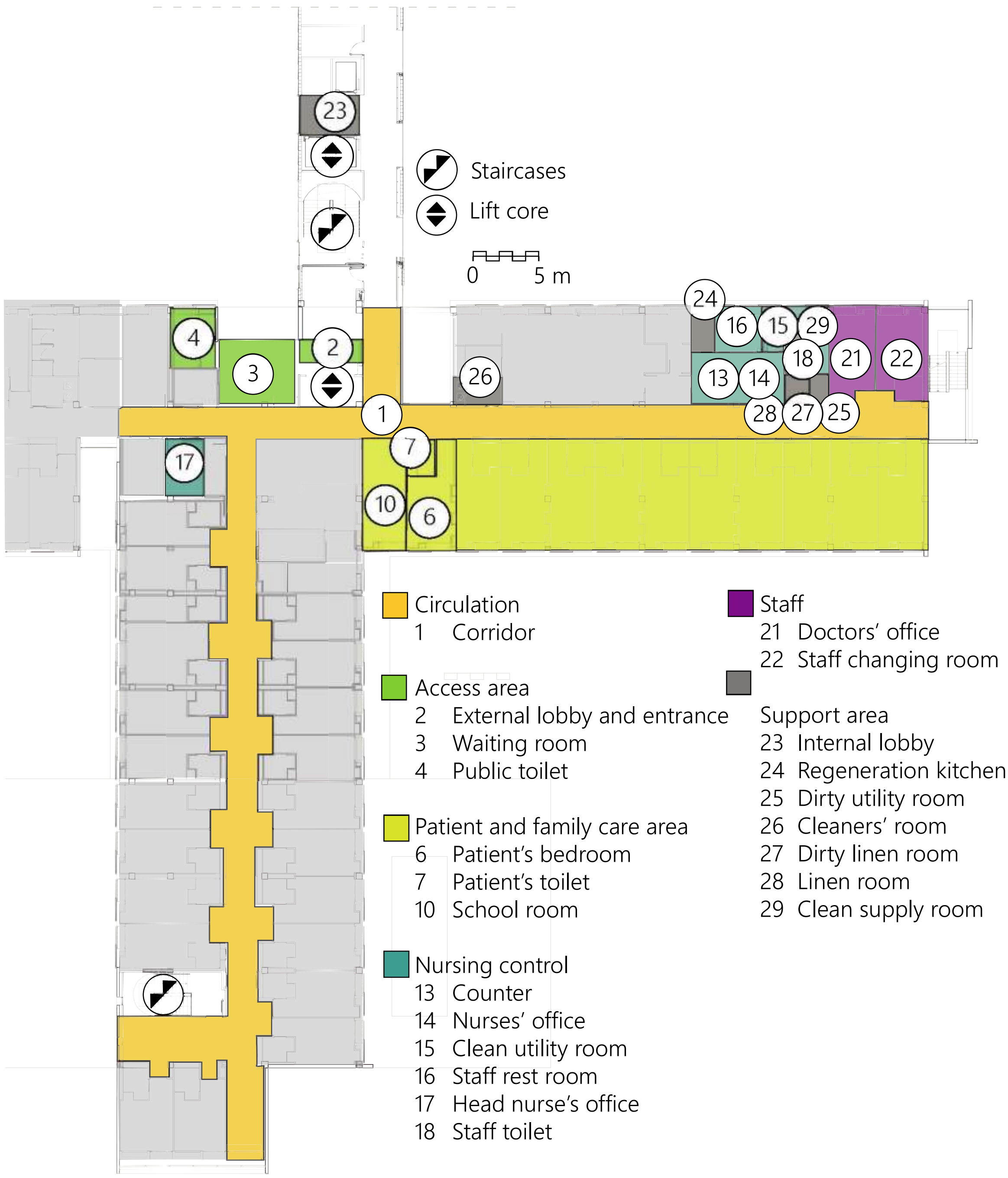



*Fig. 369 Evaluated rooms in the paediatric ward HD.*

## "Hospital Universitario del Vinalopó" (HUV)

The paediatric ward at HUV was located on the second floor of the building next to the labour ward, obstetric ward, neonatal ward, standard ward, operating theatres, and day hospital (Fig. 370). The unit was integrated with the neonatal ward (see chapter 4.7.4) with which it shared staff and support rooms. There were 15 bedrooms.

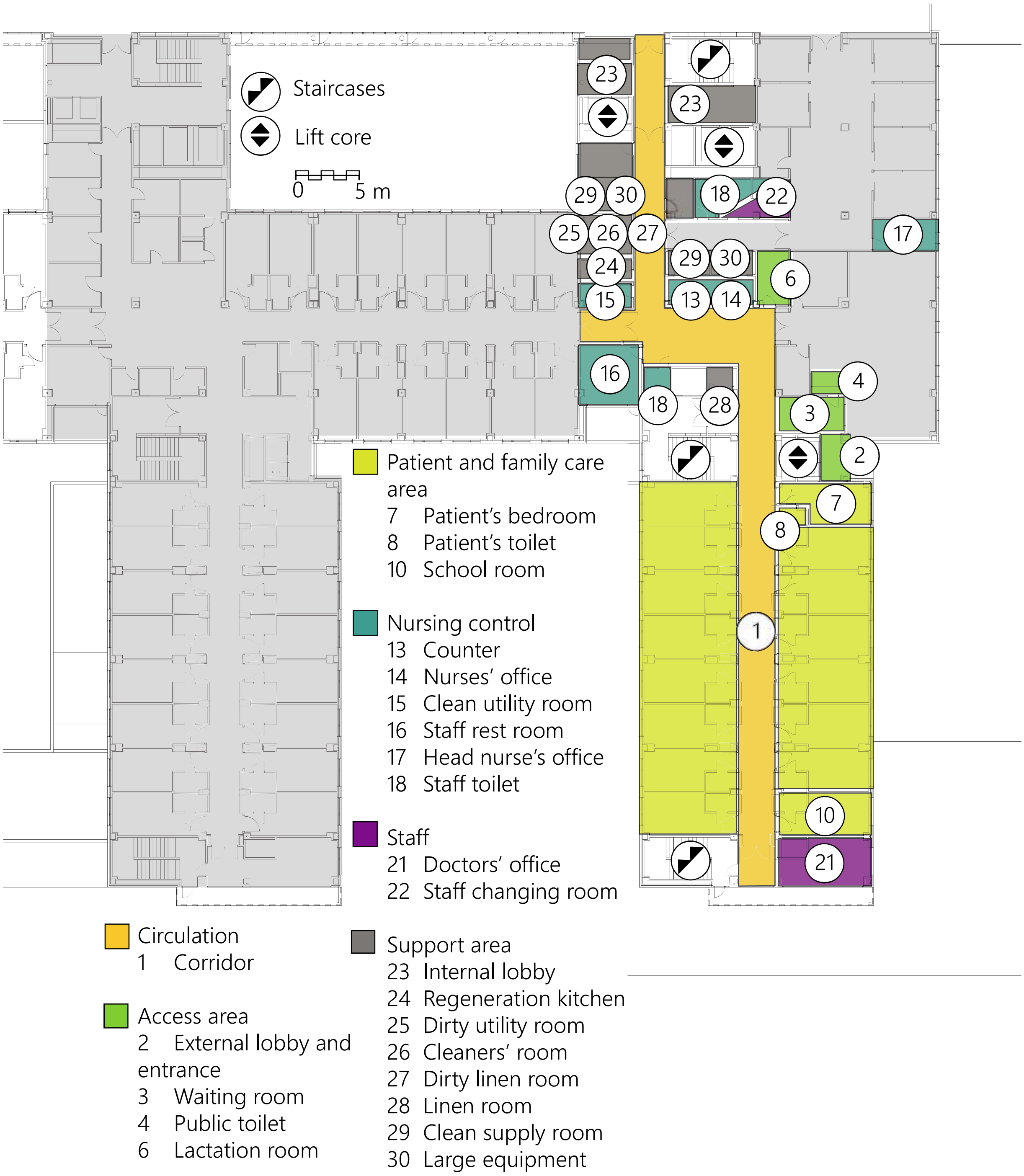



*Fig. 370 Evaluated rooms in the paediatric ward HUV.*

## "Hospital Clínico Universitario de Valencia" (HCUV)

The ward was located on the fifth floor of pavilion A (Fig. 371). Three lift cores served the unit. One for the internal flow of supplies, another for the internal use of staff and the last one for public flow. The unit had a rectangular shape with a double corridor. The area between the corridors (with no daylight) was used for staff, support, and nursing rooms while the patient bedrooms faced the façades. There was an extensive area for staff rooms. There were six individual bedrooms for isolated and infectious patients, seven double bedrooms for paediatric patients and three bedrooms for oncological patients (one of them with anteroom).

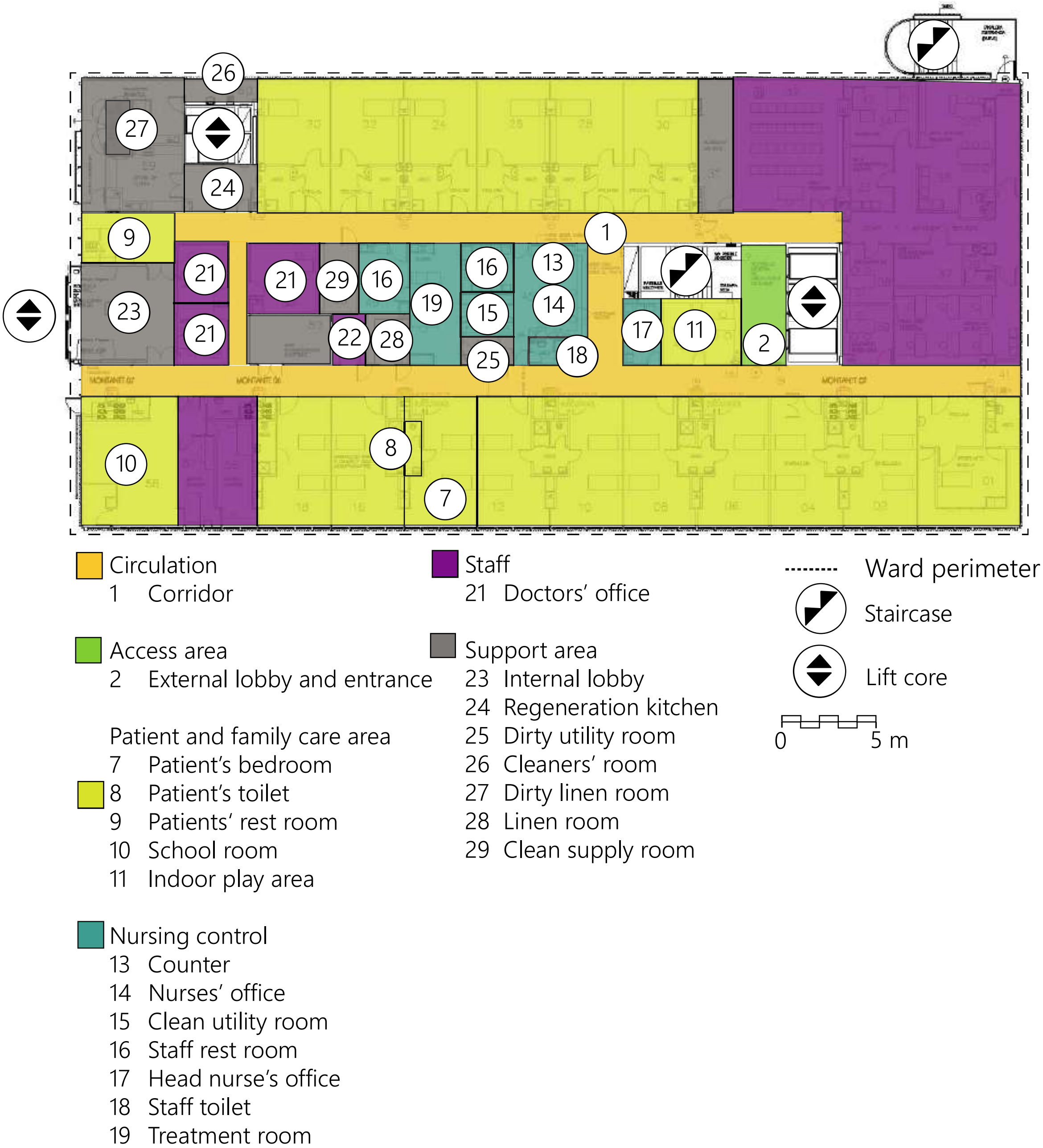



*Fig. 371 Evaluated rooms in the paediatric ward HCUV.*

## "Hospital Universitari i Politècnic La Fe" (HUPF)

The ward was located on the second floor of tower D, next to other paediatric wards and out-patient services for paediatrics. It had four lift cores (one for public access and three for private access) (Fig. 372). The unit had an F shape and the corridor had one-part double-loaded of patient bedrooms and another part with patient bedrooms on one side and staff rooms on the other side. There were 35 individual patient bedrooms.

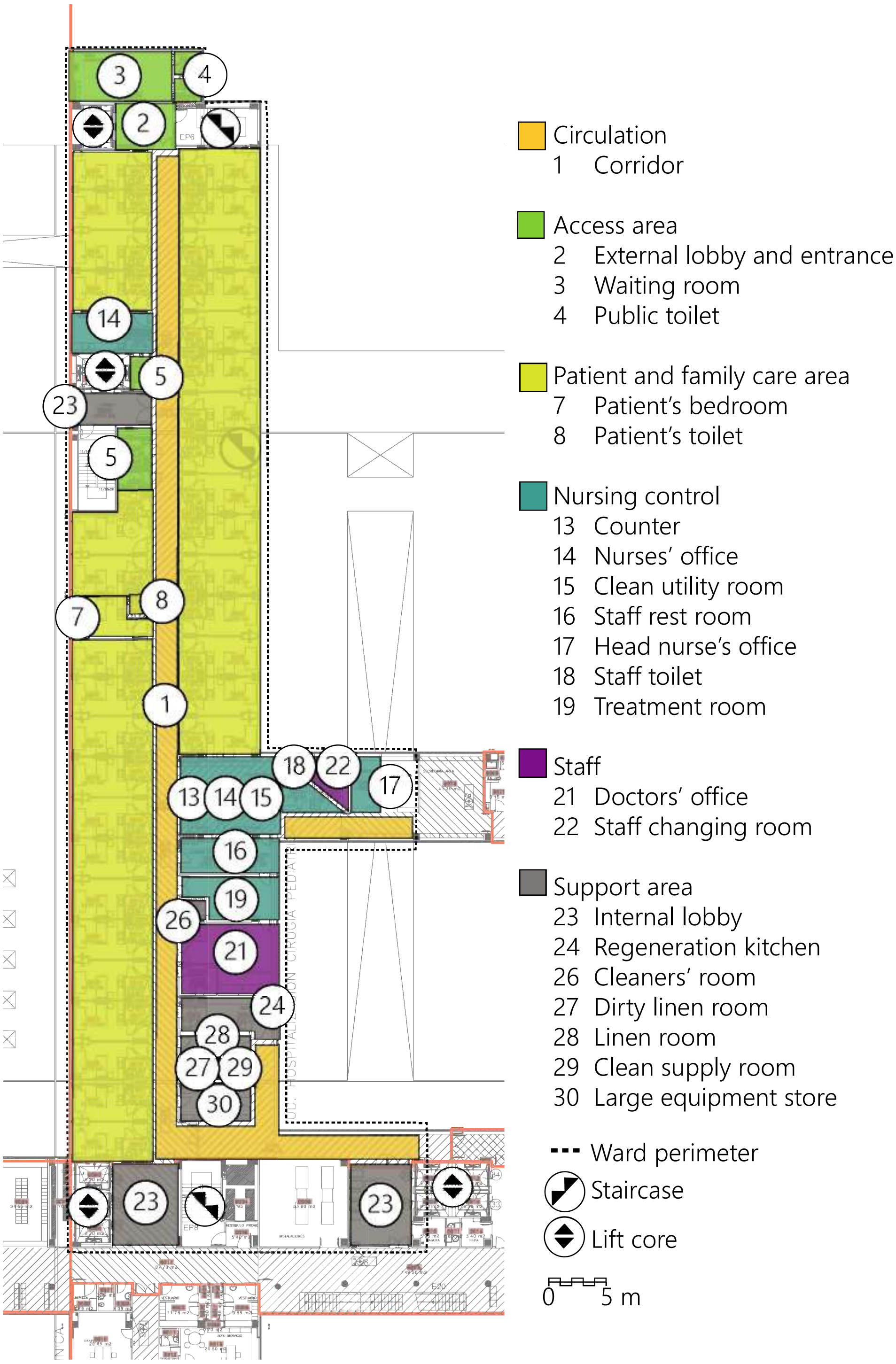



*Fig. 372 Evaluated rooms in the paediatric ward HUPF.*

## Evaluation Results

From the results obtained following the evaluation process described at chapter 4.1.2, the HD ward design scored the best results and HUV and HUPF had a similar global grade. Only HCUV had a global score below 50%. The percentage of achievement with CURARQ-Hpedi tool is shown in Fig. 373. All detailed results are available online [33].

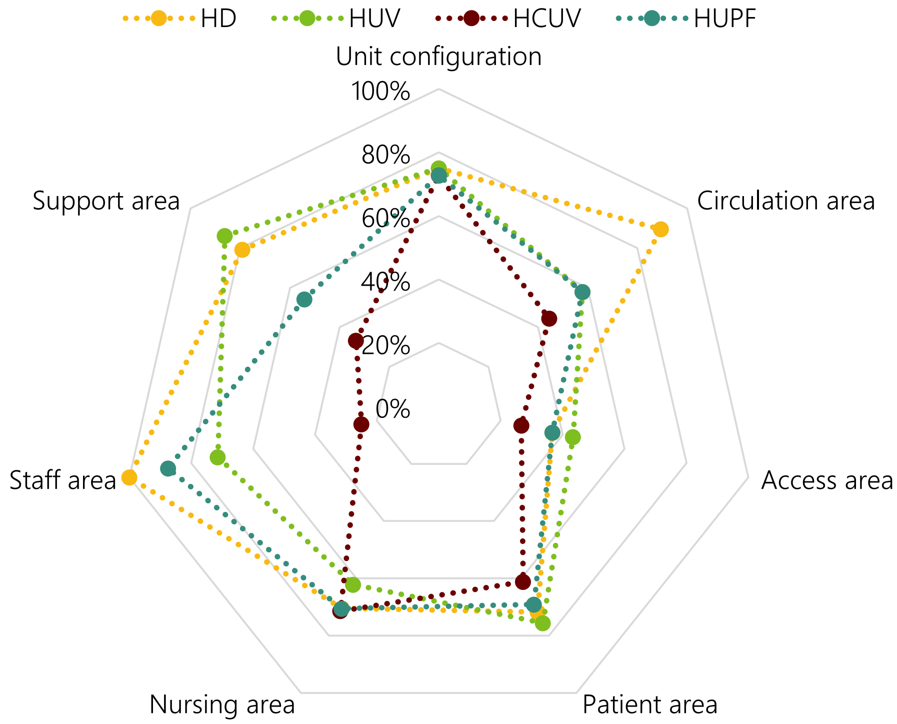



*Fig. 373 CURARQ-Hpedi results for the wards evaluated.*

The requirements associated with the unit configuration were the same as for the standard ward except for the need of proximity to the labour ward (in case they share paediatricians). In highly complex acute-care hospitals the paediatrician ward could be subdivided into two: one for toddlers (less than 3 years) and another one for school children and adolescents. The scores of all four wards were very similar and above 70%.

Regarding the ward corridor, the requirements evaluated concerned artistic representations, transparent elements in mobile parts (like doors) in order to see shorter people on the other side, or handrails at a lower height for children. In a similar way as for the other wards, HD got the best results.

In the access area there were additional features for standard premises like a lactation room or entertainment areas (with games and books) in the waiting rooms. Similarly to the standard and obstetric ward, the access area received the lowest scores of all areas. None of the acute-care hospitals had an interview room. Only HUV had its own lactation room (Fig. 374), and HCUV had a lactation room (Fig. 375) but on a different floor (with the obstetric ward).

Regarding the patients' and family area, the patients' bedrooms could be double or individual (for infectious or immunosuppressed patients). In addition to the rooms of a standard ward, the patient ward should have a school room (Fig. 376-Fig. 379), and play areas both indoor and outdoor. In this regard, HD and HUV had one school room while HCUV and HUPF, in addition to the school room, had an indoor playing area. Only HUPF had an outdoor play area at a project stage during the acute-care hospital evaluation (January 2018).

