
# 4th VIBRARCH

NOVEMBER 13-15, 2024

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

ESCOLA TÈCNICA SUPERIOR D'ARQUITECTURA

Publisher:

Editorial Universitat Politècnica de València,2025
http://www.lalibreria.upv.es

ISBN 978-84-1396-026-5

November, 2024





Coordination and design:

Júlia Martínez Villaronga
Mariví Monfort Marí
Carles Rosaleny Gamón

4th VIBRArch: Wellbeing for all. / Editorial Universitat Politècnica de València

PAPER #9.02

# GEOMETRIC AND DIMENSIONAL ANALYSIS OF LABOR, DELIVERY AND RECOVERY ROOMS (LDR) IN A HOSPITAL MATERNITY CENTER

Juan Serra Lluch[a], Eduardo Baviera Llópez[a], Ximena Gutiérrez-Jiménez[a]
[a] Universitat Politècnica de València, Valencia, Spain

How to cite
Serra Lluch, Juan, Eduardo Baviera Llópez, and Ximena Gutiérrez-Jiménez. "Geometric and dimensional analysis of Labor, Delivery and Recovery Rooms (LDR) in a hospital maternity center" In *Proceedings of 4th Valencia International Biennial of Research in Architecture. Wellbeing for all*. Valencia. 2024. https://doi.org/10.4995/VIBRArch2024.2024.18441

## ABSTRACT

In the Spanish healthcare model, hospital maternity centers (MC) are usually designed following a sequential model, with differentiated architectural spaces for each phase of childbirth: dilation rooms, delivery rooms, postpartum recovery rooms and the maternity/puerperal room. However, in other countries MCs usually have an integrated space called the Labor, Delivery and Recovery Room (LDR) which is the most appropriate architectural models to promote natural birth and avoid excessive medical attention. LDR's design must respond to both functional and sensory needs. We carried out a systematic study of the most adequate functional and dimensional requirements for LDRs depending on their geometry. For this, we gathered information from a qualitative study with mothers and midwifes, bibliographical revision of regulations and scientific papers, and relevant architectural case studies. In an LDR, we identified 8 areas that have different functional requirements: 1) access, 2) rest area, 3) bathroom, 4) dynamic area, 5) wet area, 6) an area for the newborn, 7) storage space, 8) exterior space. We developed 8 proposals of LDR distribution with a square, rectangular and L-shaped layout. The geometry was rectilinear and curvilinear and with individual and shared wet areas. Once the proposals were evaluated by 5 mothers, 5 midwifes and 5 architects and designers, it was observed that all the alternatives present adequate dimensional and functional conditions apart from their geometry in plan, with a certain greater preference for the L-shaped design among mothers and midwives. Among architects, the square shape was preferred, and the rectangular design had the greatest consensus among the 3 collectives. The use of rectilinear geometries was preferred by architects, while the curvilinear by mothers and midwives. Consensus is reached in reference to rounded corners as a constructive solution. This paper provides the recommended functional areas, dimensions and surfaces to help architects in the design of a LDR for a MC.

## KEYWORDS

Maternity; hospital; labor; delivery; architecture

## 1. INTRODUCTION: From a sequential model to an integrated model for Hospital Maternity Centers

In the existing Spanish healthcare model, hospital maternity centers (MC) are usually designed following a sequential model, in which various architectural spaces follow each other in a differentiated way to respond to the different stages of the birth process (dilation,

delivery and birth): dilation rooms, delivery rooms, post-partum recovery rooms and maternity/ puerperal room. However, in other countries such as the United States and the United Kingdom, the most common system is an MC with an integrated model, so that in one single architectural space, referred to as Unit of Labor, Delivery and Recovery (LDR), the entire birth process is carried out, favoring greater comfort and privacy for women and their companions. In the case of the LDRs designed in Spain, this room is expected to be occupied until delivery, the adaptation of the newborn to the extrauterine environment, skin-to-skin contact and completion of the first intake, as well as the maternal recovery phase that it can extend for one or two hours, to later pass to a conventional hospital bed in the obstetrics unit (Ministerio de Sanidad y Política Social, 2009, pp. 17, 67, 69).

LDR seems to be the adequate architectural model to favor natural birth and avoid excessively medicalized births, and its design must respond to both functional and sensory needs (Bellini et al., 2023). The first refers to those spatial requirements related to the adequate functioning and dimensioning of the elements that intervene, at a technical and ergonomic level, while the second refers to the subjective evaluation of the spaces in relation to aspects such as security or intimacy, which can favor or hinder labor. It is clear that the true "functionality" of an LDR is not guaranteed if it does not respond to the indicated sensory needs, particularly important in the case of natural childbirth. However, it is necessary, in the first instance, that the LDRs respond to functional requirements and dimensions that are often compromised by the geometry of the space to be designed.

