THE EFFECT OF WARD TYPOLOGIES ON QUALITY OF CARE
Lessons From the Past to Inform the Future
Predictions of Social Economic Environmental and Technological Changes by 2050

World / Urban Population
Life Expectancy
Global Warming
Global Oil Demand
Technology
Artificial Intelligence
Driverless Vehicles
Advances in Medicine
What Are the Predictions for Healthcare?

- The Empowered Patient
- Prevention of ‘Lifestyle’ Diseases
- Rise in Alternative Therapies
- Increased Focus on Acute Care

- Personal Control
- Design for the Aging Population
- New Diseases
- Caregivers as Highly Regarded
Introduction

Healing Temple

Ancient Greece
- Nature views
- Natural ventilation
- Natural light

Christian Hospitals

Middle Ages
- Faith as a healer
- Dark and cold

Nightingale Ward

1860 - WWI
- Open ward
- Natural ventilation
- Natural light

Mega Hospitals

WWI - 2000
- Deep floor plan
- Mechanical ventilation
Ward Typologies

1867

Nightingale
St Thomas Hospital
UK

1963 1965

Corridor
Airedale Hospital
UK

1973 1976

Duplex
Ninewells Hospital
UK

1984 1986

Cluster
Weston-super-Mare
UK

Racetrack
High Wycombe Hospital
UK

Courtyard
York Hospital
UK

Radial
Chesterfield Hospital
UK
Why Are There Different Typologies?

- Natural light and ventilation in patient and staff areas
- Centralised vs decentralised nursing station
- Privacy vs supervision (single beds vs bays)
- Minimise walking distance
- Maximise outside views
- Centralised vs decentralised ancillary spaces
- Number of beds per nursing unit
How Do Design Features Influence Healthcare Outcomes?

Metrics

Environmental

Factors

noise [51]
ventilation [20]
light [24]
nature views [19]
handwashing [37]
single vs multi bed [25]
.......
How Do Design Features Influence Healthcare Outcomes?

2008

460 Empirical Studies

Metrics
- noise [51]
- ventilation [20]
- light [24]
- nature views [19]
- handwashing [37]
- single vs multi bed [25]

Environmental Factors

2018

Empirical Studies
("a new literature review is needed"
Ulrich, 2015)

Metrics

Environmental Factors
- communication
- culture
- behaviours
- human experience

Environmental & Behavioural Factors

.......
What are the Spatial Implication of Cultural Differences?

American Wards

Chinese Wards

The research question is: How different hospital ward typologies influence work processes and communication and how does this affect the quality of care provided to patients? Knowing this kind of evidence, would we design differently and can we inform future healthcare design?
1 introduction
2 case studies
3 methodology
4 analysis & results
5 conclusions
Case Studies

University College London Hospital

Area - 1420 m²
Number of beds - 43
Single rooms - 22

National Hospital for Neurology and Neurosurgery

Area - 1380 m²
Number of beds - 20
Single rooms - 3

Chelsea and Westminster Hospital

Area - 470 m²
Number of beds - 11
Single rooms - 1

Racetrack layout

Duplex layout

Corridor layout
Methods

SPATIAL LAYOUT
SPACE SYNTAX

WORK PROCESSES
DIRECT OBSERVATIONS

COMMUNICATION
SOCIOMETRIC BADGES

QUALITY OF CARE
PERFORMANCE DATA

diseases & infections
health outcomes
building maintenance
patient services
staff satisfaction
Methods

THE ARCHITECTURAL SPACE AS A NETWORK - THE METHOD OF SPACE SYNTAX

Space Syntax is a theory and method to study spatial configurations developed at UCL in the 70s by Prof Bill Hillier and colleagues.

What is the relationship between the spatial design of buildings and the way they work socially?

Configuration is the way in which spatial elements are put together to form an interconnected system of spaces.

Analysis & Results

Connectivity (what one can see locally)

UCLH

NHNN

CW

Connectivity Distribution

- **Max**: 706
  - **Ave**: 240
  - **Min**: 4
  - **SD**: 139

- **Max**: 1008
  - **Ave**: 361
  - **Min**: 11
  - **SD**: 240

- **Max**: 576
  - **Ave**: 230
  - **Min**: 13
  - **SD**: 124

Racetrack layout

Duplex layout

Corridor layout

larger distribution of values

smaller distribution of values
Analysis & Results

Mean Depth (what one can see globally)

Intelligibility - how much the whole environment can be understood from its parts

R2 = 0.53
R2 = 0.35
R2 = 0.85

highest correlation
How different layouts affect activities and walking distances?