In terms of the nursing control area, the only additional room was the support room for unsupervised infants but none of the acute-care hospitals evaluated had one. The results of all four acute-care hospitals were very similar and above 60%. In all of them, the counter was shared with the nurses' office working area (Fig. 380-Fig. 383).

Only the doctors' office and the staff changing room was evaluated for the staff area. HUV shared the staff toilets with the staff changing room. HD did not have a staff changing room in the ward as it was centralised. At HCUV staff had improvised a staff changing room in a storage room.

The support area included the same rooms as in the standard ward with the addition of a milk preparation area in the regeneration kitchen. The worst results went to HCUV because some of its rooms did not meet the recommended requirements such as the regeneration kitchen without a basin, or the combination of functions in small rooms due to the lack of floor area.

*Fig. 374 Lactation room at HUV.*

*Fig. 375 Lactation room at the obstetric ward. HCUV.*

*Fig. 376 School or play room at HD.*


*Fig. 377 School or play room at HUV.*


*Fig. 378 School or play room at HCUV.*

*Fig. 379 School or play room at HUPF.*

*Fig. 380 Counter and nurses' work area at HD.*

*Fig. 381 Counter and nurses' work area at HUV.*

Fig. 382 Counter and nurses' work area at HCUV.

Fig. 383 Counter and nurses' work area at HUPF.

## 4.5.5 Discussion

Paediatric patients differ from adult patients in their need for socialising, learning, and playing. That is why the configuration of the paediatric ward is very similar to the standard or obstetric ward with the addition of some rooms at the access and patient areas (indoor and outdoor playing rooms, school rooms, and the possibility of double patient bedrooms [34]). However, none of the four acute-care hospital cases had an outdoor playing area.

The acute-care hospital visits showed that while Spanish buildings are tailored to infants by means of their decoration, Sweden and Norway include a welcoming environment for infants from the very beginning of the acute-care hospital.

# 4.7 Neonatal Ward

## 4.7.1 Acute-care Hospital Placement

From the interviews performed during the acute-care hospital placement, the topics that came up were regarding room size, security, and lighting. Observation of the open bay room pointed out the importance of visual control and direct proximity of the staff communication base to the newborn infant. The need for single cot rooms in a basic-care ward was also questioned because one of the two designated rooms (with no natural light) was reconverted into storage area. Additionally, the interviews allowed for the description of several users' scripts as follows (Fig. 384).

*Family A: The pregnant woman arrived at the emergency department. From there, she was taken directly to the labour-delivery-recovery (LDR) room in the labour ward. Due to labour complications, she had a caesarean-section in the surgery room of the ward. She knew the labour ward thanks to a visit during <u>prenatal care</u>. After the operation, she stayed in the post-anaesthesia care room with her partner, but her daughter had to go to the neonatal ward with an incubator. After a few hours of recovery, the mother was able to see her daughter in the neonatal ward but had to go to her patient bedroom in the obstetric ward.*

*Fig. 384 Family A at HD.*

## 4.7.2 Literature Analysis

From the literature analysis came the organisation of the neonatal ward, which in turn depends on the level of care needed and the integration of family members into the unit. In this basic schedule (Tab. 7) the most common rooms are presented. This distribution only considers open bay units with basic, intermediate, and intensive care as they are the most frequently seen units in existing Spanish acute-care hospitals. All the CURARQ-UNeo tool requirements per each room can be read online.

| | Room | Function |
|---|---|---|
| Circulation | 1. Corridor | To allow for the horizontal movement of people and supplies. |

| | | |
|---|---|---|
| Access | 2. External lobby and entrance | To enter the unit, for parents, siblings and visitors. |
| | 3. Reception desk | To give basic information to external visitors. |
| | 4. Waiting room | To wait when visits are not possible. |
| | 5. Visitors' changing room | To get appropriate clothing with access to hand hygiene. |
| | 6. Public toilet | To empty the body of urine or solid waste. |
| | 7. Interview room | To provide confidential information in private. |
| | 8. Consultation room | To explore babies without entering the unit. |
| | 9. Lactation room | To feed babies. |
| Parents | 10. Reception | To receive the parents into the parents' area. |
| | 11. Interview room | To provide information, training, and support to parents. |
| | 12. Sitting and beverage room | To prepare light meals and beverages. |
| | 13. Play area for siblings | To allow siblings to play and stay in the unit. |
| | 14. Parents' toilet | To empty the body of urine or solid waste. |
| | 15. Bedroom | To allow parents to stay overnight in acute-care hospitals with a large catchment area. |
| | 16. Grief room | To allow family members to grieve over their lost baby. |
| Clinical | 17. Staff communication base | To provide workspace and facilitate communication between staff members. |
| | 18. Clean utility room | To prepare and store medication. |
| | 19. Single-cot room | To isolate babies in need of intensive care. |
| | 20. Neonatal bay for intensive care | To provide intensive care. |
| | 21. Neonatal bay for intermediate care | To provide intermediate care. |
| | 22. Neonatal bay for basic care | To provide basic care. |
| | 23. Treatment room | To allow for specific treatment difficult to perform in the open bay. |
| | 24. Transfer room | To prepare the baby for his/her transportation to another acute-care hospital or for his/her retrieval into the unit. |
| | 25. Milk expression room | To support mothers who are expressing. |
| | 26. Milk kitchen | To store human milk or prepare make-up formula. |

| | | |
|---|---|---|
| Staff | 27. Head nurse's office | To organise and supervise the work of nurses in the unit. |
| | 28. Head doctor's office | To organise and supervise the work of doctors in the unit. |
| | 29. Doctors' office | To provide workspace for doctors. |
| | 30. Seminar room | To gather clinical staff for teaching and communication sessions. |
| | 31. Staff rest room | To rest and relax. |
| | 32. Staff toilet | To empty the body of urine or solid waste. |
| | 33. Staff changing room | To get dressed and leave their personal clothing. |
| | 34. On call doctor's bedroom | To sleep during on call shifts. |
| Support | 35. Internal lobby | To provide access to clinical and non-clinical staff and supplies. |
| | 36. Dirty utility room | To store dirty materials. |
| | 37. Cleaners' room | To store cleaning material. |
| | 38. Dirty linen room | To store dirty clothing before its transport to the laundry. |
| | 39. Linen store | To store clean clothing. |
| | 40. Clean supply room | To store small clean items. |
| | 41. Large equipment store | To store larger clean equipment. |
| | 42. Building services room | To store and maintain the needed services. |

*Tab. 7 Areas and rooms in the neonatal ward.*

## 4.7.3 Acute-care Hospital Visits

### "Hospital Sant Joan de Déu" (HSJD)

The neonatal ward in HSJD was visited in 2018 (Fig. 385-Fig. 386). It had an open bay design that was outdated both for family and staff needs. During the visit, the staff talked about the ongoing design process for the renovation of the unit. The usage of cardboard mock-ups was commented for the simulation of clinical procedures to facilitate the decision process and agree on the final design.

*Fig. 385 Open bay area for neonatal care at HSJD.*

*Fig. 386 Storage of clean incubators in the ward rooms at HSJD.*

## "Hospital Materno-Infantil 12 de Octubre" (H12O)

Interestingly the H12O was visited before (2017) and after (virtually in 2020) the renovation of the unit.

The original ward had three open-bay rooms for intensive care (with 10, 4 and 5 pods) and two open-bay rooms for intermediate care (with 10 and 12 pods) (Fig. 387-Fig. 392). Additionally, there were two family rooms for the transition of healthy babies to their home. There was also an observation open room that connected the unit with the labour ward.


*Fig. 387 Old unit layout at H12O.*

*Fig. 388 Room for intermediate care. H12O.*

*Fig. 389 Room for intensive care. Equipment in columns, not very accessible at H12O.*

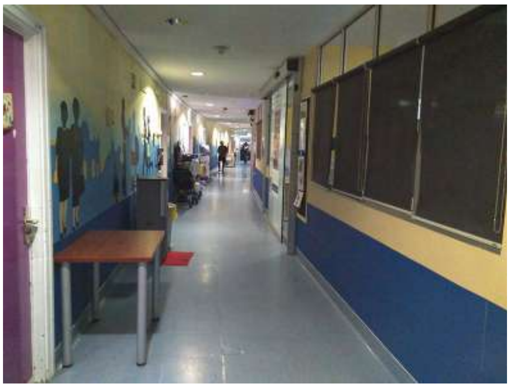


*Fig. 390 Ward corridor for all flow types at H12O.*

*Fig. 391 Workstation for doctors in a corner of the corridor at H12O.*

*Fig. 392 Old visitors' corridor used for storage at H12O.*

The renovation works took place between January 2019 and February 2020 (Fig. 393-Fig. 399). Despite the challenges of the construction process while running the unit without losing any cot, the final unit was inaugurated just before the COVID-19 pandemic in Spain. The staff members prepared an online course titled: "El reto de cuidar en habitaciones familiares de cuidados intensivos" to disseminate their experience on the transition from open bays to single family rooms (SFR). Most of the references of chapter 2.2.6 are based on this fantastic course. The new unit has improved the in-patient area (with 11 cots in SFR for intensive care and more floor area for the open-bay in intermediate care), the distribution of the staff working areas and modified the access points for a more efficient circulation of flows and renovated the technological equipment and building installations.


*Fig. 393 New unit layout at H12O.*

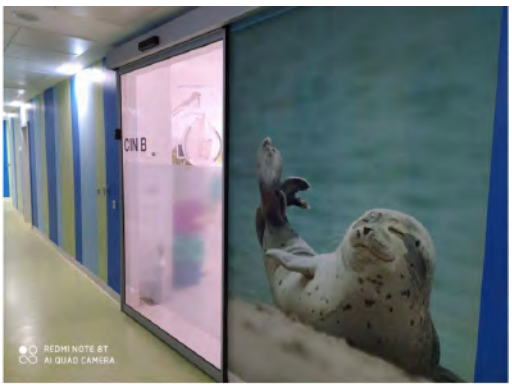



*Fig. 394 Access to intensive care B at H12O. Figure by [35].*

*Fig. 395 Central area intensive care A with the single family rooms (SFR) at H12O. Figure by [35].*

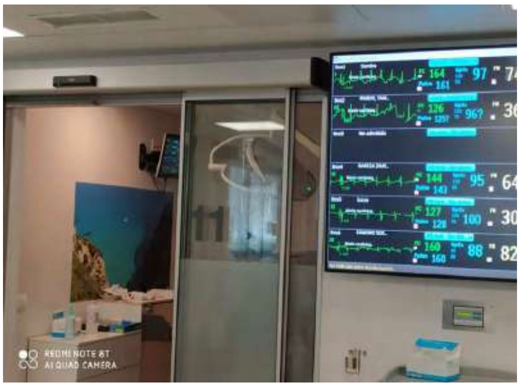


*Fig. 396 Main display at central area. H12O. Figure by [35].*

*Fig. 397 Mother sleeping next to her baby in a SFR at H12O. Figure by [35].*

*Fig. 398 Intermediate care open bay at H12O. Figure by [35].*

*Fig. 399 Another staff room at H12O. Figure by [35].*

## "Hospital Universitario Central de Asturias" (HUCA)

The neonatal ward in HUCA is organised in two open bay areas, one for basic or intermediate care and another one for intensive care (Fig. 400-Fig. 401). Both units are located on the ground floor next to the labour ward and the paediatric intensive care unit.

*Fig. 400 Medication preparation area in the open bay in HUCA.*

*Fig. 401 Open bay for neonatal care in HUCA.*

## "Hospital General Universitario de Ciudad Real" (HGUCR)

The neonatal open bay ward in HGUCR is located on the first floor next to the obstetric ward. It consists of an open bay design (Fig. 402-Fig. 403).


*Fig. 402 View of incubators and wall mounted equipment in HGUCR.*


*Fig. 403 Intermediate care neonatal bay in HGUCR.*

## "Universitetssjukhuset i Linköping" (ULKÖ)

The neonatal ward at Linköping University Hospital has a variety of care rooms according to the intensity of the neonatal care needed (Fig. 404-Fig. 417). There are eight individual family rooms for intensive care and one double room for twins. These single-family rooms (SFR) are organised in pairs so that they can be controlled by a shared expedition room and staff can access directly from one room to the other. All these rooms have one bed for a parent. There are also eight family rooms for basic care in which the two parents and siblings can stay with their baby.

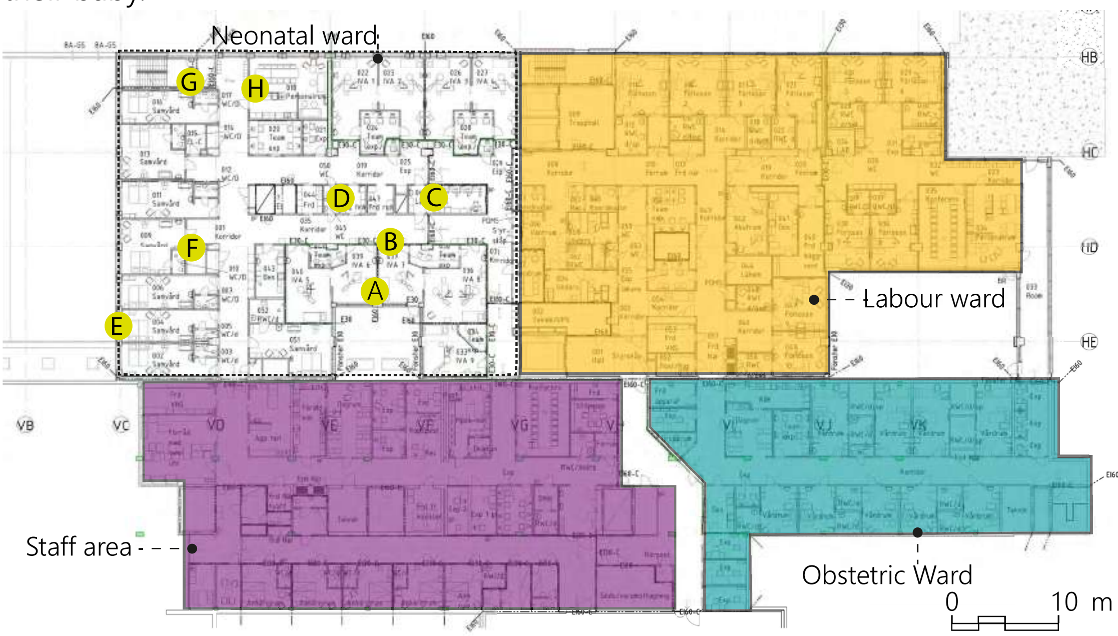



*Fig. 404 Neonatal ward location at ULKÖ.*

*Fig. 405 Individual intensive care Room with equipment for incubator, bed and sofa for parents. (Room A). ULKÖ.*

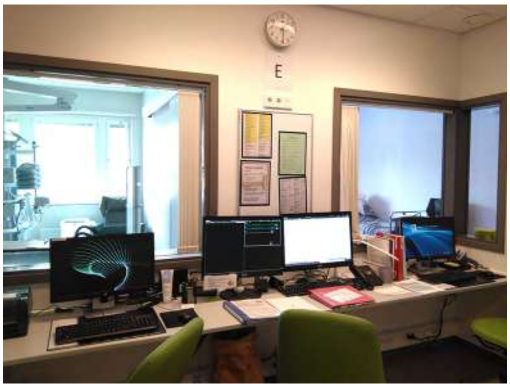


*Fig. 406 Shared expedition for staff that can control and monitor on their screens two intensive care rooms. (Room B). ULKÖ.*

*Fig. 407 Medication preparation room for staff. Accessed by security card to avoid unnecessary distractions. The medication does not come prepared from the pharmacy but is prepared in this room. (Room C). ULKÖ.*

*Fig. 408 Interior rooms for storage. (Room D) ULKÖ.*

*Fig. 409 Family room for basic neonatal care with bathroom for parents. (Room E) ULKÖ.*

*Fig. 410 Area for parents and siblings. (Room E) ULKÖ.*

*Fig. 411 Basin and storage for staff. (Room E). ULKÖ.*

*Fig. 412 Neonatal incubator with headmounted equipment, easier to access from different heights. (Room E). ULKÖ.*

*Fig. 413 Milk storage in the family room. ULKÖ.*

*Fig. 414 Staff rest area. (Room H). ULKÖ.*

*Fig. 415 Kitchen for staff. (Room H). ULKÖ.*

*Fig. 416 Dead neonates' preparation and transportation room. ULKÖ.*

*Fig. 417 Grief room for parents. ULKÖ.*

## 4.7.4 Acute-care Hospital Cases

Fig. 418 shows the location of the evaluated wards within each of the four acute-care hospitals studied.

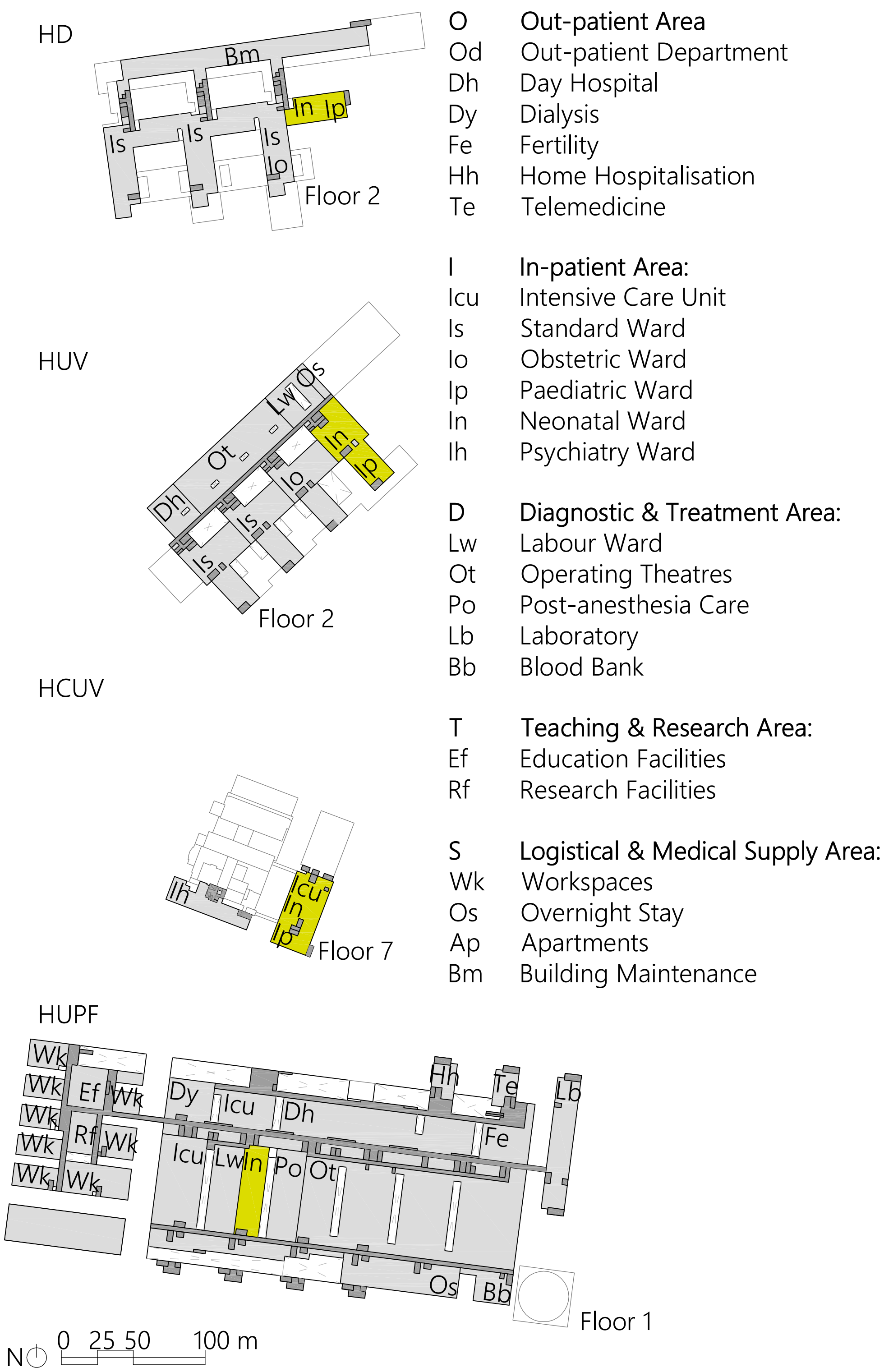



*Fig. 418 Location of the neonatal ward evaluated.*

## "Hospital de Dénia" (HD)

The neonatal ward in HD is located on the second floor, together with the obstetric ward (see chapter 4.5.4) and the paediatric ward (see chapter 4.6.4) (Fig. 419). It shares several rooms with these other two in-patient units such as the two lift cores (one for public access and one for private access) and support and staff rooms. It provides basic care for up to twelve neonates.