## 2. OBJECTIVES

This communication contains a systematic study of the possibilities of functional organization of the LDR depending on its geometry. The objective is to analyze the most suitable functional and dimensioning possibilities to respond to the main needs to which an LDR must respond.

## 3. METHODOLOGY

The methodology used consisted of a study of the functional requirements to which the architectural design of an LDR must respond, the development of schematic proposals for interior spaces, and the evaluation by a panel of specialists.

For the study of the functional requirements at the architectural level, the following sources of information were used: 1) a previous qualitative study with mothers and midwives, carried out by the *Instituto de Biomecánica de Valencia* (IBV)/ The Biomechanics Institute of Valencia, in the facilities of the La Plana Hospital in Vila Real in Castellón (López-Vicente, 2024); 2) indications collected in technical guides and regulations (Jenkinson et al., 2014; Ministerio de Fomento, 2019; Ministerio de Sanidad y Política Social, 2009; Postigo-Mota et al., 2019); 3) study of relevant cases developed by architectural studios such as Parra-Müller (Müller & Parra Casado, 2015; Parra & Müller, 2008), Dolmus Architeckten, Vilalta Studio, Rafael Moneo and José María del Mata, Cor Arquitectos, etc.; 4) indications collected in scientific literature, with particular mention to papers by specialists belonging to the Global Birth Environment Design Network (GBEDN) (Bellini et al., 2023).

To develop the schematic design proposals of an LDR, the organization of square, rectangular or L-shaped plans were chosen (fig. 1). It was ensured that they were all similar in surface area, dimensions and in equipment. Rectilinear and orthogonal geometries were used (the most common in construction), and also some solutions with curvilinear geometries, often considered in the scientific literature when relating to architecture specific to the birthing environment (Balabanoff, 2017).

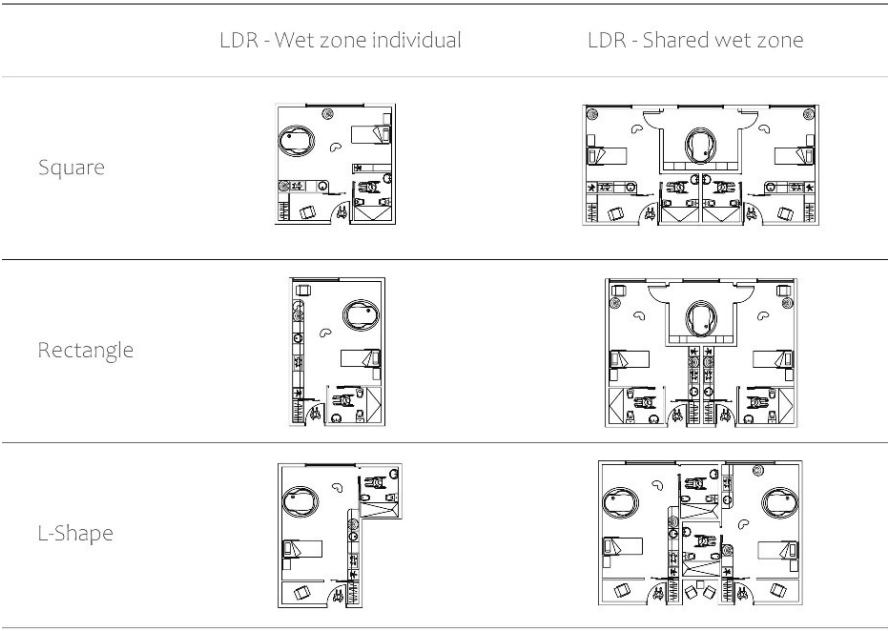


*Figure 1. Schematic development of LDRs with square, rectangular or L-shaped plans, and with individual and shared wet areas. Source: (Authors 2024)*

The different functional organization solutions were evaluated by a panel of specialists composed of 5 mothers, 5 midwives, and 5 architecture and interior designers, under the supervision of the Biomechanics Institute of Valencia.