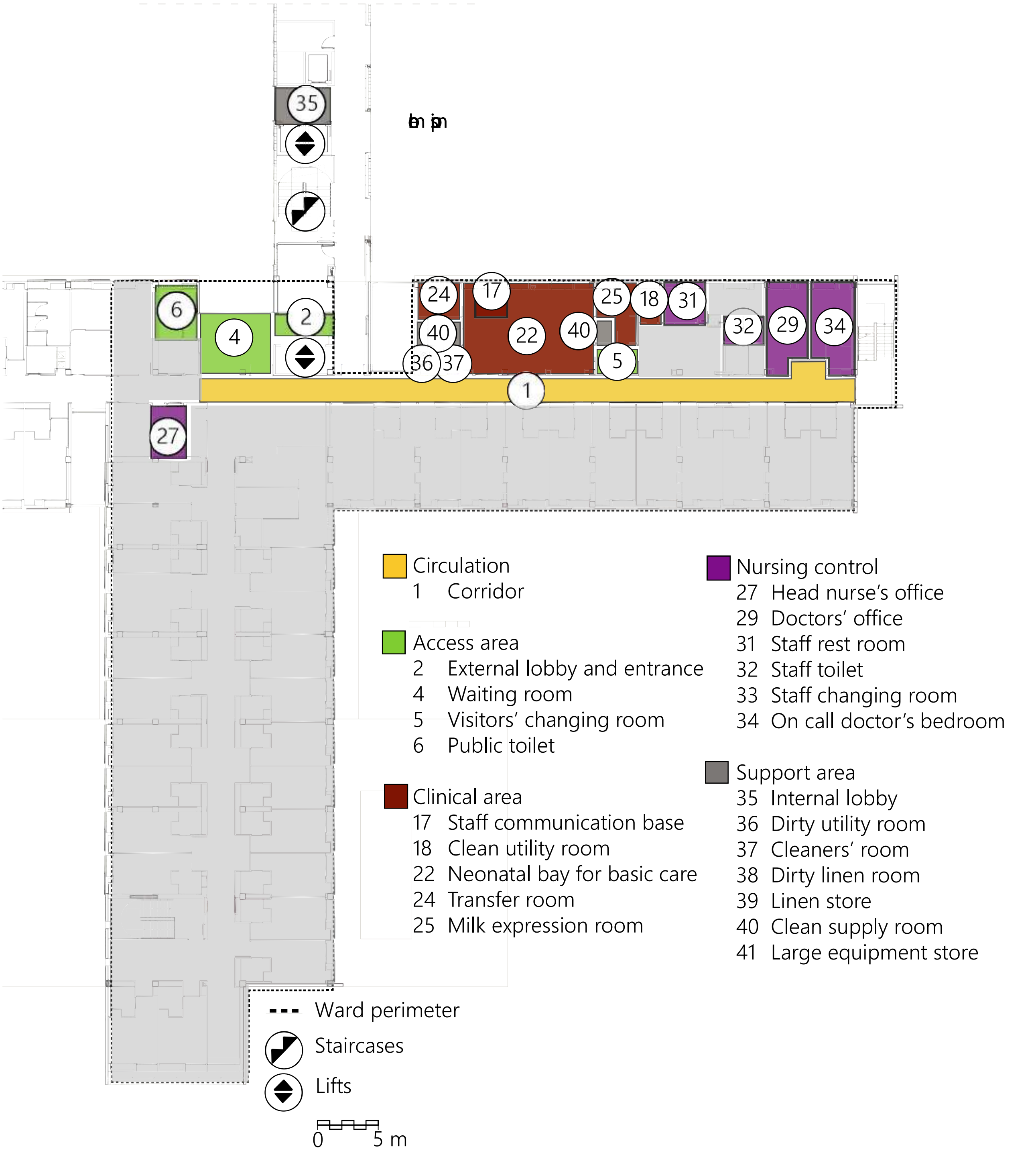
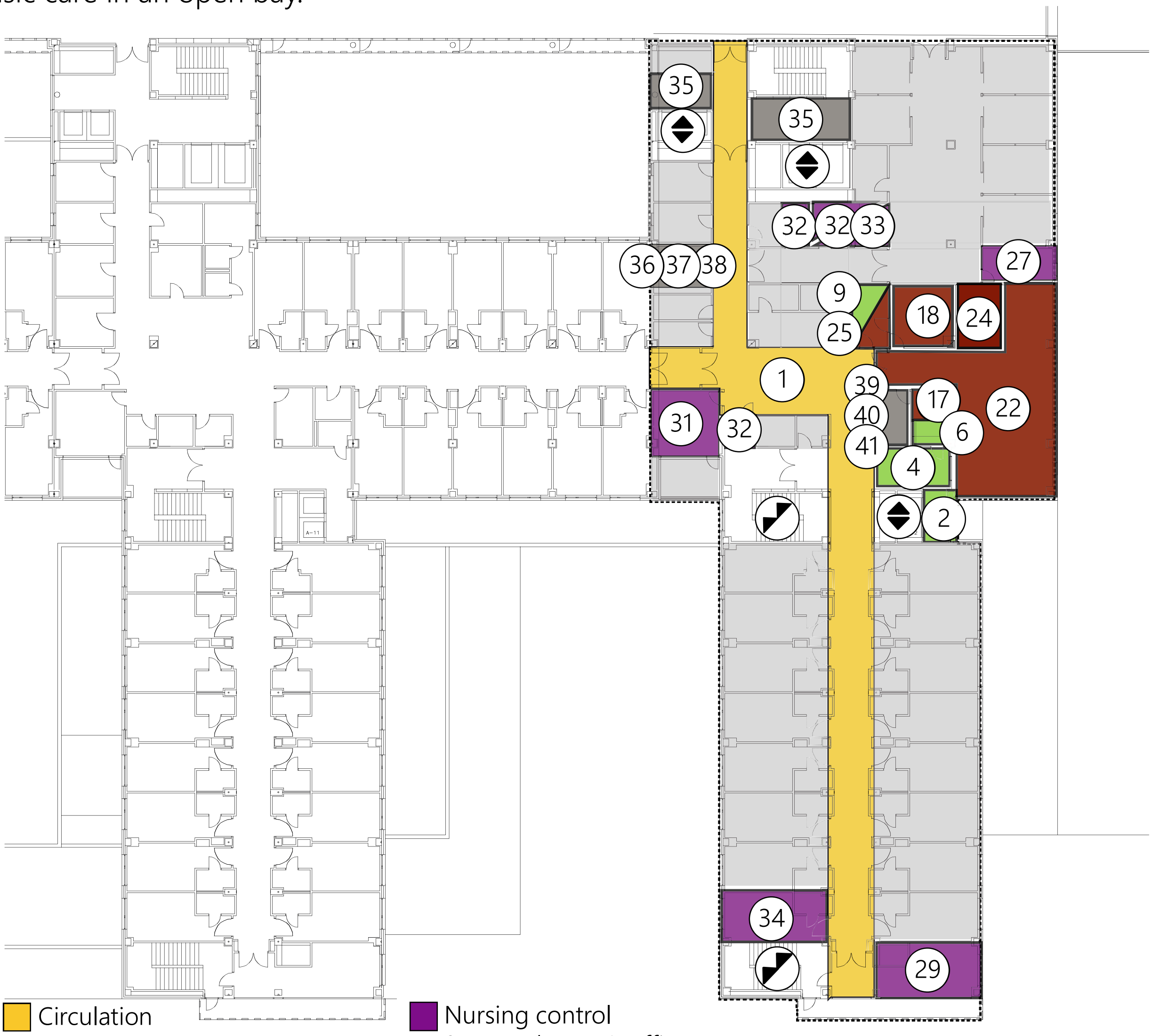



*Fig. 419 Neonatal ward evaluated rooms at HD.*

## "Hospital Universitario del Vinalopó" (HUV)

The neonatal ward in HUV is located on the second floor of the building next to the obstetric ward (see chapter 4.5.4), and paediatric ward (see chapter 4.6.4) (Fig. 420). The unit is integrated in the paediatric ward with which it shares staff and support rooms. It provides basic care in an open bay.



Circulation
1 Corridor

Access area
2 External lobby and entrance
4 Waiting room
6 Public toilet
9 Lactation room

Clinical area
17 Staff communication base
18 Clean utility room
22 Neonatal bay for basic care
24 Transfer room
25 Milk expression room

Nursing control
27 Head nurse's office
29 Doctor's office
31 Staff rest room
32 Staff toilet
33 Staff changing room
34 On call doctor's bedroom

Support area
35 Internal lobby
36 Dirty utility room
37 Cleaners' room
38 Dirty linen room
39 Linen store
40 Clean supply room
41 Large equipment store

--- Ward perimeter
Staircases
Lifts
0 5 m

*Fig. 420 Neonatal ward evaluated rooms in HUV.*

## "Hospital Clínico Universitario del Valencia" (HCUV)

The neonatal ward in HCUV is located on the seventh floor of pavilion A (Fig. 421). It has three access points to this floor: one lift core for supplies, another for internal circulation and a third one for external flow. On this floor the hospitalisation area for infants under two years and the paediatric intensive care unit are also found. These three units share several rooms for support and staff. The outdated design of the neonatal ward still has a perimetral corridor for visitors. The ward has two open bays for critical care (with four and six cots) and another open bay for intermediate care (with twelve cots).


Ward perimeter
Staircases
Lifts
N 0 5 m

Circulation
1 Corridor

Access area
2 External lobby and entrance
4 Waiting room
6 Public toilet

Parents area
14 Parents' toilet

Clinical area
17 Staff communication base
18 Clean utility room
20 Neonatal bay for intensive care
21 Neonatal bay for intermediate care
25 Milk expression room
26 Milk kitchen

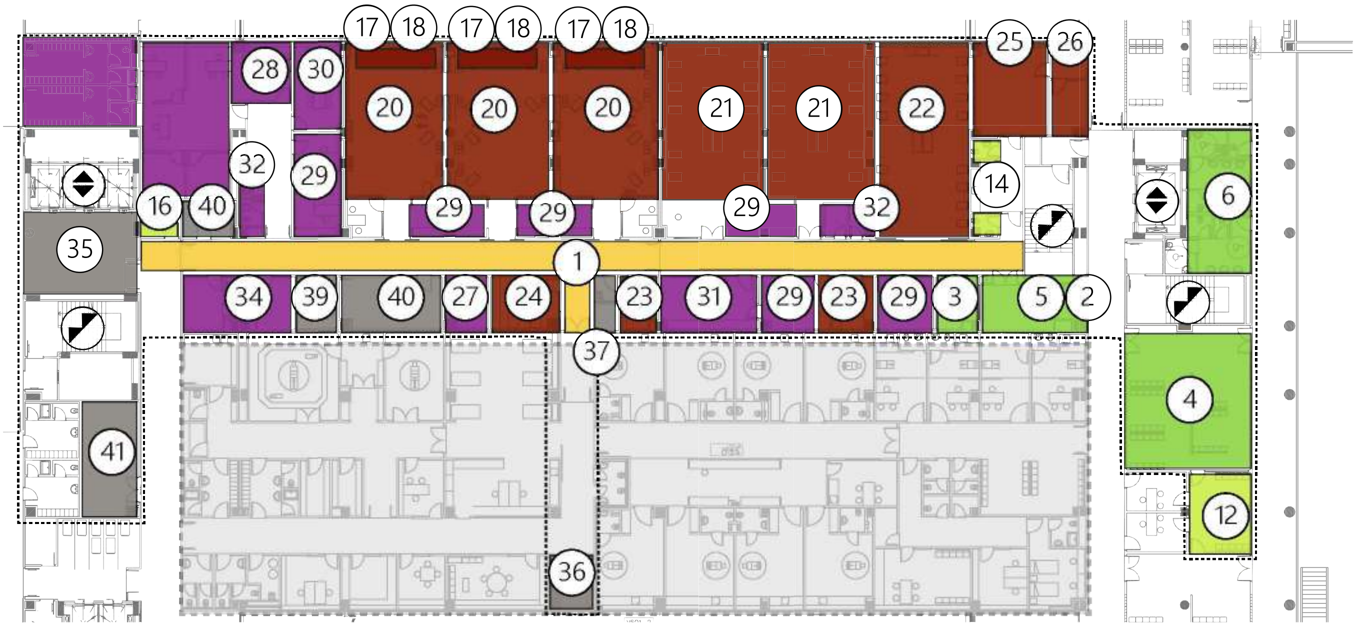
Nursing control
27 Head nurse's office
28 Head doctor's office
30 Seminar room
31 Staff rest room
32 Staff toilet
33 Staff changing room
34 On call doctor's bedroom

Support area
35 Internal lobby
36 Dirty utility room
37 Cleaners' room
38 Dirty linen room
39 Linen store
40 Clean supply room
41 Large equipment store

*Fig. 421 Neonatal ward evaluated rooms in HCUV.*

## "Hospital Universitari i Politècnic La Fe" (HUPF)

The neonatal ward in HUPF is located on the first floor of tower F, next to the labour ward. It has three access points: one for external access and two for internal flow (with connection to the labour ward and in vertical to the obstetric ward) (Fig. 422). The unit is organised in a rectangular shape with some parents' rooms (toilet and waiting room) outside this area. It also has an accommodation facility for parents in the Ronald McDonald House next to the acute-care hospital. The clinical area of the unit has three open bays for intensive care (with six cots each one), two open bays for intermediate care (with ten cots each one) and an open bay for basic care (with up to sixteen cots).



------ Ward perimeter

Staircases

Lifts

N

0 5 m

**Circulation**
1 Corridor

**Access area**
2 External lobby and entrance
3 Reception desk
4 Waiting room
5 Visitors' changing room
6 Public toilet

**Parents area**
12 Sitting and beverage room
14 Parents' toilet
16 Grief room

**Clinical area**
17 Staff communication base
18 Clean utility room
20 Neonatal bay for intensive care
21 Neonatal bay for intermediate care
22 Neonatal bay for basic care
23 Treatment room
24 Transfer room
25 Milk expression room
26 Milk kitchen

**Nursing control**
27 Head nurse's office
28 Head doctor's office
29 Doctors' office
30 Seminar room
31 Staff rest room
32 Staff toilet
34 On call doctor's bedroom

**Support area**
35 Internal lobby
36 Dirty utility room
37 Cleaners' room
39 Linen store
40 Clean supply room
41 Large equipment store

*Fig. 422 Neonatal ward evaluated rooms at HUPF.*

## Evaluation Results

Following the evaluation process described in chapter 4.1.2, Fig. 423 shows the punctuation scored by each acute-care hospital. HD and HUV get the best grades while HCUV scored the lowest. For a detailed analysis of each item, the results of CURARQ-UNeo are available online [36]. Next, there is a summary of the main findings and some photographs of the rooms evaluated organised by areas.

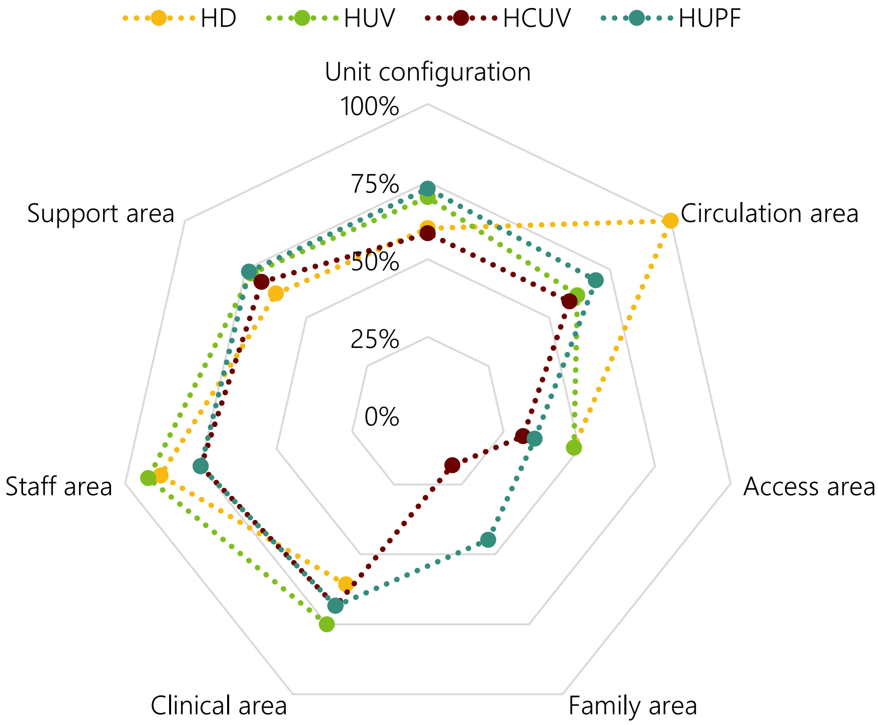



*Fig. 423 CURARQ-UNeo results.*

The analysis of these units was complex due to the variety of the wards evaluated. While HD and HUV had neonatal wards for basic care with only one open bay; HCUV and HUPF were much more complex units that incorporated intensive care. This fact meant that HD and HUV were part of the maternity ward and shared resources with the obstetric and paediatric wards. On the contrary, the neonatal wards in HUPF and HCUV were designated spaces for neonatal care, away from the obstetric or paediatric wards. The neonatal ward in HUPF had good functional relationships with the labour ward and obstetric ward. However, the neonatal ward in HCUV scored lower grades because its relationship with the labour ward and the obstetric ward was difficult as they were situated on different floors and pavilions.

In the circulation area, the corridor width, walls, and floor features such as handrails, art and finishes were evaluated. HD and HUV shared the corridor with the paediatric ward. The HD corridor complied with all the optimal requirements (such as corridor width, handrail, decoration, easy to clean and resistant finishes) and had no direct artificial light.

The access area was one of the areas with the lowest scores because there were very few rooms (Fig. 424-Fig. 425). On the one hand, the neonatal ward in HD and HUV, due to the healthcare services offered, had no need for reception, information room or consultation room because they shared spaces with the other two wards (obstetric and paediatric). On the other hand, the neonatal ward in HCUV had no reception, visitors' changing room, information room, or lactation room. It did have an external lobby, waiting area and parents' toilets but the amenities of these rooms were very limited. The neonatal ward in HUPF had many more rooms (such as the reception or visitors' changing room) but still did not comply with all the recommended requirements.

In a similar way as the access area, the family area was only evaluated for the HCUV and the HUPF and again it scored the lowest marks as there were very few rooms specifically for parents. In the HCUV confidential conversation took place in the doctor's office as there were no information rooms. This ward did not have room for the preparation of light meals and beverages for parents or for the entertainment of siblings. HUPF, on the contrary, scored a higher grade as it had a waiting room for parents with an eating area, toilets, a grief room and even overnight accommodation in the Ronald McDonald House.

The clinical area in the four acute-care hospitals was very different because while HD and HUV only had one open bay for basic care, HCUV and HUPF had several bays for different care levels. The rooms in the clinical area depend on the health care services offered by each acute-care hospital. In HD the staff communication base was relocated because it offered no good visual control of the patients (Fig. 426). In HUV the staff communication base scores higher grades because the initial design was appropriate (Fig. 427). In HCUV, the staff communication base in the intensive-care bay was improvised in a previous cot location (Fig. 428). This new place was better for visual control but had the installation equipment (with a U-shape hung from the ceiling) over the head of staff. Similarly, at HUPF, the staff communication base in the intensive-care bay, situated in a specific room now used only by doctors, was moved to a side of the open bay with uncomfortable and small working areas (Fig. 429).

Of all the open bays in the HCUV and HUPF, only the intensive care bays were evaluated. In the neonatal ward of HUPF there were two rooms that were not present in the HCUV: the treatment room and the transfer room. In this last one, it was possible to take care of a neonate that came from the labour ward, for example. The milk preparation room in HCUV was larger than usual and divided into two compartments (clean and dirty).

Most of the staff rooms in HD and HUV were shared with the obstetric and paediatric ward (Fig. 430-Fig. 431). In HCUV there was a shortage of floor space for these functions. Thus, several functions were combined in the same room (staff changing room with linen storage, for example). Despite the fact that HUPF had many of the recommended rooms, their design quality was lower, for example the staff rest room had no natural light or armchairs. The best results went to HUV because it had both furniture for resting but also for eating and food preparation equipment.

In the support area there were the necessary rooms for the healthcare activity (Fig. 432-Fig. 433). In HD the same rooms had different uses (dirty linen room with dirty utility room) and a single-cot room was transformed into a storage room. In HUV the dirty utility room was shared with the cleaners' room. The unit in HCUV had the recommended rooms but with a shortage of floor space. Thus, there were circulation areas used for storage of bulky equipment such as cots. In HUPF the dirty utility room was shared with the labour ward and several storage rooms were too small.

*Fig. 424 Visitors' preparation room at HD.*

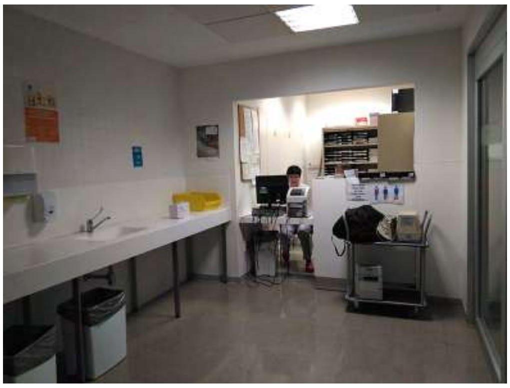


*Fig. 425 Visitors' preparation room at HUPF.*

*Fig. 426 Staff communication base at HD.*

*Fig. 427 Staff communication base at HUV.*

*Fig. 428 Staff communication base at HCUV.*

*Fig. 429 Staff communication base at HUPF.*

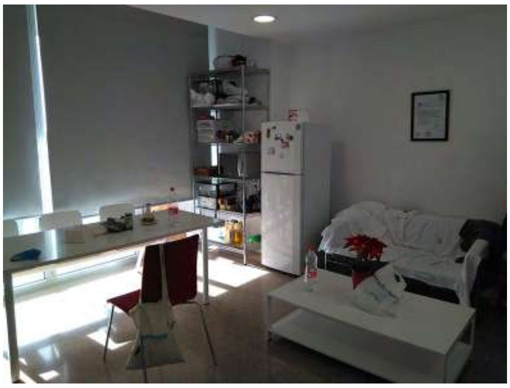


*Fig. 430 Staff rest area at HUV.*

*Fig. 431 Staff rest area at HUPF.*

*Fig. 432 Clean supply room combined with other functions at HCUV.*

*Fig. 433 Clean supply room combined with other functions at HUV.*

### 4.7.5 Discussion

From the literature review, the evolution of parental care involvement and the architectural response becomes very clear. In the early 2000s, parents were included in the units as a support resource. The floor area per cot or incubator had to be increased to facilitate parents' stay and interaction with the newborn infant. Open-bays or multi-cot bays were the norm, and the single-cot rooms were provided only for more acute patients. In the following decade, the trend towards separating newborn infants in single rooms increased but there was major concern regarding the neurodevelopmental outcomes derived from this sensory deprivation [37], which was the reason why national standards in Australia [38], England [39] and Spain [40] only considered the option of single cot rooms for the isolation of very weak infants. However, more recent research has proved better outcomes incorporating family members into Single-Family Rooms (SFR) [41-43] and the European Foundation for the Care of Newborn Infants [44] has established the SFR as the optimal design of the neonatal ward. Considering that the Spanish standard was published in 2014, and the European Standard was launched at the end of 2018 (after CURARQ-UNeo tool was created and data was collected from the four acute-care hospital cases) it is normal that CURARQ-UNeo tool does not yet include this major design modification. This time lag could be overcome by fixed a revision period for the Spanish standard, as is stated in the European standard [45], which aims to be reviewed by 2023 (5 years after its release).

If CURARQ-UNeo tool were to be updated to incorporate the latest research, its rooms schedule should be reconsidered. The clinical and parents' area should be merged into one (taking out of this new area the support rooms exclusively for parents, such as rooms for beverage, toilet, shower, room for siblings, outdoor area or playground). Storage areas could also be decentralised, with space for bulky equipment (such as incubators or cots) away from the unit and a minimum provision available in the unit. Another discussion is the need for basic-care neonatal wards. If newborn infants could be cared for in SFR within the obstetric ward, there would be no need for an open-bay room and the support rooms for neonates could be integrated into the obstetric ward while providing permanent contact with the mother. Additionally, if parents were integrated into the clinical area, many rooms such as waiting room, lactation room, parents' bedroom, interview room or the milk expression room would no longer be needed.

Regarding the acute-care hospital visits in Spain, they did not reflect the full incorporation of family members into the neonatal ward. This fact evidences the national delay compared to the Swedish designs. An exception to this was the transformation of the neonatal ward at "Hospital Materno-Infantil 12 de Octubre" from an open-bay unit to a hybrid design that combines open-bay rooms with single family rooms. The online course that the healthcare staff prepared at this acute-care hospital for the dissemination of their transformation

[35] shows the amount of extra work the healthcare staff had to prepare and organise for the design transformation without the deserved support from the academic or architectural side. This means that even though design transformation can be performed by the acute-care hospital professionals, it involves additional work and time that must be taken from the dedication to patients, which could imply an inefficient usage of staff.

From the acute-care hospital case studies, it is relevant to mention that the four acute-care hospitals had very different units because of their level of complexity. While HD and HUV had basic-care wards incorporated into the maternity area, HCUV and HUPF offered intermediate and intensive care in specialised and complex neonatal units. However, in all of them, the worst scores went to the access and parents' area. These results demonstrate the added difficulty to promote parental involvement when the design does not facilitate it.

# 4.8 Labour Ward

## 4.8.1 Acute-care Hospital Placement

From the interviews performed in the labour ward at "Hospital de Dénia", the following topics came up: ventilation, room area, noise, privacy, security, ergonomics, smells, lighting and views. Additionally, the interviews allowed for the description of several users' scripts as follows (Fig. 434).


*Fig. 434 With the midwife team at HD.*

*MIDWIVES They either arrived by car and parked or came on foot. They used both the men's and women's changing room in the labour ward (according to space availability). They left their handbag with personal belongings in the changing room locker at the nurses' communication base or in the head nurses' office (for extra safety and proximity). They carried out the relief with the previous shift in the nurses' communication base. They prepared patient medication in the corridor where the Pyxis MedStation (automated medication dispensing system) was situated. They attended births in the LDR (labour-delivery-recovery) rooms. Complicated births were attended in the delivery room or operating room. They supervised postpartum women in the recovery room and attended urgent patients in the consulting room of the labour ward. When the unit was not busy, they liked to read, stretch their legs and rest. For that they used the staff rest room, the armchairs at the nurses' communication base, an empty LDR room or the reanimation room.*

*GYNAECOLOGIST He arrived by car, parked and got changed in the men's changing room in the labour ward. He left his valuable objects in the on-call doctors' bedroom. He carried out the relief at the nurses' communication base. He attended urgent patients in the consulting room, complicated births in the LDR rooms, instrumental deliveries or caesarean sections in the operating room. He carried out his administrative work in the consulting room or at the nurses' communication base counter. He usually ate at the hospital cafeteria.*

## 4.8.2 Literature Analysis

From the literature analysis came the organisation of the labour ward according to several areas which in turn might contain the rooms shown in Tab. 8. All the CURARQ-Pari tool requirements per each room can be read online.

| | Room | Function |
|---|---|---|
| Circulation | 1. Corridor | To allow for the horizontal movement of people and supplies. |
| Access | 2. External lobby and entrance | To enter the unit. |
| | 3. Admission | To receive and admit patient into the unit. |
| | 4. Waiting room | To wait until the admission to the unit. |
| | 5. Assessment room | To assess patients' level of emergency. |
| | 6. Interview room | To provide confidential information in private. |
| | 7. Public toilet | To empty the body of urine or solid waste. |
| Examination | 8. Consulting room | To explore women for the evaluation of delivery risk. |
| | 9. Observation room | To wait between the different consultations needed. |
| | 10. Treatment room | To provide additional services such as monitoring and procedures. |
| Patient | 11. LDR room | To allow for the labour, delivery and recovery phases (LDR). |
| | 12. Toilet in LDR room | To empty the body of urine or solid waste. |
| Surgical | 13. Surgeons' preparation room | To disinfect hands and put on personal protective equipment. |
| | 14. Operating theatre | To perform caesarean sections. |
| | 15. Recovery room | To provide post-anaesthesia care. |
| Nursing control | 16. Staff communication base | To provide workspace and facilitate communication within staff members. |
| | 17. Staff rest room | To rest and relax. |
| | 18. Clean utility room | To prepare and store medication. |
| | 19. Head nurse's office | To organise and supervise the work of nurses in the unit. |
| | 20. Staff toilet | To empty the body of urine or solid waste. |
| Staff | 21. Head doctor's office | To organise and supervise the work of doctors in the unit. |
| | 22. Doctors' office | To provide workspaces for doctors. |
| | 23. Staff changing room | To get dressed and leave their personal clothing. |
| | 24. On call doctor's bedroom | To sleep during on call shifts. |
| Support | 25. Internal lobby | To provide access to clinical and non-clinical staff and supplies. |
| | 26. Regeneration kitchen | To store patients' food at the required temperature. |
| | 27. Dirty utility room | To store dirty materials. |
| | 28. Cleaners' room | To store cleaning material. |
| | 29. Dirty linen room | To store dirty clothing before its transport to the laundry. |
| | 30. Linen store | To store clean clothing. |
| | 31. Clean supply room | To store small clean items. |
| | 32. Large equipment store | To store larger clean equipment. |

*Tab. 8 Areas and rooms in the labour ward.*

## 4.8.3 Acute-care Hospital Visits

### “Hospital Sant Joan de Déu” (HSJD)

The labour ward had three emergency boxes, six LDR rooms and two operating theatres. Each LDR room had telemetric equipment (to promote women’s movement), Pilates balls, mirrors, labour chair, lianas, music, showers and one room had a bathtub (Fig. 435-Fig. 439).

*Fig. 435 Observation box next to nurses’ control for patients that might stay longer (better than going to the obstetric ward as there is more surveillance in the labour ward). HSJD.*

*Fig. 436 Nurses’ control with standard exploration boxes at the back. HSJD.*

*Fig. 437 LDR room with folding neonatal changing table with light, integrated in the wall. Bath for a water birth. HSJD.*

*Fig. 438 Standard LDR with neonatal changing table and less integrated headboard equipment. HSJD.*

*Fig. 439 Lianas, Pilates ball and labour chair. HSJD.*

## "Maternidad Gregorio Marañón" (MGM)

The labour ward at this acute-care hospital was located on the second floor, next to the women's operating theatres, neonatal intensive care, paediatric intensive care and children's operating theatres. The unit had a rectangular shape with a visitor corridor, eight LDR rooms, an internal corridor, and staff area (Fig. 440-Fig. 443).

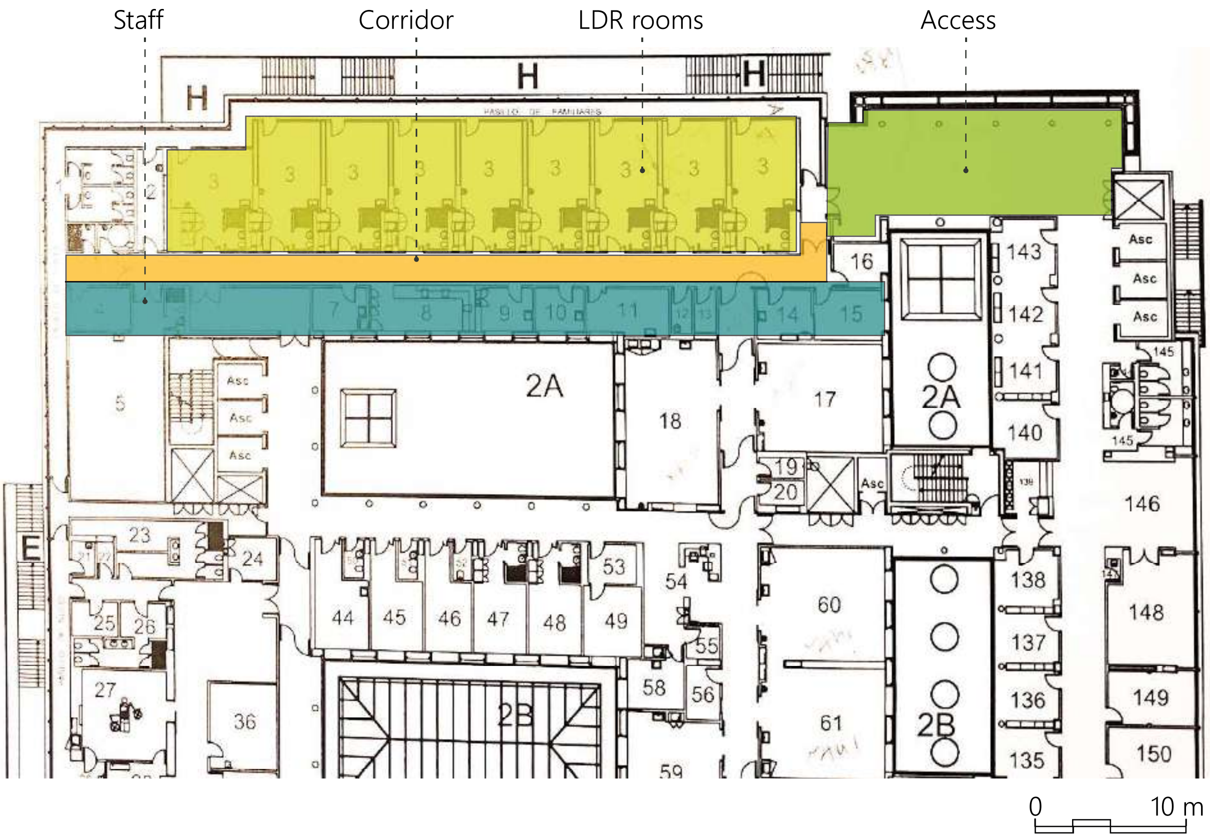



*Fig. 440 Labour ward on the second floor at MGM.*

*Fig. 441 Visitors' corridors that took the natural light and views away from the LDR rooms. MGM.*

*Fig. 442 LDR room at MGM.*

*Fig. 443 Back wall of the LDR room with personal handbasin and patient's toilet access. MGM.*

## "Hospital Universitario HM Nuevo Belén" (HMNB)

The labour ward in the acute-care hospital had an outdated design (with different rooms for the birth process) and three LDR rooms refurbished to promote natural labour (Fig. 444-Fig. 446).

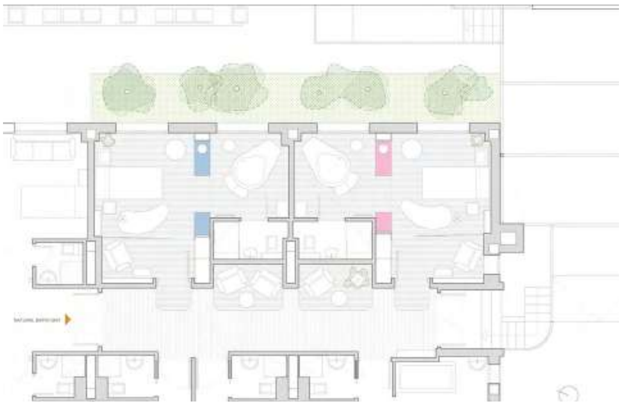


*Fig. 444 Layout of the LDR rooms at HMNB.*

*Fig. 445 Concealed obstetric bed. Window with dimming control. Obstetric ropes. Photo by David Frutos. HMNB.*

*Fig. 446 Basin for hand hygiene, mirrors, integrated bench and bathtub. Photo by David Frutos. HMNB.*

## "Hospital Universitario Central de Asturias" (HUCA)

The labour ward at HUCA was located on the ground floor next to the operating theatres, the neonatal ward and the neonatal intensive care unit (Fig. 447-Fig. 449). It had six LDR rooms whose design resembled operating theatres.

*Fig. 447 Outdated newborn bathtub in the LDR room at HUCA.*

*Fig. 448 LDR room without natural light at HUCA.*

*Fig. 449 Hand basin for staff and newborn incubator in LDR room at HUCA.*

## "Universitetssjukhuset i Linköping" (ULKÖ)

The labour ward in the acute-care hospital was located next to the neonatal ward and the obstetric ward (Fig. 450-Fig. 454). It had ten LDR rooms, some of them with a bathtub.

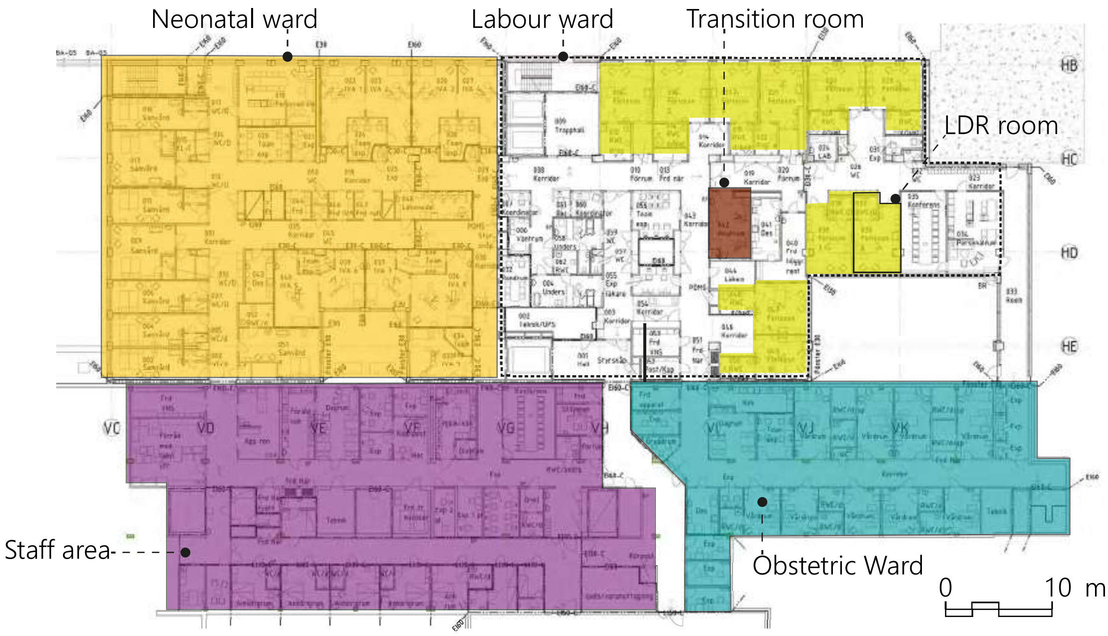



*Fig. 450 Labour ward layout. ULKÖ.*

*Fig. 451 LDR room with wall mounted headboard equipment. ULKÖ.*

*Fig. 452 Working area for midwife and wardrobe for patient and visitor. ULKÖ.*

*Fig. 453 Transition or stabilisation room for neonates that either go to the obstetric ward with their mothers or to the neonatal ward. ULKÖ.*

*Fig. 454 Bathroom for pregnant women with shower and contrasting colours. ULKÖ.*

## 4.8.4 Acute-care Hospital Cases

Fig. 455 shows the location of the evaluated ward within each of the four case studies.