## 4. RESULTS

### 4.1. Identification of the areas with different functional requirements in an LDR

Our work began with a previous qualitative study, which consisted in a dialogue with 11 mothers, 8 midwives and 1 gynecologist, at the Hospital La plana de Vila Real in Castellón, in which the main expectations regarding an ideal delivery environment, as well as functional aspects to be improved with respect to the LDRs currently existing in that hospital were discussed. The most outstanding aspects pointed out were: 1) the promotion of mobility, 2) the generation of free spaces around the bathtub and neonatal resuscitation area, 3) the existence of varied resources that can be moved easily. 4) leaving areas clear, with scopes and dimensions that will allow the midwife to access from different angles. 5) the presence of a Hill Rom bed outside the room and brought into the LDR only if necessary. 6) the existence of a shower in the bathroom, and in general 6) promote versatility, shared decision-making and the perception of warmth (IBV Report, Analysis of Needs).

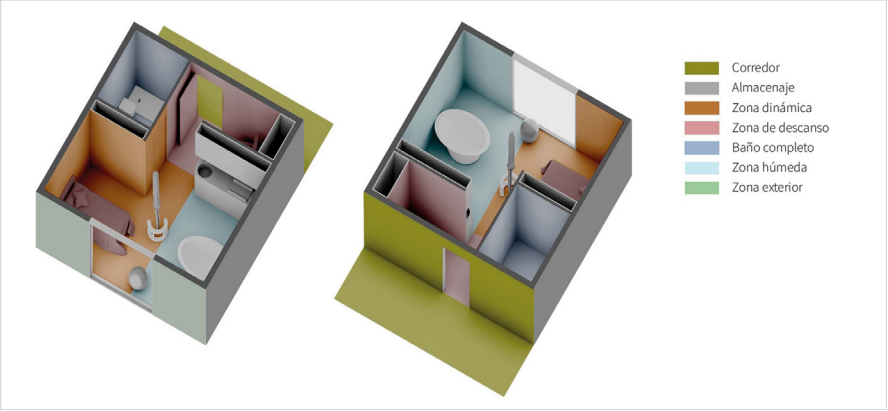


*Figure 2. Military perspective of an LDR in square geometry. Source: (Authors 2024)*

| *Areas with different functional requirements in an LDR* | | *Recommended usable surface area* |
|---|---|---|
| Rest area | | 2-3 $m^2$ |
| Bathroom | | 5.40-5.70 $m^2$ |
| Dynamic area | | 14.70-21 $m^2$ |
| Wet area | | 10-12 $m^2$ |
| Storage area | Total | 3-4 $m^2$ |
| | Personal belongings | 0.70-0.90 $m^2$ |
| | Surgical materials | 0.36-0.72 $m^2$ |
| | Sanitary materials | 0.72-0.90 $m^2$ |
| | Mobile lamp | 0.36 $m^2$ |
| | Obstetric stool or chair and birthing ball etc. | 0.72 $m^2$ |
| | Others | 0.36 $m^2$ |
| Total LDR | | 35-38$m^2$ |

*Table 1. Recommended surfaces for the different functional areas identified in an LDR. Source: (Authors 2024)*

So that these requirements can be fulfilled and all the phases of the birth process that must be developed in the LDR are carried out properly (from labor to recovery), our study has considered that the architectural space must contain the *following areas with different functional requirements* (fig. 2): 1) access corridor to the room; 2) rest area for companion; 3) complete private *bathroom*; 4) *dynamic area*, in which there is space to

move around, a birthing bed, a birthing ball, an obstetric chair and an obstetric sling system for a standing birth, etc.; 5) *wet area,* in which there is an obstetric bathtub in the event that water birth is chosen; 6) Adequate space to attend to the newborn; 7) *storage area* to hide personal belongings of the mother and her companion if necessary, but above all to store the necessary technical equipment: air and oxygen intakes, surgical and sanitary materials, mobile lamp, space to store the obstetric chair and birthing ball, etc.; 8) *outdoor area*, with natural views if possible, and views that can be blocked.

Other functional requirements considered have been: 1) ensure sufficient dimensions to be able to move the obstetric bed outside the LDR; 2) ensure that the entire LDR, including its bathroom, is adapted for the access of persons with reduced mobility; 3) have filter elements that ensure sufficient privacy for the mother and avoid visuals from areas of public use; 4) have physical or visual contact with the outside, if possible with some natural views. The recommended usable surface for each of the functional areas is indicated in table 1.