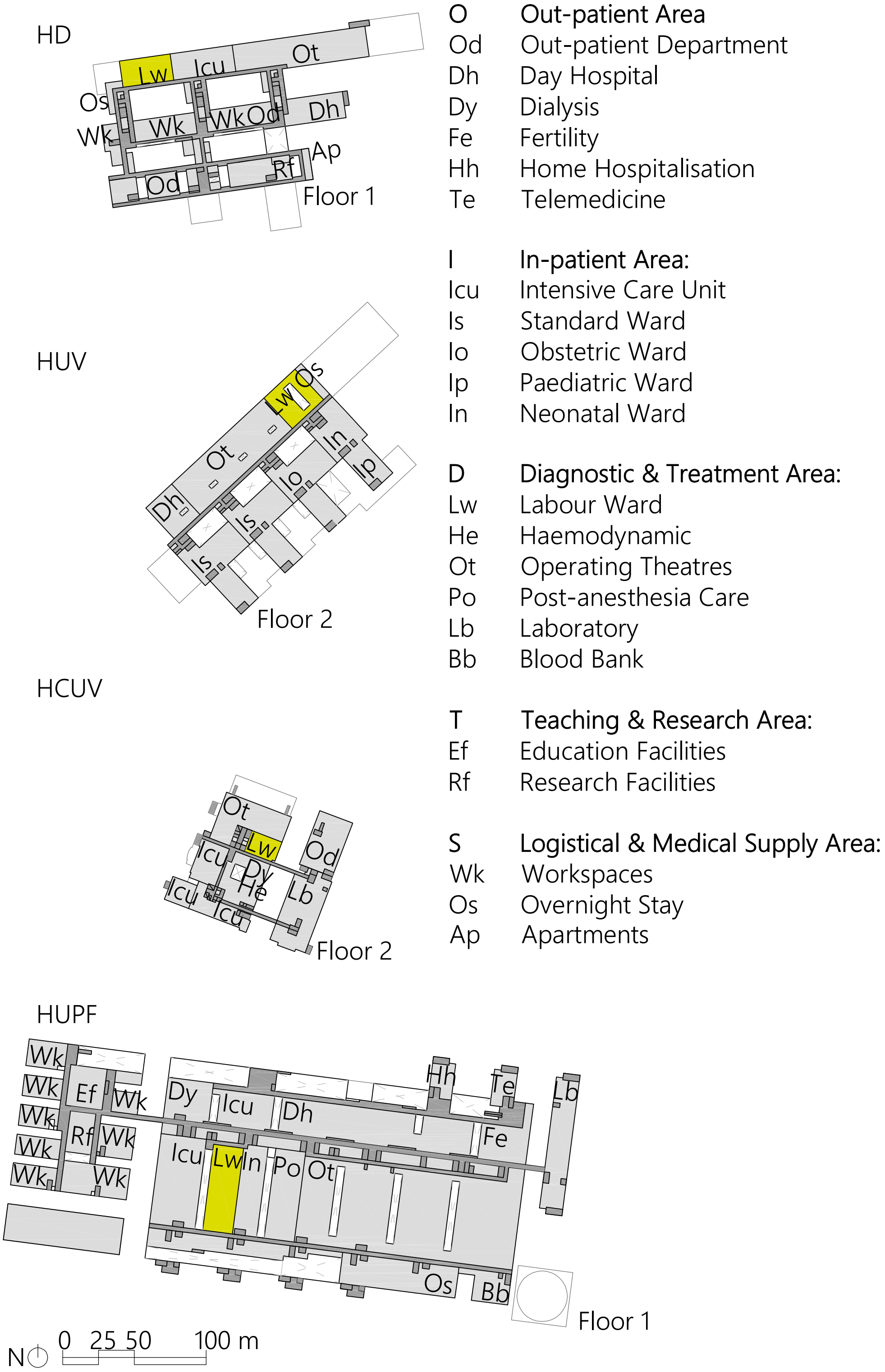



*Fig. 455 Location of the labour ward evaluated.*

## "Hospital de Dénia" (HD)

The labour ward at HD was located on the first floor next to the intensive care unit (see chapter 4.3.4) and the operating theatres (Fig. 456-Fig. 457). The unit had eight LDR rooms, one delivery room for instrumental births and one operating theatre for caesarean sections. All the LDR rooms had natural lighting and views. The unit had two accesses and a rectangular shape with a longitudinal corridor with the LDR rooms on one side and the surgery and support area on the other side.

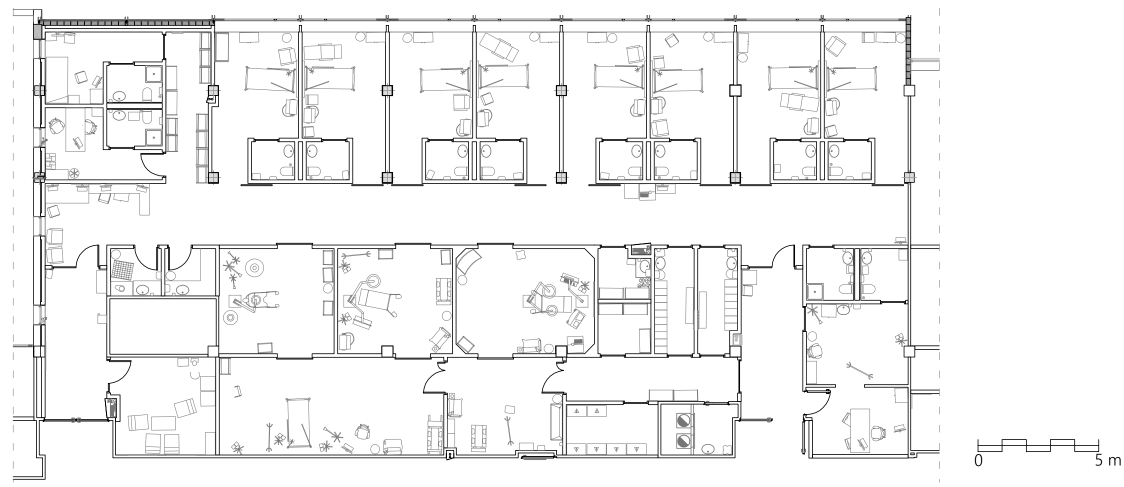



*Fig. 456 Labour ward with furniture and equipment in use. HD.*

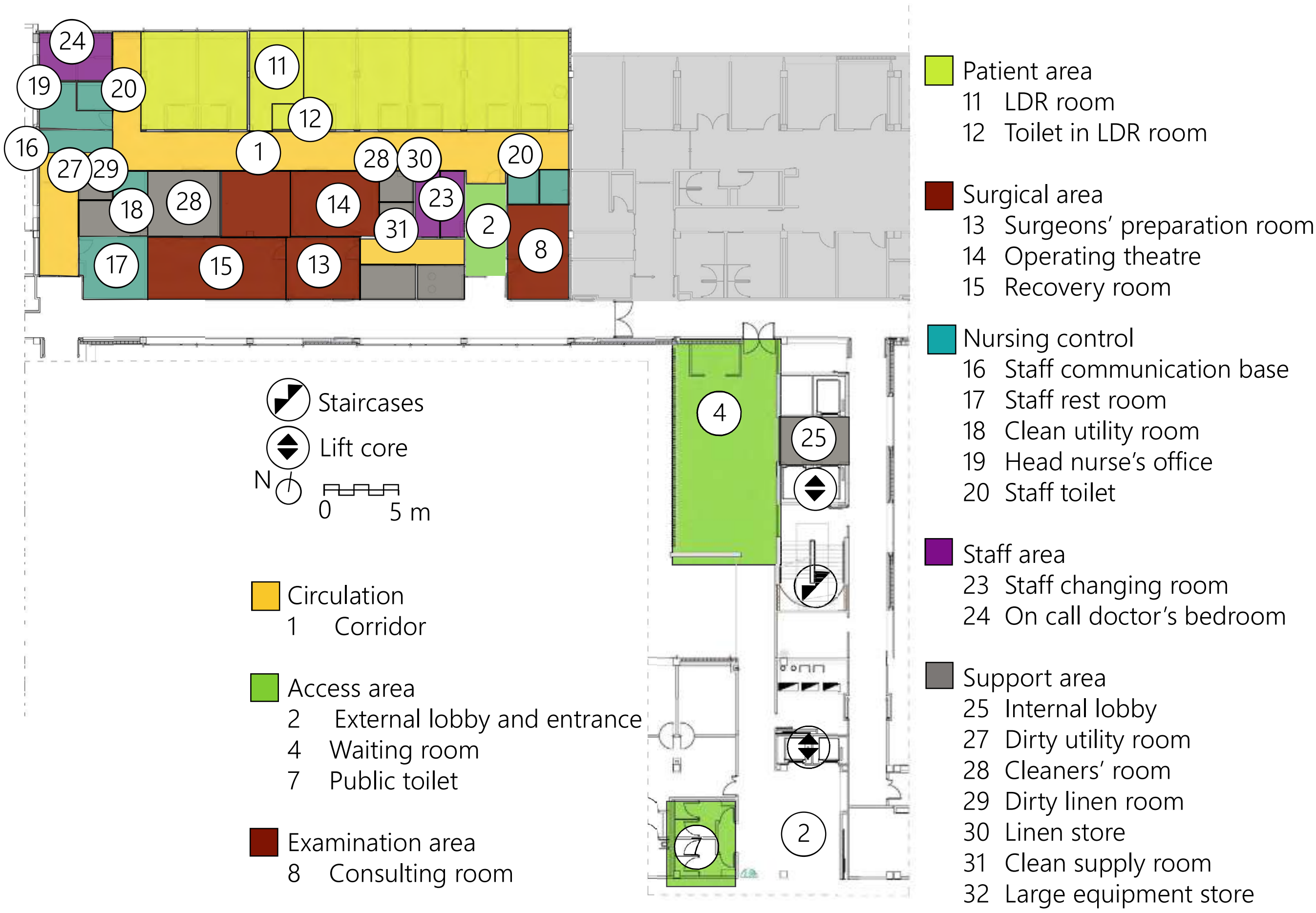



*Fig. 457 Evaluated room labour ward HD.*

## "Hospital Universitario del Vinalopó" (HUV)

The labour ward was located on the second floor next to the operating theatres, neonatal ward (see chapter 4.7.4), paediatric ward (see chapter 4.6.4) and obstetric ward (see chapter 4.5.4) (Fig. 458). It had one external access and was internally connected to the operating theatres. The unit had a square shape with a rectangular courtyard for providing natural lighting to all LDR rooms.


Circulation
1 Corridor

Access area
2 External lobby and entrance
4 Waiting room
6 Interview room
7 Public toilet

Examination area
8 Consulting room
10 Treatment room

Patient area
11 LDR room
12 Toilet in LDR room

Surgical area
15 Recovery room

Nursing control
16 Staff communication base
17 Staff rest room
19 Head nurse's office
20 Staff toilet

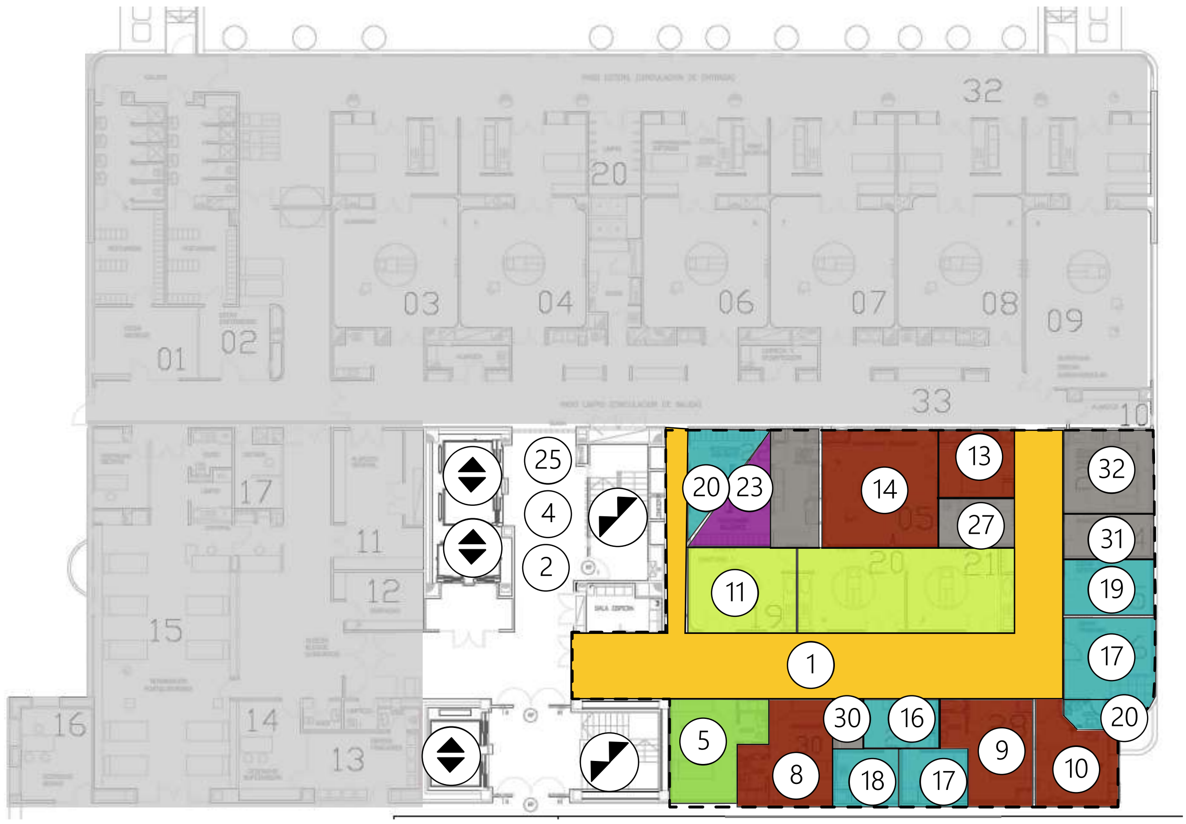
Staff area
21 Head doctor's office
22 Doctors' office
23 Staff changing room

Support area
25 Internal lobby
27 Dirty utility room
29 Dirty linen room
31 Clean supply room

*Fig. 458 Evaluated room labour ward HUV.*

## "Hospital Clínico Universitario del Valencia" (HCUV)

The labour ward in HCUV was located on the second floor next to the operating theatres (Fig. 459). It had two consultation rooms, three LDR rooms and one surgical room for caesarean sections. It had one external access point and was linked to the operating theatres.




Ward perimeter
Staircase
Lift core
N
0 5 m

**Circulation**
1 Corridor

**Access area**
2 External lobby and entrance
4 Waiting room
5 Assessment room

**Examination area**
8 Consulting room
9 Observation room
10 Treatment room

**Patient area**
11 LDR room

**Surgical area**
13 Surgeons' preparation room
14 Operating theatre

**Nursing control**
16 Staff communication base
17 Staff rest room
18 Clean utility room
19 Head nurse's office
20 Staff toilet

**Staff area**
23 Staff changing room

**Support area**
25 Internal lobby
27 Dirty utility room
30 Linen store
31 Clean supply room
32 Large equipment store

*Fig. 459 Evaluated room labour ward HCUV.*

## "Hospital Universitari i Politècnic La Fe" (HUPF)

The labour ward at HUPF was located on the first floor next to the neonatal ward (see chapter 4.7.4) (Fig. 460). It had eight LDR rooms and because of the healthcare services provided, it had its own surgical unit with its own staff and areas (nursing control, support rooms, post-anaesthetic care and operating rooms). The labour ward configuration was arranged in three squares: the first one for the access area, the second for natural birth and the third one for the surgical area.

Perimeter
Staircases
Lift cores
N 0 5 m

Circulation
1 Corridor

Access area
2 External lobby and entrance
4 Waiting room
5 Assessment room
7 Public toilet

Examination area
8 Consulting room
9 Observation room
10 Treatment room

Patient area
11 LDR room
12 Toilet in LDR room

Surgical area
13 Surgeons' preparation room
14 Operating theatre
15 Recovery room

Nursing control
16 Staff communication base
17 Staff rest room
19 Head nurse's office
20 Staff toilet

Staff area
21 Head doctor's office
22 Doctors' office
24 On call doctor's bedroom

Support area
25 Internal lobby
27 Dirty utility room
28 Cleaners' room
29 Dirty linen room
30 Linen store
31 Clean supply room

*Fig. 460 Evaluated room labour ward HUPF.*

## Evaluation Results

From the results obtained following the evaluation process described in chapter 4.1.2, the HD ward design scored the best results. The percentage of achievement with CURARQ-Pari tool is shown in Fig. 461 and all acute-care hospitals had a global grade of over 60%. While HUV and HD scored about 70%, the results were about 50% for HUCV and HUPF. All detailed results are available online [46].

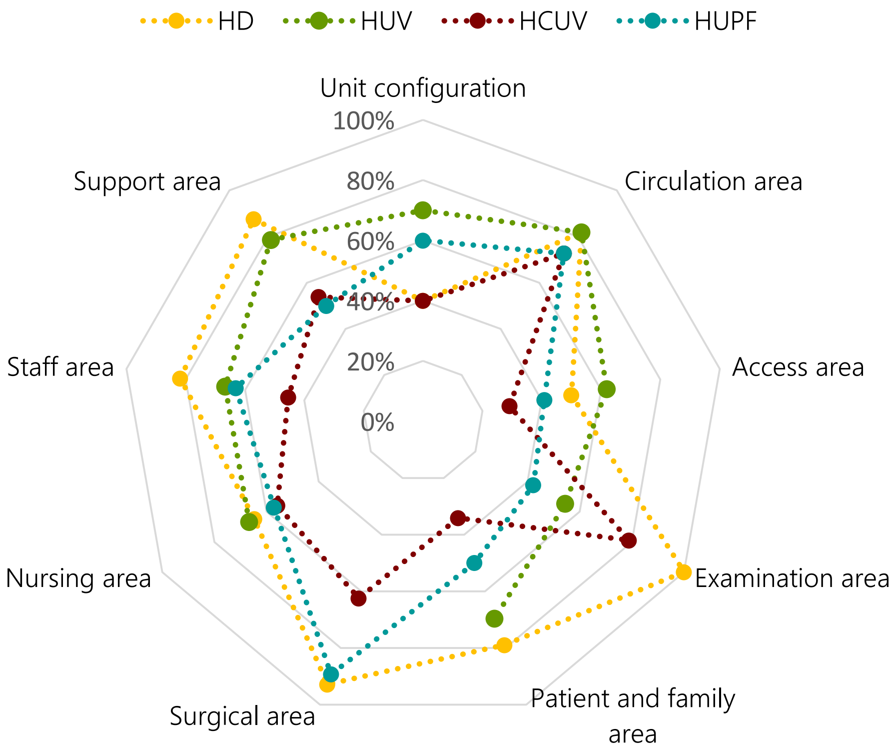



*Fig. 461 CURARQ-Pari results for the wards evaluated.*

The requirements associated with the unit configuration tackled the relationship of the labour ward with the external access to the accident and emergency department and the neonatal ward. Also, whether there was a segregated flow to separate the normal birth path from that of grief. The worst scores went to HD and HCUV because of their relationship to the other acute-care hospital units.

Regarding the circulation area, the four units received scores of over 70% (Fig. 462-Fig. 465).

In the access area, in addition to the standard rooms of an in-patient area, there should be and admission room and an assessment room (Fig. 466-Fig. 467). In the four acute-care hospitals, admission was carried out at the emergency department. None of the four had an interview room.

The examination area included a consulting room, observation room and treatment room (Fig. 468-Fig. 470). HD and HUV did not have an observation room and they used an LDR room instead. The low results of HUPF were due to the fact that they had reconverted the original waiting room within the labour ward into an improvised observation room and treatment room. Hence, their qualities did not meet the recommended standards.

With regards to the patient and family area, it was noted that HCUV received a result under 40% because as it was the oldest labour ward, they were using as an LDR what was designed as a delivery room only, and thus did not have the necessary amenities such as a toilet or even a chair for the partner (Fig. 471-Fig. 474). None of the other acute-care hospitals, which did have a toilet in the LDR room, had a shower or a bathtub.

The surgical area had more variations. While HUV did not have an operating room because it was directly linked to the operating theatres, HUPF had their own surgical subarea within the labour ward with their own support room and specialised staff (Fig. 475-Fig. 477).

Regarding the nursing control area, the scores of the four units were similar even though HD had to improvise this area at the end of the corridor as there was no room in the initial design (Fig. 478-Fig. 481). HUV used trolleys or the same LDR for medication preparation and not a separated room.

In the staff area, because of the healthcare services offered, HD and HUV did not have a head doctor's office or doctors' room. The only gynaecologist in the labour ward also worked at the out-patient department. HUV did not have an on-call doctor's bedroom because the overnight stay area was next to the labour ward.

With regards to the support area, several rooms did not appear, such as the regeneration kitchen, there was no large equipment store (at HD they used a delivery room for storage), and several functions were combined in the same room.

*Fig. 462 Unit corridor at HD.*

*Fig. 463 Unit corridor at HUV.*

*Fig. 464 Unit corridor at HCUV.*


*Fig. 465 Unit corridor at HUPF.*

*Fig. 466 Access to unit at HD.*

*Fig. 467 Access to unit at HUPF.*

*Fig. 468 Consulting room at HD.*

*Fig. 469 Consulting room at HCUV.*

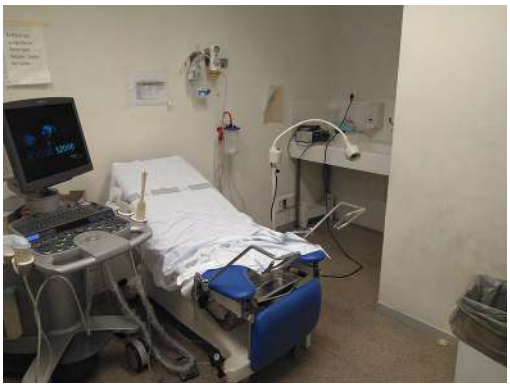


*Fig. 470 Consulting room at HUPF.*

*Fig. 471 LDR room at HD.*

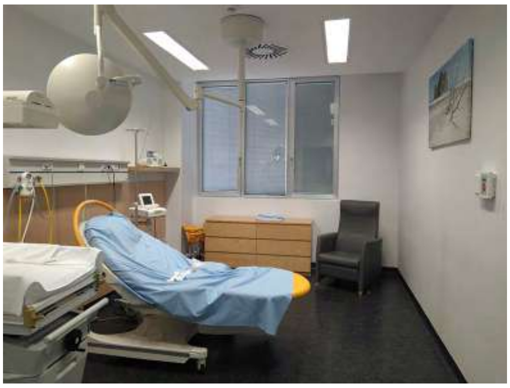


*Fig. 472 LDR room at HUV.*

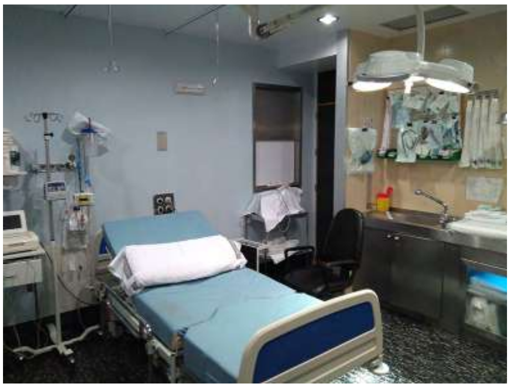


*Fig. 473 LDR room at HCUV.*

*Fig. 474 LDR room at HUPF.*

*Fig. 475 Operating theatre at HD.*

*Fig. 476 Operating theatre at HCUV.*

*Fig. 477 Operating theatre at HUPF.*

*Fig. 478 Staff communication base at HD.*

*Fig. 479 Staff communication base at HUV.*

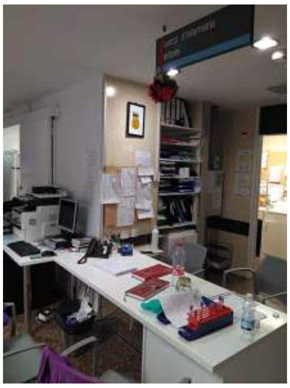


*Fig. 480 Staff communication base at HCUV.*

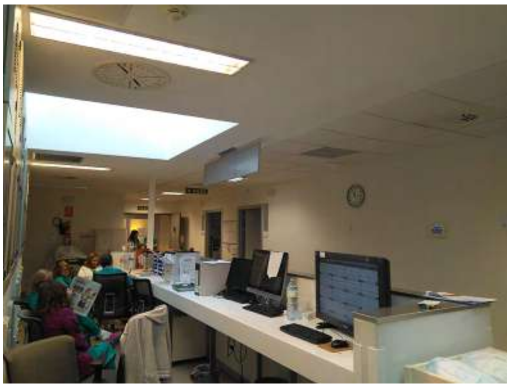


*Fig. 481 Staff communication base at HUPF.*

### 4.8.7 Discussion

Despite the fact that scientific research has shown the importance of the labour environment in the labour process [47, 48], several acute-care hospital visits and acute-care hospital cases presented outdated designs in Spain. For example, the labour ward in “Maternidad Gregorio Marañón” still had a visitors’ corridor that prevented the LDR room from having day-light or outdoor views. Another example was the lack of provision for the partner accommodation in HCUV, where the LDR room resembled an operating theatre and did not even have a chair. The only Spanish exception was the LDR rooms in “Hospital Universitario HM Nuevo Belén”, but still this small renovation work tackled the LDR room only and not the labour ward as a whole, and its relationship with other units relevant to the labour process such as the emergency department, the operating theatres or the obstetric ward. These national examples greatly contrast with the current Nordic research on adaptable birthing rooms [49].

# 4.9 References

## 4.9.1 Tables



## 4.9.2 Figures

## 4.9.3 Glossary

- Caesarean section: extraction of the foetus by means of abdominal hysterotomy. Hysterotomy: an incision in the uterus, performed through either the abdomen or the vagina (Medical Dictionary Online).
- Midwives: the practice of assisting women in childbirth (Medical Dictionary Online).
- Prenatal Care: care provided the pregnant woman in order to prevent complications and decrease the incidence of maternal and prenatal mortality (Online Medical Dictionary).
- Sensory deprivation: the absence or restriction of the usual external sensory stimuli to which the individual responds (Online Medical Dictionary).

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# 5. Conclusion

# 5.1 Summary

This thesis focuses on the evaluation of functional and environmental factors in Spanish acute-care hospital design. It uses a mixed-method methodology based on four perspectives: 1) the field, with ethnographic study during a three-month acute-care hospital placement; 2) the theory, with a literature analysis; 3) the future, with ethnographic study of sixteen acute-care hospital visits, and 4) the present with the evaluation of four acute-care hospitals in Spain. The aim of this work is to generate new information from each one of the four perspectives as well as to create the evaluation tool CURARQ. The purpose of this tool is on one hand to provide a first diagnostic of the functional and environmental quality of the studied unit, and on the other hand to guide in the design decision process of a new development.

Because this thesis uses an explorative approach, it becomes difficult to draw general conclusions, beyond a general view of the topic from many observations. However, this document provides a current overview of functional and environmental factors in acute-care hospitals, which evidence:

- The need for refurbishment to promote clinical innovation. Acute-care hospitals in Spain should incorporate field experience, best practice design, and latest research to become more efficient buildings and facilitate innovation in the healthcare activity.
- The need to update national standards. Spanish standards were published by the Spanish Government around the year 2010, some of its content is already outdated and they do not cover all the possible acute-care units. CURARQ tool could be used to facilitate the review process for the upgrading of national documents.
- The usefulness of CURARQ tool to identify priority buildings to intervene. CURARQ tool generates new data from existing acute-care hospitals that can be added to other clinical variables. This additional information may help healthcare policies to identify which are the most needed buildings for a design intervention. Within the four acute-care hospital cases of this thesis, the most adverse conditions went to "Hospital Clínico Universitario del Valencia", which was the oldest building (from 1960) located in an urban environment (with expansion constraints), with an attended population more than double that of two others and the lowest ratio of square meters per bed. These facts would hinder staff performance and effectivity as they might need to make greater efforts to deliver the best care possible in an inconvenient building.
- The usefulness of CURARQ tool to promote the evidence-based design process. CURARQ tool could be an enabler for generating synergies between healthcare staff, patients, researchers, and architects in Spain. This transdisciplinary collaboration is very much needed in both the professional sector but also in the academic world, in order to promote the evidence-based design process in Spain.

# 5.2 Limitations

The limitations found in this study can be summarised as follows:

- Literature analysis:
  - It would have been more effective to start with a literature review instead of a literature analysis for each unit considered at the very beginning. This would have also helped me with the discussion section. However academic papers usually consider manageable variables in specific places and not such a global and holistic approach of several acute-care units, which is more associated with design guidelines or standards. Nevertheless, the acute-care hospital placement was the first stage of the study and a fantastic opportunity for me to learn at a greater pace than from literature. This first stage also determined the character of this thesis, which is based on the field nature of the whole work.
- Acute-care hospital placement:
  - The immaturity of qualitative methods hindered a rigorous process for data collection and analysis.
  - The lack of training in professional social skills like ethnographic research technics resulted in a longer period invested in preparation while in the acute-care hospital. However, the great amount of time available gave me flexibility in order to adapt my schedule to staff timetables and daily incidents. This predisposition was fundamental to build trust among acute-care hospital users.
  - The records were taken by only one researcher. While two or more independent observers would help to reduce personal bias, the thesis is produced by only one person.
  - Personal interaction during interviews might introduce some biases in the participant's responses.
  - Interviews should have been recorded and transcribed. Instead of this, only notes were taken, so that some information was lost in the process.
- Acute-care hospital visits:
  - More acute-care hospitals could have been included, but there were time and financial limitations.
  - A knowledge of Swedish would have been very useful during the stay at Chalmers University as many activities and documents were delivered only in Swedish.
  - Previous collaboration with the "Centrum för vårdens arkitektur" would have accelerated the interaction and collaboration with more researchers.
- CURARQ tool:
  - There should have been a more rigorous process for the eligibility of the content.
  - While each tool item scores 1 point, there should have been a validation process

for the weighting system. Several alternatives were studied and dismissed in the process.

· The tool framework is organised in rooms, however several room classifications from Spanish standards are already outdated and do not coincide with latest research.

# 5.3 Contribution

The main contribution of this work is to provide an overview of Spanish healthcare architecture. This new documentation tailored to the Spanish context, together with the tested tool CURARQ, could guide design decisions for future healthcare developments.

Although, this thesis does not follow a paper-based study, several publications arose from this work.

- Journal paper (peer-reviewed):

  · Cambra-Rufino L, Brambilla A, Paniagua-Caparrós JL, Capolongo S. "Hospital Architecture in Spain and Italy: Gaps Between Education and Practice." HERD: Health Environments Research & Design Journal 0(0): 1937586721991520. February 2021. Related to chapter 1.5.

  · Cambra-Rufino L, Paniagua-Caparrós JL, Bedoya-Frutos C. "Evaluación de la arquitectura hospitalaria: unidad de neonatología" Informes de la Construcción 72(560): e361. December 2020. Related to chapter 2.2.6 & 4.7.4.

  · Cambra-Rufino L, Paniagua-Caparrós JL, Bedoya-Frutos C. "La acreditación y certificación del diseño basado en evidencias para la arquitectura sanitaria llega a España". Rev Esp Salud Pública. 2019;93: 4 de octubre e201910091. October 2019. Related to chapter 1.4.

- International conferences:

  · Cambra-Rufino, Laura; Paniagua-Caparrós, José León; Bedoya-Frutos, César. "A Comparative Evaluation of Internal Medicine Wards in Spain" ARCH19: BUILDING FOR BETTER HEALTH Research & innovation in architecture & urban design for care & health. Institute of Architecture & Planning, NTNU Faculty of Architecture & Design. 12-14/06/2019 Trondheim, Norway. Related to chapter 4.4.

  · Cambra-Rufino, Laura. "Designing a Post-Occupancy-Evaluation (POE) Tool for Hospitals". RETROACTIVE RESEARCH: Architecture's capacity to challenge and extend the limits of other disciplines. European Research in Architecture and Urbanism (EURAU). 19-22/09/2018 Alicante. Related to chapter 3 & 4.1.

  · Cambra-Rufino, Laura y Paniagua-Caparrós, José León. "Analyzing Users Experience of an Intensive Care Unit (ICU)". ANFA 2018 Conference. Academy of Neuroscience for Architecture (ANFA). Selected poster (online) 20-22/09/2018 California, USA. Related to chapter 4.3.

  · Cambra-Rufino, Laura. "Arquitectura por prescripción médica". III Congreso Internacional de Espacios de Arte y Salud. Marina Salud Departamento Salud Dénia, Generalitat Valenciana, DKV Salud y Seguros Médicos. ISBN: 978-84-09-02289-2, volumen: 1, páginas: 58-64. 09-11/11/2016 Dénia, Alicante. Related to chapter 3.

From a professional point of view, in July 2019 I completed the evidence-based design accreditation and certification (EDAC) program and became the first EDAC certified person in Spain. Moreover, in addition to the academic and professional field, I have worked on several activities to increase the outreach of this work towards a more popular public:

· The creation of www.curarq.net website where all CURARQ tool files are downloadable and the blog "Arquitectura por prescripción médica".
· The creation of acute-care hospital design feedback for the four acute-care hospital cases. The detailed conclusions for each unit evaluated are available in a downloadable document online. Each file shows which requirements are not met and why.
· Dissemination news and radio interviews such as the participation at El Bisturí nº 213. programme for "Agencia EFE" in February 2020.

All these activities have focused on generating open material accessible online to bring the healthcare sector closer to architects and to strengthen transdisciplinary collaboration. The aim of this effort is to advocate the value of architecture for caring as a challenging and fascinating architectural typology. Only by mutual understanding and collaboration between researchers, users, healthcare and architecture practitioners, will the evidence-based design process be applied in Spain to explore its maximum potential.

# 5.4 Future Research

From the present thesis, several issues have emerged as suggestions for future research relating to three main topics: acute-care hospital, pandemics, and urban design.

- Acute-care hospital:
  · To reproduce the CURARQ tool for all acute-care hospital units (such as emergency unit, out-patient department, psychiatric ward, or operating theatres). *Could all the acute-care hospital be evaluated?*
  · To explore alternatives to the CURARQ tool and produce other tools to evaluate existing or new acute-care hospital designs. *How different could we evaluate acute-care hospital units?*
  · To explore evaluation strategies for the continuous improvement of the acute-care hospital design. *How to incorporate acute-care hospital evaluation as a learning opportunity for acute-care hospital performance?*
  · To explore design factors that could be health promotive within the acute-care hospital building. *How could the acute-care hospital promote health?*
  · To extrapolate the functional and environmental factors that are key for patients in acute-care hospitals to the residential sector. *How could dwelling design foster home care and tele health care?*
- Pandemics:
  · To evaluate the design strategies to increase acute-care hospital capacity during COVID-19 pandemic in Spain. *Which were the most-effective design measures to increase acute-care hospital capacity during the pandemic in Spain?*
  · To explore design features for acute-care hospital preparedness for future outbreaks. *How could acute-care hospital design prepare for future outbreaks?*
  · To specifically study the impact of dealing with infectious disease into acute-care hospital design. *How will pandemics impact on acute-care hospital design?*
- Urban design:
  · To explore the relationship between urban planning and healthcare resources and needs. *How to overlap the urban map with the healthcare map in Spain?*
  · To explore the relationship between the acute-care hospital and mobility. *How do acute-care hospitals influence mobility?*
  · To explore the relationship between urban design and public health. *How could healthy urban design improve public health?*

# A. Appendixes

# A.1 CV

## A.1.1 Datos personales



| | | | |
|---|---|---|---|
| Nombre y apellidos | Laura Cambra Rufino | | |
| DNI/NIE/pasaporte | 48601074G | Fecha nacimiento | 04/06/87 |
| | Open Researcher and Contributor ID (ORCID**) | 0000-0002-3450-152X | |
| | Researcher ID (*) | E-7133-2017 | |



## A.1.2 Situación professional actual

| | | | |
|---|---|---|---|
| Organismo | Universidad Politécnica de Madrid | | |
| Dpto./Centro | Construcción y Tecnología Arquitectónicas (D020) / E.T.S. de Arquitectura | | |
| Dirección | Av. Juan de Herrera 4, 28040 Madrid | | |
| Teléfono | 699863406 | correo electrónico | Laura.cambra.rufino@upm.es |
| Categoría profesional | Personal investigador predoctoral en formación | Fecha inicio | 16/09/2016 |
| Palabras clave | investigadora predoctoral | | |
| Palabras clave inglés | predoctoral researcher | | |

## A.1.3 Formación académica

| Licenciatura/Grado/Doctorado | Universidad | Año |
|---|---|---|
| Doctorado en Construcción y Tecnología Arquitectónicas | Universidad Politécnica de Madrid | 2021 |
| Arquitecta | Universitat Politècnica de València | 2012 |

## A.1.4 Publicaciones indexadas

- Cambra-Rufino L, Brambilla A, Paniagua-Caparrós JL, Capolongo S. “Hospital Architecture in Spain and Italy: Gaps Between Education and Practice.” HERD: Health Environments Research & Design Journal 0(0): 1937586721991520.
- Cambra-Rufino L, Paniagua-Caparrós JL, Bedoya-Frutos C. “Evaluación de la arquitectura hospitalaria: unidad de neonatología” Informes de la Construcción 72(560): e361.
- Cambra-Rufino L, Paniagua-Caparrós JL, Bedoya-Frutos C. “La acreditación y certificación del diseño basado en evidencias para la arquitectura sanitaria llega a España”. Rev Esp Salud Pública. 2019;93: 4 de octubre e201910091.

## A.1.5 Congresos

Comunicación seleccionada con revisión por pares:

- Cambra-Rufino, Laura; Paniagua-Caparrós, José León; Bedoya-Frutos, César. "A Comparative Evaluation of Internal Medicine Wards in Spain" ARCH19: BUILDING FOR BETTER HEALTH Research & innovation in architecture & urban design for care & health. Institute of Architecture & Planning, NTNU Faculty of Architecture & Design. 12-14/06/2019 Trondheim, Norway
- Cambra-Rufino, Laura. "Designing a Post-Occupancy-Evaluation (POE) Tool for Hospitals". RETROACTIVE RESEARCH: Architecture's capacity to challenge and extend the limits of other disciplines. European Research in Architecture and Urbanism (EURAU). 19-22/09/2018 Alicante.
- Cambra-Rufino, Laura. "Arquitectura por prescripción médica". III Congreso Internacional de Espacios de Arte y Salud. Marina Salud Departamento Salud Dénia, Generalitat Valenciana, DKV Salud y Seguros Médicos. ISBN: 978-84-09-02289-2, volumen: 1, páginas: 58-64. 09-11/11/2016 Dénia, Alicante

Póster:

- Cambra-Rufino, Laura y Paniagua-Caparrós, José León. "Analyzing Users Experience of an Intensive Care Unit (ICU)". ANFA 2018 Conference. Academy of Neuroscience for Architecture (ANFA). Póster seleccionado (presentación virtual) 20-22/09/2018 California, Estados Unidos

## A.1.6 Estancias de investigación

- Centro: Centrum för vårdens arkitektur (Centro de arquitectura sanitaria). Chalmers Tekniska Högskola, Gotemburgo (Suecia). Del 01/03/2018 hasta el 01/06/2018. Residencia de investigación predoctoral.
- Centro: Hospital Marina Salud de Dénia. Marina Salud Departamento Salud Dénia, Alicante. Del 01/04/2016 hasta el 30/06/2016. Residencia de investigación predoctoral.

## A.1.7 Becas

- Beca de investigación para españoles en Suecia y para suecos en España. Fundación Margit y Folke Perhzon. Beca predoctoral para financiar la estancia en el Centrum för vårdens arkitektur de la Chalmers Tekniska Högskola, Gotemburgo (Suecia).
- Beca DKV Arte y Salud destinada a poner en valor proyectos artísticos que contribuyan a la recuperación y bienestar de personas de cualquier edad, afectadas por dolencias de diversa índole y que se encuentren hospitalizadas o en su entorno doméstico. DKV Seguros Médicos, Cátedra DKV Arte y Salud (Universitat Politècnica de València), Factoría Cultural (Vivero de Industrias Creativas Matadero Madrid). Duración de 10 meses en:

Factoría Cultural Vivero de Industrias Creativas Matadero Madrid (7 meses) y Hospital Marina Salud de Dénia (3 meses).

- Programa de subvenciones para la movilidad de estudiantes universitarios "Séneca". Ministerio de Educación. Del 01/10/2009 hasta el 30/06/2010.

## A.1.8 Proyectos de investigación

- PROYECTO BIA2016-78893-C3-1-R Metodología para la valoración de requisitos de confort, condiciones ambientales y funcionalidad espacial de los hospitales y su entorno. Propuestas de adecuación a los nuevos conceptos asistenciales. Ministerio de Economía, Industria y Competitividad MINECO. Programa Estatal de I+D+i Orientada a los Retos de la Sociedad. Del 30/12/2016 al 29/12/2019. IP Chías Navarro, Pilar (Universidad de Alcalá de Henares). Responsabilidad como investigadora colaboradora.

## A.1.9 Contratos de investigación

- Personal Investigador Predoctoral en Formación. Ministerio de Educación, Cultura y Deporte. Programa Estatal de Promoción del Talento y su Empleabilidad, en el marco del Plan Estatal de Investigación Científica y Técnica y de Innovación 2013-2016 (FPU15/02660).

## A.1.10 Colaboración docente

- 4º curso del Grado en fundamentos de la arquitectura/ Instalaciones y Servicios Técnicos. Departamento de Construcción y Tecnología Arquitectónicas/ Escuela Técnica Superior de Arquitectura de Madrid. 30 h Desde 15/febrero/2021 hasta 20/abril/2021
- 3er curso del Grado en fundamentos de la arquitectura/ Acondicionamiento ambiental y habitabilidad. Departamento de Construcción y Tecnología Arquitectónicas/ Escuela Técnica Superior de Arquitectura de Madrid. 50 h Desde 09/septiembre/2019 hasta 26/noviembre/2019
- 2º curso del Grado en fundamentos de la arquitectura/ Construcción 1, Departamento de Construcción y Tecnología Arquitectónicas/ Escuela Técnica Superior de Arquitectura de Madrid 60 h Desde 31/enero/2019 hasta 17/mayo/2019
- 5º curso del Grado en fundamentos de la arquitectura/ Arquitectura Legal, Departamento de Construcción y Tecnología Arquitectónicas/ Escuela Técnica Superior de Arquitectura de Madrid, 40 h Desde 19/septiembre/2017 hasta 13/diciembre/2017

## A.1.11 Formación académica no reglada

- Investigación cualitativa sobre Atlas.ti: Un enfoque práctico, Instituto de Ciencias de la Educación, UPM, 8 h, 12,14,19,21/01/2021.
- El reto de cuidar en habitaciones familiares de cuidados intensivos, INVServicio de Neonatología del Hospital 12 de Octubre (online), 12 h, noviembre 2020.