### 4.2. Identification of the surfaces and minimum distances required in an LDR

The areas identified with different functional requirements in an LDR, require certain dimensions that might be considered minimal to be fulfilled in rather a square, rectangular or L-shaped room plan (table 2). Regarding the *dynamic area*, which requires the biggest surface, a mobile hospital bed is incorporated, with a surrounding area that needs to be large enough to allow free movement of at least 3 people from the medical staff, additionally the bed must have a direct exit route to the main corridor. If the mother needs to be transported to another room due to an emergency, the area must be kept tidy and unobstructed. Therefore, it is necessary room enough in the *storage area* to keep the medical equipment and personal belongings hidden. Since the

| *Recommended distances between elements* | | |
|---|---|---|
| *Element* | *Recommended Distance* | *Justification* |
| LDR's door | ≥1,05 m (clear width) | Fire protection regulations (CTE DB-SI 3) |
| Passages (distance between walls) | ≥1,20 m | Accessibility regulations (CTE DB-SUA 9) |
| Wheelchair turning space | 1,50 m diameter | Accessibility regulations (CTE DB-SUA 9) |
| Toilet, washbasin and shower | 80 cm | Transfer space from wheelchair (CTE DB-SUA 9) |
| Birthing bathtub | 90 cm all around | Personnel manoeuvring space for assistance during labour and delivery |
| Obstetric chair and birthing sling | 90 cm all around | Personnel manoeuvring space for assistance during labour and delivery |

*Table 2. Summary table of recommended distances between elements in an LDR. Source: (Authors 2024)*

birth takes place in this room, the presence of a newborn care table and neonatal resuscitation equipment must be considered and preferably blocked from direct views. It is essential to have a washbasin and hand dryer outside the *bathroom*, which is designed with a toilet, washbasin and shower, and with the possibility of wheelchair access and free transfer spaces. These transfer spaces respect the minimum area of 80x80 cm. An important factor in this design is that the shower has the total width of the room even thus facilitating wheelchair access and also serve as a transfer space. The bathroom needs to have an empty space for the wheelchair rotation to fit a circle with a diameter of 1.50m. Following this same logic, the total of linear meters of storage was calculated to cover the needs to store medical equipment, personal belongings and companions, and free storage modules, thus giving a total of 1.80 linear meters of wardrobe space. Other empty areas around each essential element for childbirth are recommended in 90 cm., that is to say: the movable bed, the bathtub and the obstetric chair (fig. 3).

### 4.3. Individual or shared wet areas between adjacent LDRs

In the developed study we have considered for each of the square, rectangular and L-shaped plan geometries, the possibility that two adjacent LDRs can share the same wet area. By sharing resources, it would be cost effective in terms of the construction and maintenance of a birth center, since it is not common that two mothers simultaneously opt for a natural water birth. This would reduce the built surface of two LDRs from 77 m2 to 74 m2 and in some way anticipate a system of grouping units that could be sequential in the case of private wet areas in each LDR, or paired, with an even number of LDRs in the case of sharing a wet area (table 3).

For each of the plan organizations carried out, a strictly orthogonal geometry of 90° angles between the elements has been considered (the common system in industrialized construction in Spain). However, alternative distributions have been developed that include curved geometries, which could be considered more appropriate to the nature of the space, respecting similar dimensions.

## 5. RESULTS

With the outlined indications, a total of 9 alternative proposals of LDR functional organization were generated. Each was designed in DIN A2 format with a 1:50 scale plan, a short text and a scheme indicating the different functional areas. A 3D military perspective observing two opposite angles, allows for easy understanding the distribution represented in the plan. It must be highlighted that the aim of this graphic information was not to develop an exhaustive design of an LDR but to evaluate the functional scheme and of dimension, in which the furniture elements are merely representative icons. Therefore, an abstract representation rather than a realistic one was prioritized without focusing on materiality, lighting or color details (fig. 3).

| *Geometry in plan* | *2 LDR with individual wet area* | *2 LDR with shared wet area* |
|---|---|---|
| Square | 2 x 37.75 $m^2$ = 75.50 $m^2$ | (2 x 30.05) + 13.75 $m^2$ = 73,85 $m^2$ |
| Rectangular | 2 x 37 $m^2$ = 74 $m^2$ | (2 x 31,25) + 11.55 $m^2$ = 74,85 $m^2$ |
| L-shaped | 2 x 37 $m^2$ = 74 $m^2$ | --- |

*Table 3. Measurements of wet areas in LDRs with different geometries. Source: (Authors 2024)*


*Figure 3. Example of a DIN A2 sheet with the graphic information shown to the evaluators. Source: (Authors 2024)*

The evaluation of the proposals by the panel of specialists indicates that, with respect to the design of the room, it is considered that all the prototypes present good dimensional and functional conditions, although the following order of preference could be assigned: the rectangular layout being the best valued, followed by the L-shaped one, chosen mostly by midwives and women; and finally the square, with greater preference on the part of architects and designers, although with the worst rating given mainly by the midwives. It is considered that all the prototypes have generous dimensions that facilitate the work of mothers and midwives, allowing control of the room and a comfortable area for the family. The mothers consider that any space proposed is adequate and that the most important thing is the personal attention of the midwife.