- Formación en el Programa de Certificación Agenda 2030-ODS (Programa ALCAEUS de ACPUA), Agencia de Calidad y Prospectiva Universitaria de Aragón (vía Zoom), 1,5 h, 02/07/2020.
- Investigadores y medios de comunicación, Universidad Politécnica de Madrid (UPM), 4,5 h 23/05/2019.
- Plagio y antiplagio. El uso de la herramienta Turnitin, Instituto de Ciencias de la Educación, UPM, 3 h 20/02/2019.
- Workshop tutorial on oral presentations, Instituto de Ciencias de la Educación, UPM, 4 h, 07/02/2019.
- ¿Cómo hacer mi investigación más responsable? Explorando la RRI, Universidad Politécnica de Madrid, 5 h, 11/10/2018.
- Impulsa tu idea de negocio en clave de mujer, Red de Economía Alternativa y Solidaria (REAS Madrid), 3 h, 22/06/2018.
- Estrategias para la difusión y evaluación positiva de la investigación científica, Instituto de Ciencias de la Educación, UPM, 8 h, 7-8/02/2018.
- Workshop on research-article writing, Instituto de Ciencias de la Educación, UPM, 12 h, 17-19/01/2018.
- ¿Cómo enseñan los mejores profesores universitarios?, Instituto de Ciencias de la Educación, UPM, 9 h, 11, 15 y 18/01/2018.
- Formación Inicial para la Docencia Universitaria, Instituto de Ciencias de la Educación, UPM, 15 ECTS, 08/11/2016 hasta el 06/06/2017.
- Patentes y derechos de autor: Lo que todo investigador debe saber, Oficina de Transferencia de Resultados de Investigación, UPM, 5 h, 30/03/2017.
- El papel de la ANECA en el desarrollo y evaluación de la carrera docente: Programa de evaluación del profesorado (PEP), Instituto de Ciencias de la Educación, UPM, 8 h, 11-12/01/2017.
- Comunicación en Público 2, Universidad Politécnica de Madrid, 20 h, 19/10/2015 hasta el 11/01/2016.

## A.4.12 Otros méritos relevantes

- Baja de maternidad en el año 2020, 2019 y 2017.
- Asesora de la fundación "Cultura en Vena" cuya misión es inyectar cultura en espacios poco convencionales como los hospitales.
- Primera persona en España que consigue la certificación EDAC por "The Center for Health Design" en julio de 2019. El acrónimo EDAC corresponde a las siglas inglesas "Evidence-based Design Accreditation and Certification" e identifica a las personas capaces de aplicar el proceso de diseño basado en evidencias en la arquitectura sanitaria.
- Participación en la mesa redonda online de "La UPM en el día internacional de la mujer y la niña en la ciencia 2021", 2 h, 11/02/2021, UPM, Madrid.

- Vocal estudiante en la comisión de ingeniería y arquitectura 2 de grado y máster para la evaluación del programa VERIFICA y MONITOR de la Agencia Nacional de Evaluación de la Calidad y Acreditación (ANECA) desde el 01/04/2018 hasta la actualidad.
- Primer puesto en el simposio “Cuéntanos tu tesis” Formación transversal de Doctorado el día 10/10/2019 organizado por la Escuela Internacional de Doctorado UPM. Escuela Internacional de Doctorado UPM.
- “Mención Honorífica en reconocimiento del esfuerzo, implicación y aprovechamiento” en el curso de “Formación inicial para la docencia universitaria”. Instituto Ciencias de la Educación. Universidad Politécnica de Madrid. Octubre 2017.
- Certificate of Proficiency in English 24/03/2017.
- Engineer (2014-2015) y Graduate Engineer (2012-2014) Ove Arup & Partners Ltd, London, UK.
- Proyecto Final de Carrera seleccionado por la Comisión de Proyectos y publicado en el libro y la exposición de mejores PFC de la ETSAV 2011/2012. ISBN: 978-84-943704-3-4.
- Proyecto Final de Carrera finalista en el concurso internacional IS ARCH 2013.

# A.2 Documentation

## A.2.1 Hospital Placement

GENERALITAT VALENCIANA
CONSELLERIA DE SANITAT UNIVERSAL I SALUT PÚBLICA

marinaSalud
Departamento Salud Denia

Certificado otorgado a
Laura Cambra Rufino
Con DNI número 048601074G
ha realizado una residencia de investigación
en el Hospital Marina Salud de Dénia
en los meses de abril, mayo y junio de 2016.
Su estancia en el hospital se enmarca en la concesión
de la Beca DKV Arte y Salud, concedida por Factoría Cultural y
DKV Seguros, y le ha permitido desarrollar la parte experimental
de una investigación en torno a los criterios de diseño ambiental para
mejorar la calidad de las obras en hospitales existentes o de nueva planta.

Dénia, 20 de octubre de 2016

Teresa Cháfer
Directora Cátedra DKV Arte y Salud

Alicia Ventura Bordes
Directora Proyecto Arte Hospital de Dénia

Ángel Giménez Sierra
Gerente Departamento de Salud Dénia

## A.2.2 Hospital Evaluation

HOSPITAL UNIVERSITARIO
DEL VINALOPÓ
Departamento de salud del Vinalopó

Dña. Maria del Carmen Vivancos Albentosa

CERTIFICA

Que Laura Cambra Rufino con DNI 48601074G, ha visitado el Hospital Universitario del Vinalopó los días 12, 13 y 14 de febrero de 2018.

Durante este tiempo ha tomado datos sobre determinadas unidades del hospital para su investigación doctoral en arquitectura hospitalaria. Estas unidades incluyen:

- Paritorios
- Neonatos
- UCI
- Hospitalización adultos
- Hospitalización obstétrica
- Hospitalización pediatría
- Espacios de comunicación y circulación.

En Elche, a 21 de Febrero de 2018

HOSPITAL UNIVERSITARIO
DEL VINALOPÓ
Departamento de salud del Vinalopó
Servicios Generales
CIF: A97858633

Maria del Carmen Vivancos Albentosa

Subdirectora de Infraestructuras Hospital del Vinalopó

DEPARTAMENT DE SALUT DE VALÈNCIA
CLÍNIC-LA MALVA-ROSA

GENERALITAT VALENCIANA
Conselleria de Sanitat Universal i Salut Pública

La Dirección Médica del Hospital Clínico Universitario de València

**CERTIFICA**

Que Doña Laura Cambra Rufino, con DNI 48601074G, Arquitecta, ha visitado este hospital los días 27, 28 y 29 de diciembre de 2017 y los días 2 y 3 de enero de 2018.

Durante este tiempo ha visitado y recopilado datos de las siguientes estancias para su investigación doctoral en arquitectura hospitalaria:

- Salas de hospitalización de Obstetricia, Unidad Médica de Corta Estancia (polivalente) y en pediatría la sala de Escolares.
- UCI Pediátrica y Neonatal, Lactantes e Intermedios.
- Paritorio.
- Unidades de pacientes críticos: UCI y Reanimación.
- Accesos y circulaciones del entorno.

Y para que así conste a petición de la interesada expido el presente certificado

València, 07 de febrero de 2018

LA SUBDIRECTORA MÉDICO

Amparo Rufino Valor

GENERALITAT VALENCIANA CONSELLERIA DE SANITAT DEPARTAMENT DE SALUT CLÍNIC - LA MALVA-ROSA DIRECCIÓN MÉDICA

**Hospital Clínic Universitari de València.** Avda. Vicente Blasco Ibáñez, 17. 46010. València. Tel: 96 197 35 00. Fax: 96 197 36 09

GENERALITAT VALENCIANA
CONSELLERIA DE SANITAT UNIVERSAL I SALUT PÚBLICA

La Fe
Hospital Universitari i Politècnic
Innovación y experiencia al servicio del paciente

Vicente Garrigues Gil, Director del Área de Docencia del Hospital Universitari I Politècnic La Fe de València,

## CERTIFICA

Que Laura Cambra Rufino con DNI 48601074G, ha visitado el Hospital Universitari i Politècnic La Fe de València los días 29, 30 y 31de enero y los días 1 y 2 de febrero de 2018.

Durante este tiempo ha tomado datos sobre determinadas unidades del hospital para su investigación doctoral en arquitectura hospitalaria. Estas unidades incluyen:

- Paritorios
- UCI neonatal
- UCI adultos
- Hospitalización adultos
- Hospitalización obstétrica
- Hospitalización pediatría
- Espacios de comunicación y circulación.
- Casa Ronald McDonald Valencia

En València, a 10 de febrero de 2010

EL DIRECTOR DEL ÁREA DE DOCENCIA

GENERALITAT VALENCIANA · La Fe Hospital Universitari I Politècnic · ÀREA DE DOCÈNCIA · CONSELLERIA DE SANITAT

Fdo.: Vicente Garrigues Gil

# A.3 Interviews

## A.3.1 Staff Interview

| INFORMACIÓN PERSONAL | | | |
|---|---|---|---|
| Apellidos y nombre: | xx | Profesión: | Enfermera |
| Sexo: | ♀ | Cargo actual: | Enfermera |
| Edad: | 41 | Experiencia en hospitales: | 16 años |
| Mail contacto: | xx | Experiencia en este hospital: | 8 años |
| Unidad: | UCI | Turnos: | 8-15 / 15-22 / 22-8 |

| | Acción | Lugar | Condiciones ambientales | Experiencia |
|---|---|---|---|---|
| 1 | Desplazarse de casa al hospital | Coche | Espacio | Faltan plazas de aparcamiento gratuitas. |
| 2 | Llegar a la parcela del hospital | Aparcamiento de coches subterráneo | Señalética, arte | Algunos visitantes entran en la rampa del aparcamiento y cuando se dan cuenta que es de pago, paran y quieren dar marcha atrás. Se producen atascos en la rampa. Habría que mejorar la señalización del aparcamiento en la rotonda para que se sepa antes que es de pago y los visitantes no lleguen a la rampa por equivocación.<br><br>Le gustan las esculturas de la parcela, especialmente la fuente de agua en el aparcamiento subterráneo, por su belleza y el sonido del agua, que le relaja. |
| 3 | Entrar al edificio | Escaleras núcleo B | Ergonomía | Las puertas de acceso a las escaleras de emergencias van muy duras y tiene que empujar muy fuerte. |
| 4. | Desplazarse | Vestíbulo núcleo 2B | Iluminación natural | Le encantan los ventanales de suelo a techo del pasillo. |
| 5 | Cambiarse de ropa | Vestuario y aseos mujeres UCI | Espacio, almacenamiento, olor, higiene | En los cambios de turnos pueden llegar a cambiarse más de 10 personas a la vez entre enfermeras, estudiantes de enfermería y auxiliares de enfermería. No existe espacio suficiente para el libre movimiento de tantas usuarias. Tampoco hay suficientes taquillas por lo que la ropa y los zapatos se quedan en el suelo o amontonados. No hay ventilación ni natural ni mecánica. El inodoro y la acumulación de zapatos producen un olor muy desagradable. No tiene ducha en los aseos, cuando necesita limpiarse se desplaza a los vestuarios del bloque quirúrgico. |
| 6 | Dejar el bolso | Estar de enfermería | Seguridad | Prefiere tener sus objetos a mano y donde pueda verlos. En el pasado han desaparecido cosas del vestuario. |
| 7 | Relevo con el turno anterior | Control de enfermería | - | - |

| | | | | |
|---|---|---|---|---|
| 8 | Revisar a los pacientes en boxes | Boxes | Acabados | Le gustaría tener más elementos transparentes para mejorar el control visual entre boxes. |
| 9 | Tomarse un café | Sala de estar enfermería | Almacenamiento vistas | No hay espacio suficiente para dejar todos los bolsos. Tampoco para la comida que se trae el personal, los espacios para tal fin se están utilizando para zumos y bebidas de pacientes. Las vistas al exterior son muy agradables. |
| 10 | Programa seguimiento de los pacientes | Ordenadores control de enfermería | Espacio, almacenamiento | Le gusta el techo alto porque le da sensación de espacio. No hay suficientes habitaciones para almacenar los equipos de la UCI, el material portátil se suele dejar detrás del mostrador o en el pasillo principal, pero estaría mejor si hubiese un espacio apropiado y no se colocaran entorpeciendo el paso. |
| 11 | Limpieza de los pacientes | Boxes | Espacio, iluminación natural | Los boxes sin ventana le resultan muy tristes. La iluminación natural permite reconocer mejor el tono de piel del paciente. |
| 12 | Preparación de medicamentos | Sala preparación medicamentos | Almacenamiento, espacio, higiene | Como la sala de estar no tiene pileta, todos los platos, vasos y cubiertos que usa el personal se friegan en esta sala. El espacio de banco para preparación de medicamentos queda muy limitado. |
| 13 | Hacer analíticas o rayos a los pacientes | Boxes | - | - |
| 14 | Desplazarse entre boxes | Pasillo principal | Seguridad | La junta de dilatación que atraviesa la unidad es un punto débil en el pavimento. Muchas de las baldosas están debilitadas en este punto y el recubrimiento de la junta vencido por el uso intensivo de la unidad. Se han llegado a producir caídas por esta discontinuidad en el revestimiento. Las puertas dobles abatibles no tienen elementos transparentes para poder ver si hay alguien al otro lado. Se han producido muchos golpes por este motivo. |
| 15 | Comer | Sala de estar | Ergonomía | Los sillones son muy bajos y la mesita también, tiene que comer encorvada. Preferiría tener una mesa de comedor con sillas y aparte unos sillones para descansar. |
| 16 | Ir al servicio | Baños personal, pacientes y del vestuario central | Privacidad, olores | Para aguas menores suele ir al baño de pacientes de la unidad y al del vestuario de personal, aunque suele oler muy fuerte en este último. Cuando necesita más intimidad se desplaza una planta para llegar al vestuario central del sótano ya que suele estar más tranquilo. |
| 17 | Descansar | Sala de estar | Ergonomía | Coloca los sillones de la sala de estar juntos y se acuesta para estirar las piernas. También utiliza los sillones para pacientes que hay en el control. |

## A.3.2 Caregiver Interview

INFORMACIÓN

| Acompañante | | Paciente | |
|---|---|---|---|
| Nombre: | XX | Nombre: | XX |
| Vínculo: | Hija | Habitación: | A330 |
| Edad: | 67 | Edad: | 92 |
| Sexo | ♀ | Sexo | ♀ |
| Estancia: | día y noche | Estancia: | 22 días |

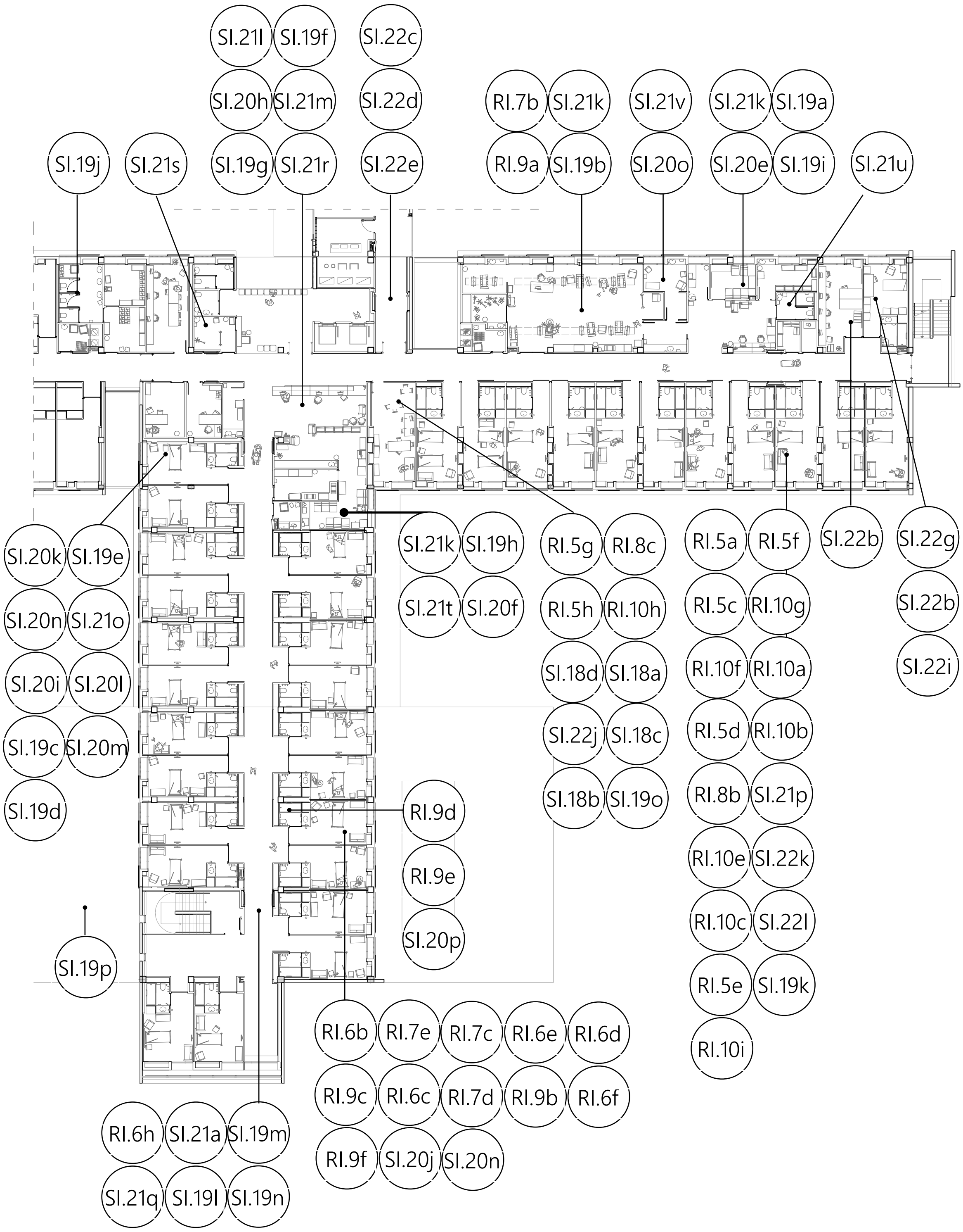
RECORRIDO

| | Acción | Lugar o elemento | Condiciones ambientales | Experiencia |
|---|---|---|---|---|
| 1 | Ingreso | Urgencias, pasillos | Orientación | Cuando llegaron al hospital, su madre estaba totalmente desorientada, le decía "¿qué hacemos aquí? vamos a casa". La primera impresión del edificio de la hija fue muy buena, no le pareció que entraba en un hospital, no huele a medicina ni a enfermo y no le dio nada de miedo. Piensa que es muy agradable. La hija se orienta bastante bien en el edificio. La primera vez que llegó, desde el hall principal no encontraba la A, pero vio el palito y dedujo que sería la A porque no la podía leer entera. No tiene problemas para andar, ni oír ni ver. Su madre en cambio no puede salir de la habitación porque está muy débil. |
| 2 | Recibir atención asistencial | Habitación, control de enfermería | Seguridad | Si la hija tiene cualquier problema, no llama al timbre de la habitación, prefiere estirar un poco las piernas y hablar personalmente con la enfermera. Cuando baja a la cafetería también avisa en el control para que sepan que su madre se queda sola. |
| 3 | Aseo | Habitación | Higiene | La madre está tan flojita que no se puede levantar de la cama, lleva un pañal y la cambia el personal auxiliar de enfermería. La hija sí que utiliza el cuarto de baño de la habitación, pero para ducharse se va a su casa. |
| 4 | Comer | Cafetería | Contacto exterior | La hija come en la cafetería del hospital. Le parece que está muy bien y piensa que el personal es muy amable. |
| 5 | Dormir | Sillón | Seguridad, iluminación, ruido | La hija suele dejar la puerta de la habitación abierta por la noche, entra un poco de luz del pasillo, pero no le molesta y lo prefiere así porque en cualquier momento puede ir al mostrador si lo necesita. No hay mucho ruido por la noche. Está acostumbrada a los ruidos que hace el equipamiento de la habitación. De vez en cuando se oye a algún vecino de manera puntual, pero es lo normal en un hospital. No le molesta nada. Como la hija es pequeñita de tamaño, le sobra sillón. Al principio pensaba que no se iba a quedar mucho tiempo y aunque le ofrecieron un sofá cama dijo que no lo necesitaba. Ahora se ha acostumbrado y espera que no le queden muchas más noches en el hospital. |

| | | | | |
|---|---|---|---|---|
| 6 | Entretenerse | Habitación, pasillo | Control, iluminación, confort, actividad física, arte, vistas | Si quiere puede oscurecer completamente la habitación, cosa que le parece estupendo. También puede regular la temperatura. El confort es muy bueno, no necesita nada más. Me cuenta que su madre de toda la vida tiene la manía de querer cerrar todas las puertas. De vez en cuando, mira la ventana y como es tan grande y transparente se piensa que la puerta está abierta y le pide constantemente que la cierre. La madre no se puede mover de la cama, todos los días los celadores o auxiliares la sientan unas horas en el sillón para que cambie de postura. Para entretenerse pone la tele, pero su madre no se fija, a veces ni la mira, le da un poco igual, pero entre cabezada y cabezada levanta un poco la vista y la tiene de fondo. La hija suele leer, mirar la tele y el móvil. Le pasan los días muy rápidos y no se aburre. Por la noche, antes de dormirse lee un ratito y se enciende la luz del cabecero para no molestar a su madre. Le gusta poder controlar la cantidad de luz. Tiene dos sillones reclinables y una silla. Si viene visita se pueden sentar bien. De vez en cuando sale un poco a estirar las piernas, pero no se va muy lejos, unas dos habitaciones hacia cada lado de la suya y vuelve. Tiene espacio suficiente para todos los objetos personales. Las exposiciones de arte las ve de paso, no se para. Pero piensa qué chulos, le da mucha curiosidad. Le enterneció la de la lactancia materna, le transmitía ternura, se acordaba de cuando le daba de mamar a su hijo y piensa que es algo tan natural que sientes tanto a tu hijo y que te conecta mucho con él. Le hace recordar esos momentos tan tiernos y bonitos. Le gustan mucho las vistas de la habitación. No es que pase mucho tiempo mirándolas, pero le gusta tenerlas, piensa que ha tenido mucha suerte con la habitación que le ha tocado. Tener vistas a una pared sería algo horrible. Le gusta tener tanta vegetación y tanto verde alrededor del hospital. |