Regarding the use of rectilinear or curvilinear geometries, the distribution proposals with straight shapes are chosen by the architects by consensus, and the curved shapes are better valued by midwives and mothers, although with approximately 50% opposing opinions. Curved shapes are considered "more feminine and pleasant," on the contrary, "are more complex in construction, with loss of space and a complex coexistence with straight shapes." The consensus is reached with all 3 collectives with respect to rounded corner as a constructive solution. The proposals with a shared wet area were rejected by both midwives and mother for reasons of hygiene, all of them opting for an individual wet area.

## 6. CONCLUSION

To promote natural birth without the need for medical intervention in Spain, the architectural model of maternity centers must evolve from a sequential model to an integrated one, similar to those found in other countries. It is especially important to study LDR units in which all the birthing stages (from dilation to recovery) take place. We carried out a systematic study of the most adequate functional and dimensional requirements for LDRs applying different types of geometry. For this, we gathered information from a qualitative study with mothers and midwifes, bibliographical revision of regulations and scientific papers, and relevant architectural case studies. In an LDR, we identified 8 areas that had different functional requirements: 1) access, 2) rest area, 3) bathroom, 4) dynamic area, 5) wet area, 6) an area for the new born, 7) storage space, 8) exterior space. We developed 8 proposals of LDR distribution with a square, rectangular and L-shaped layout. The geometry was rectilinear and curvilinear and with individual and shared wet areas. Once the proposals were evaluated by 5 mothers, 5 midwifes and 5 architects and designers, it was observed that all the alternatives present adequate dimensional and functional conditions apart from their geometry in plan, with a certain greater preference for the L-shaped design among mothers and midwives. Among architects, the square shape was preferred, and the rectangular design had the greatest consensus among the 3 collectives. The use of rectilinear geometries was preferred by architects, while the curvilinear by mothers and midwives. Consensus is reached in reference to rounded corners as a constructive solution.

The study we have carried out to date has been limited to a proposal in the initial ideation phase, responding to dimensional and functional requirements. In a later stage we will revisit the proposed models but with a more specific development, studying other perceptual aspects that are also important in the well-being of all the people involved in the birth process and that not only depend on geometric issues but also on finishes, materials, chromatic and lighting.

## ACKOWLEDGEMENTS

This preliminary study is part of the project “Strategies and models for the improvement of security, functionality and user experience in birth centers” (GVA. INNEST/2023/93) within the Programme of Strategic Projects in Cooperation, financed by the European Union in the framework of the European Regional Development Fund (FEDER) and the Valencian Community.

REFERENCES


Balabanoff, D. (2017). *Light and Embodied Experience in the Reimagined Birth Environment* (Issue June).

Bellini, E., Macchi, A., Setola, N., & Lindahl, G. (2023). Sensory Design in the Birth Environment: Learning from Existing Case Studies. *Buildings*, *13*(3), 1–30. https://doi.org/10.3390/buildings13030604

Jenkinson, B., Josey, N., & Kruske, S. (2014). BirthSpace: An evidence-based guide to birth environment design. *Queensland Centre for Mothers & Babies, The University of Queensland*, *February*, 1–25.

López-Vicente, A. (2024). *Informe de claves del proceso de parto basado en las preferencias de las mujeres y propuesta de casa de partos*.

Ministerio de Fomento. (2019). Documento Básico SUA: Seguridad de utilización y accesibilidad. In *Documento normativo SUA - CTE*.

Ministerio de Sanidad y Política Social. (2009). *Maternidad Hospitalaria Estándares y Recomendaciones*. 229.

Müller, A. E., & Parra Casado, M. (2015). La arquitectura de la maternidad. Recuperar y crear nuestros espacios The Architecture of Motherhood. Retrieving and Creating our Spaces. *ILEMATA Año*, *7*, 147–155.

Parra, M., & Müller, Á. (2008). *Arquitectura Integral de Maternidades: Material de apoyo a la estrategia de atención al parto normal en el sistema nacional de salud.* https://www.sergas.es/Asistencia-sanitaria/Arquitectura-integral-de-maternidades

Postigo-Mota, F., González-Pérez, I., & Rocca-Ihenacho, L. (2019). *Estándares Europeos para Centros de Nacimiento*.