# A.4 “Hospital de Dénia” Summary

De todas las unidades evaluadas, tan solo se incluyen los comentarios del área de maternidad. Las siglas “S” hacen referencia a los compentarios de las “Staff interviews” y las “R” a los de las “Room interviews” a pacientes y acompañantes.



| | Nº | Acción | Condiciones ambientales | Experiencia |
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| Habitación obstetricia | RI.6b | Recuperarse | Privacidad | La habitación individual les da mucha más libertad, pueden hacer lo que les da la gana, como en un hotel. |
| | RI.7e | Recuperarse | Privacidad | Tiene mucha privacidad porque es una habitación individual. |
| | RI.7c | Recuperarse | Iluminación | La iluminación de la habitación le gustaba mucho. Entraba el sol y por la noche tenía dos posiciones para graduarla. |
| | RI.6e | Dormir | Iluminación | No hay ninguna luz tenue que puedan dejar encendida por la noche. Se han traído una lamparita nocturna infantil para poder ver si el niño duerme bien o les reclama. No se puede regular la luz, o la enciendes o la apagas. |
| | RI.6d | Dormir | Ruido | Los ruidos durante la noche no son molestos, lo normal en una sala con bebés, se oye a los niños llorar. |
| | RI.9c | Dormir | Ruido | Hay algún ruido, pero lo normal en un hospital, algún portazo o bebés que lloran, pero nada incómodo. |
| | RI.6c | Dormir | Ergonomía | El padre duerme fatal, los hierros del sofá cama se le meten en la espalda. |
| | RI.7d | Dormir | Ergonomía | El sofá cama para su pareja está fatal. |
| | RI.9b | Dormir | Ergonomía | Para la madre muy bien pero el padre bastante incómodo en el sofá cama, el colchón es demasiado fino y se hunde. |
| | RI.6f | Atender visitas | Tamaño | Lo máximo que han llegado a tener han sido seis personas. |
| | RI.9f | Atender visitas | Tamaño | Hay espacio suficiente para todos, y mejor que no haya más muebles para que se sienten todos porque si no, la habitación estaría muy recargada y no les dejarían estar a solas. Lo máximo que han tenido han sido cinco personas en la misma visita. |
| | SI.20j | Atender pacientes | Iluminación | No hay ninguna luz artificial tenue que se pueda dejar por la noche encendida. Para la enfermera es difícil entrar por la noche porque no encienden la luz para no despertar a los pacientes. O las madres se despiertan y quieren mirar al bebé para asegurarse de que respira bien pero no quieren despertarlo con la luz. |
| | SI.20n | Atender pacientes | Iluminación | La iluminación artificial de la habitación no es suficiente para ver las venas de los bebés o niños y niñas pequeños para coger las vías. Algo tipo flexo que pudieran regular y enfocar sería ideal. |

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| Habitación pediatría | RI.5a | Comer | Ergonomía | Los padres compran la comida de fuera y se la comen en la habitación. Utilizan la silla que tienen de mesa, la madre se sienta en el sofá y el padre en la cama, aunque les resulta bastante incómodo. |
| | RI.5c | Dormir | Iluminación | La iluminación del cabecero está muy bien porque pueden elegir qué ambiente quieren. |
| | RI.10f | Dormir | Iluminación | Les gusta poder controlar el grado de iluminación por la noche y cerrar los estores de la ventana. |
| | RI.5d | Dormir | Ergonomía | La madre duerme en la cama con el niño y el padre pone el colchón del sofá cama y otro colchón que se ha traído en el suelo. El sofá cama está muy mal, cuando se tumba se le meten todos los muelles en la espalda y se levanta fatal, vale la pena dormir en el suelo. |
| | RI.8b | Dormir | Ergonomía | Su madre no tiene almohada para dormir. |
| | RI.10e | Dormir | Ergonomía | La madre se queda a dormir todas las noches. El sofá cama lo deberían cambiar porque está fatal. |
| | RI.10c | Entretenerse | Vistas | La vista desde la habitación es muy verde y les gusta mirar por la ventana. |
| | RI.5e | Entretenerse | Vistas | Les gustaría poder abrir la ventana, Si se pudiera abrir la ventana al balconcito, el niño se acercaría a la barandilla y se quedaría embobado mirando los coches moverse y con los ruidos del exterior. |
| | RI.10i | Entretenerse | Relaciones sociales | La madre tampoco se aburre porque hace ganchillo y collares. Aunque no le gusta tener que pagar por la tele, piensa que debería haber algunos canales gratuitos. |
| | RI.5f | Entretenerse | Tamaño | Los familiares y visitas les han traído muchas cosas. La habitación tiene espacio para guardar, pero se ha ido llevando cosas a casa porque le agobiaba ver tanto desorden. |
| | RI.10g | Atender visitas | Tamaño | Han ido un máximo de cinco personas a la vez. |
| | RI.10a | Recuperarse | Arte | A la hija le gusta mucho estar en la habitación porque las paredes están pintadas como si fuera un bosque y a ella le encantan los bosques. Le gusta tanto que manda fotografías a sus amigas para que la vean. |
| | RI.10b | Recuperarse | Higiene | Según la madre, la habitación está muy limpia, el suelo, las sábanas y las toallas, todo perfecto. |
| | SI.21p | Atender pacientes | Arte | Le agradan los dibujos de las habitaciones de pediatría. Le parece que la habitación queda más animada. |
| | SI.22k | Atender pacientes | Arte | La decoración le parece adecuada. |
| | SI.22l | Atender pacientes | Tamaño | Le gusta la amplitud de la habitación ya que para el trabajo que desarrolla es suficiente. |
| | SI.19k | Atender pacientes | Arte | Le gusta las representaciones artísticas de la zona de pediatría, el arte y los colores le dan mucha vida. |

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| Habitaciones interiores | SI.20k | Atender pacientes | Privacidad | A veces se siente incómoda por la privacidad tan alta de las habitaciones individuales. La gente se piensa que está en un hotel. |
| | SI.21n | Atender pacientes | Iluminación | Alguna de las habitaciones como la 1 y la 2 tienen poca luz y le parecen muy tristes. Si a los pacientes no les entra ni un rayo de luz, les hunde. |
| | SI.20i | Atender pacientes | Iluminación | Las habitaciones 1 y 2 son muy tristes y depresivas porque no les entra casi nada de luz. |
| | SI.19c | Atender pacientes | Iluminación | Hay demasiados elementos para oscurecer la habitación: los estores y las lamas en el exterior. |
| | SI.19d | Atender pacientes | Iluminación | Las lamas están sobre marcos correderos, pero al ser exterior y como no se deben abrir las ventanas, no tienen la llave y no las pueden colocar como le gustaría según la hora del día. Le gustaría poder moverlas para controlar la iluminación del interior de la habitación porque a veces quedan demasiado oscuras con tantos mecanismos (estores y lamas). |
| | SI.19e | Atender pacientes | | Estaría muy bien tener un hilo musical en las habitaciones o radios para estos casos ya que la actitud del paciente cambia completamente. |
| | SI.21o | Atender pacientes | Higiene | El sillón reclinable y el sofá cama de ante no son adecuados para un hospital. Recogen toda la suciedad que puedan generar los pacientes (orina e incluso heces) y también hay acompañantes que son un poco cochinos. No se puede limpiar bien y todo se queda ahí, no le parece nada higiénico. |
| | SI.20l | Atender pacientes | Higiene | El sillón reclinable y el sofá cama son muy roñosos, deberían ser de escay marrón o negro, fácil de limpiar y disimular. |
| | SI.20m | Atender pacientes | Higiene | El pavimento del suelo le gusta porque es oscuro y no se ve lo que está sucio, es muy disimulado. |
| Aseo habitación obstetricia | RI.9d | Ir al aseo | Higiene | El baño es muy bonito, parece que estés en un hotel, no te da la impresión de hospital. |
| | RI.9e | Ir al aseo | Ergonomía | Aunque el inodoro está demasiado bajito y después de una cesárea duele mucho agacharse tanto. |
| | SI.20p | Ir al aseo | Ergonomía | Las tazas del inodoro son muy bajitas. A las madres que han tenido una cesárea les cuesta mucho agacharse tanto para usarlo, sienten que se les va a abrir la barriga. |
| Pasillo a otra unidad | SI.22c | Atender pacientes | Localización, privacidad | Refuerzo consultas externas. Se encuentran justamente en el extremo opuesto del edificio. No suelen hacer muchos viajes, pero podrían estar más cerca. |
| | SI.22d | Atender pacientes | Localización, privacidad, arte | Refuerzo urgencias. Su ubicación les queda cerca por si hay alguna urgencia, le parece bien. |
| | SI.22e | Atender pacientes | Localización | Paritorios les queda demasiado lejos de materno-infantil. Tardar varios minutos en llegar es peligroso para la salud del bebé si su situación es crítica. Suele bajar corriendo por las escaleras de emergencias porque en esos casos el tiempo es vital. |

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| Pasillo | RI.6h | Desplazarse | Relaciones sociales | Se saludan con otros pacientes, pero no les ha dado tiempo a conocer a nadie. |
| | SI.21q | Desplazarse | Tamaño | Los pasillos se le hacen muy largos, especialmente en maternidad ya que el control queda a una esquina. |
| | SI.22a | Desplazarse | Privacidad | Hay pacientes que cuando se aburren pasean por la zona de pediatría. Suelen ser personas mayores con goteros y bolsas de orina o sangre colgando. No es un espectáculo apto para menores. Han tenido que poner un cartelito en el suelo que avisa de que es una zona restringida y que no se debe pasar para prevenir que los niños vean a pacientes adultos enfermos. |
| | SI.19l | Desplazarse | Iluminación | Le gusta que los pasillos tengan tanta luz porque así puede controlar lo que hay, y no le dan miedo. |
| | SI.19m | Almacenar cunas | Tamaño | Falta espacio para las cunas que no se están utilizando, se acaban almacenando en una esquina del pasillo porque no tienen dónde guardarlas. Queda como desordenado. |
| | SI.19n | Atender visitas | Ruido | Por las tardes los bebés recién nacidos reciben muchísimas visitas y el pasillo es muy ruidoso. |
| Box ginecología | SI.21s | Atender pacientes | Localización | El box queda en una esquina y los desplazamientos son continuos porque debe acompañar a muchas madres. Estaría mejor que el box de exploraciones fuese una sala más céntrica. |
| Sala | SI.22b | Seguimiento pacientes | Localización | Le gusta porque está muy cerca de los pacientes, le da seguridad porque tiene capacidad de reacción en muy poco tiempo. |
| Sala neonatos | RI.7b | Cuidar a su bebé | Protección | Al entrar le dio un poco de impresión por ver tantos aparatos y a su hija tan frágil e indefensa. |
| | RI.9a | Cuidar a su bebé | Espacio | Entró a la sala de neonatos encamada para que pudiese ver a su hija y se quedara más tranquila. |
| | SI.21k | Dejar el bolso | Seguridad | Lo deja en la sala. |
| | SI.19b | Atender pacientes | Privacidad | Le gusta el estor que hay en el ventanal de neonatos hacia el pasillo. Antes los pacientes y acompañantes de todo el hospital, cuando estaban aburridos iban a ver a los bebés, no es una atracción. |
| Habitación lactancia | SI.21v | Atender pacientes | Tamaño | La sala de lactancia en neonatos se utiliza para pinchar o examinar a los niños que no están ingresados. |
| | SI.20o | Atender pacientes | Iluminación | Tienen un cambiador que sirve de camilla y un foco empotrado justo encima para poder ver las venas. |

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| Escuela | RI.5g | Relacionarse | Relaciones sociales | No les parece bien que la sala de juegos de la escuela sea solo para niños en edad escolar ya que no la puede usar ni para estar con otros niños porque todavía no tiene 3 años. Acaba pasando todo el día encerrado en la habitación y se le hace muy pesado. Aparte de esta sala, no hay ningún otro espacio para que coincida con más niños que no tengan ninguna enfermedad infecciosa. |
| | RI.5h | Relacionarse | Relaciones sociales | En toda su estancia en el hospital no ha conocido ni ha estado en contacto con ningún otro niño. |
| | SI.18d | Relacionarse | Mobiliario | Le gustaría más tener una mesa grande redonda que rectangular, de este modo los niños se pueden sentar juntos y verse las caras. Con una redonda sería más informal y crearía más interacción entre los alumnos. |
| | SI.22j | Relacionarse | Distractores positivos, juego | Como los niños no pueden ir a la salita, se quedan encerrados toda la tarde y es una pena porque se aburren mucho. |
| | SI.18b | Relacionarse | Acabados | Le gusta la pared de vidrio porque la gente que pasa por el pasillo puede verlos trabajar y conocer mejor el aula escolar. Tiene más proyección que si fuese opaca. |
| | RI.8c | Entretenerse | Relaciones sociales | Suele entretenerse con el móvil y si se aburre va al colegio con la maestra, es muy cómodo. Ha conocido a otros dos niños mientras estaba en clase. |
| | RI.10h | Entretenerse | Relaciones sociales | Le gusta ir al colegio porque juega, hace manualidades y está con más niños. Ha conocido a dos niños en la escuela. |
| | SI.18a | Entretenerse | Tamaño | Falta espacio específico para la ludoteca, como es cole y tiene ordenadores y material escolar, necesita cerrarlo por las tardes. Los niños y niñas necesitan de espacio para jugar, sobre todo por las tardes, los fines de semana y en vacaciones, cuando la sala permanece cerrada. |
| | SI.18c | Entretenerse | Decoración | Como el aula era para juegos, está muy decorada, demasiado. En la sala no hace falta tanta decoración porque los niños y niñas ya decoran mucho y querría que se pudiera personalizar, cambiar la decoración según los pacientes que atienda. Se identifican con el lugar y su marca personal porque reconocen sus trabajos, se los pueden enseñar a sus padres o a otros niños. Una clase es algo dinámico, debe poderse actualizar según los alumnos que tenga. No solamente debe haber color, también tienen que haber letras en el entorno. |
| | SI.19o | Entretenerse | Distractores positivos | Estaría muy bien que hubiese una zona exterior en la planta para que los niños se pudiesen relajar. Ahora que la sala de juegos está cerrada por las tardes, los niños se aburren mucho. |

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| Control maternidad | SI.21l | Informar | Localización | No le gusta nada el control de maternidad porque parece que sea el puesto de información de la máquina de la televisión y el café. Muchas veces llegan acompañantes que quieren ir a las habitaciones de la tercera planta, pero como la 3C es psiquiatría y no comunica con la 3B y la 3A, bajan a la 2C a preguntar y le toca redirigirles para que se puedan orientar. |
| | SI.20h | Informar | Localización | Está muy mal, son la recepción de todo el hospital porque el núcleo de ascensores C es el que utilizan la mayoría de las personas. Suben sin saber y les preguntan allí. Les preguntan para ir a la tercera planta, que no pueden porque es psiquiatría. Molesta mucho porque están haciendo las notas de enfermería y les interrumpen constantemente. Falta una señal bien grande que diga ”Maternidad” para que sepan por lo menos dónde están y que no haga falta preguntar en todo momento. |
| | SI.19g | Informar | Localización | Como el mostrador está nada más llegar en el ascensor C que está en el acceso principal del hospital, mucha gente llega y les pregunta por pacientes que no están en esa planta. Si van a la planta tercera como es psiquiatría y está cerrada, vuelven a la segunda a preguntar y les tienen que redirigir para llegar a la tercera planta desde el ascensor B. |
| | SI.19f | Informar | Localización | Pierden mucho tiempo explicando a los familiares cómo utilizar la televisión y la máquina de tiquets para la tele. |
| | SI.21m | Seguimiento pacientes | Privacidad | Preferiría que los ordenadores estuvieran en un recoveco más apartados para que no la interrumpieran constantemente. Como el mostrador es tan abierto la gente entra hasta dentro sin pedir permiso. |
| | SI.21r | Seguimiento pacientes | Privacidad | Desde las habitaciones 29, 30 y 31 se oye todo lo que hablan y se dice en el control, por su proximidad y porque las puertas no están selladas. |
| Baño personal | SI.21u | Ir al aseo | Espacio | El baño cerca del control de maternidad es muy incómodo, prefiere ir al de pediatría, aunque quede más lejos. |
| Sala estar maternidad: | SI.21k | Dejar el bolso | Seguridad | En la sala de estar. |
| | SI.21t | Comer | Privacidad | Baja el estor del cristal para aislarse un poco del mostrador. Siente que está todo demasiado abierto. |
| | SI.19h | Comer | Seguridad | Como el mostrador está abierto hay familiares que se meten hasta dentro y le da inseguridad porque puede entrar cualquiera y como en la planta justo encima está psiquiatría, le deja intranquila. |
| | SI.20f | Comer | Ergonomía | El mobiliario de la sala de estar no está preparado para comer necesitarían una mesa alta con sillas normales. |

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| Office pediatría | SI.21k | Dejar el bolso | Seguridad | En el office detrás del mostrador. |
| | SI.20e | Cambiarse | Localización | Tiene taquilla en el vestuario general, pero ha calculado que ir allí a cambiarse le supone veinte minutos de más al día extra a su jornada laboral. Se cambia en pediatría y deja toda su ropa allí. |
| | SI.19a | Cambiarse | Localización | Como el acceso al vestuario central ahora es más largo, prefiere cambiarse en la misma planta y reducir así los recorridos. |
| | SI.19i | Descansar | Ventilación | La habitación de detrás del control de pediatría siempre está muy fría. Descansa mejor en la de neonatos o en maternidad. |
| Habitación pediatra de | SI.22g | Descansar | Localización | Está muy cerca de los pacientes lo que le permite estar disponible en muy poco tiempo. |
| | SI.22h | Descansar | Iluminación | Le gusta que puede oscurecer por completo la habitación para dormir bien de noche. |
| | SI.22i | Descansar | Vistas | Le gusta tener vistas. |
| Baño | SI.19j | Ir al aseo | Seguridad | Como hay que atravesar el almacén donde hay muchas cajas en el suelo y recovecos, le da miedo. Piensa que alguien podría estar escondido y darle un buen susto porque no se ven bien los límites de la habitación entre tanta caja y al ser el almacén interior siempre está oscuro. |
| Terraza | SI.19p | Entretenerse | Vistas | Si esa terraza fuese accesible se podría tener un pequeño huerto o elementos naturales para distraer a los pacientes. Cambiaría por completo la experiencia de los pacientes y su estado emocional mejoraría notablemente. |
| | SI.20b | | | Las cubiertas vegetales eran aromáticas cuando se inauguró el edificio. Tenían vegetación autóctona y eran muy bonitas. Ahora están todas secas y descuidadas. |