<table>
<thead>
<tr>
<th>Layout</th>
<th>Ave walking distance per day</th>
<th>Ave duration of conversations</th>
<th>Mean duration of all activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Racetrack</td>
<td>4.10km</td>
<td>45sec</td>
<td>35sec</td>
</tr>
<tr>
<td>Duplex</td>
<td>2.61km</td>
<td>46sec</td>
<td>40sec</td>
</tr>
<tr>
<td>Corridor</td>
<td>3.47km</td>
<td>32sec</td>
<td>25sec</td>
</tr>
</tbody>
</table>

Racetrack layout
20 staff members [4 NIC, 8 RN, 4 doctors, 3 consultants, 1 runner]
Total: 12h 37min

Duplex layout
15 staff members [3 NIC, 7 RN, 2 doctors, 3 PT]
Total: 8h 10min

Corridor layout
17 staff members [3 NIC, 7 RN, 4 doctors, 1 consultants, 2 PT]
Total: 14h 11min
Are there significant differences between same role in different hospitals?

Mean duration of all activities by role

**Racetrack layout**
- Doctor: 69''
- Nurse: 30''
- Nurse in charge: 36''
- Consultant: 37''

**Duplex layout**
- Doctor: 58''
- Nurse: 39''
- Nurse in charge: 32''
- Consultant: 42''

**Corridor layout**
- Doctor: 32''
- Nurse: 20''
- Nurse in charge: 24''
- Consultant: 48''
- Physiotherapist: 34''
Are there significant differences between same role in different hospitals?

Mean duration of all activities by role

<table>
<thead>
<tr>
<th>Role</th>
<th>Racetrack layout</th>
<th>Duplex layout</th>
<th>Corridor layout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor</td>
<td>69''</td>
<td>58''</td>
<td></td>
</tr>
<tr>
<td>Nurse</td>
<td>36''</td>
<td>39''</td>
<td>32''</td>
</tr>
<tr>
<td>NIC</td>
<td>37''</td>
<td>30''</td>
<td>20''</td>
</tr>
<tr>
<td>Consultant</td>
<td>36''</td>
<td>32''</td>
<td>24''</td>
</tr>
<tr>
<td>PT</td>
<td>48''</td>
<td>42''</td>
<td>34''</td>
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</tbody>
</table>

**ANOVA**

<table>
<thead>
<tr>
<th>Role</th>
<th>Racetrack</th>
<th>Duplex</th>
<th>Corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor</td>
<td></td>
<td>0.721</td>
<td>0.000**</td>
</tr>
<tr>
<td>Nurse</td>
<td></td>
<td>0.088*</td>
<td>0.009**</td>
</tr>
<tr>
<td>NIC</td>
<td></td>
<td>0.009**</td>
<td>0.000**</td>
</tr>
<tr>
<td>Consultant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PT</td>
<td></td>
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</tbody>
</table>

**Pairwise comparison**

<table>
<thead>
<tr>
<th>Role</th>
<th>Racetrack</th>
<th>Duplex</th>
<th>Corridor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doctor</td>
<td></td>
<td>-</td>
<td>0.036**</td>
</tr>
<tr>
<td>Nurse</td>
<td></td>
<td>0.088*</td>
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<tr>
<td>NIC</td>
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<td>0.009**</td>
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<td>PT</td>
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</tbody>
</table>
Analysis & Results

UCLH
n=19

Node size: Betweenes centrality - who controls information flow
Link: frequency of communication

CW
n=19
Analysis & Results

UCLH
n=19

Node size: Betweenes centrality - who controls information flow
Link: frequency of communication

Differences of betweenness values

hierarchical structure

democratic structure

CW
n=19
Analysis & Results

Differences of betweenness values

UCLH  

NHNN  

CW
I feel part of a **team** where I work [rated on a scale 1 (strongly disagree) to 7 (strongly agree)]

- **UCLH**: 6.1
- **NHNN**: 6.5
- **CW**: 6.8
I feel part of a **team** where I work [rated on a scale 1 (strongly disagree) to 7 (strongly agree)]

- **UCLH**: 6.1
- **NHNN**: 6.5
- **CW**: 6.8

There is good **communication** in my department [rated on a scale 1 (strongly disagree) to 7 (strongly agree)]

- **UCLH**: 5.7
- **NHNN**: 6.0
- **CW**: 6.3
### Conclusions

<table>
<thead>
<tr>
<th>Measures</th>
<th>corridor</th>
<th>&gt;</th>
<th>racetrack</th>
<th>&gt;</th>
<th>duplex</th>
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<tbody>
<tr>
<td>Intelligibility</td>
<td></td>
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<td>Duration of Activities</td>
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<tr>
<td>Duration of Conversations</td>
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<tr>
<td>Walking Distance</td>
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<tr>
<td>Hierarchical Culture</td>
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<tr>
<td>Teamwork</td>
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<tr>
<td>Communication</td>
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</table>
Conclusions

These results are based on 3 case studies and more cases are required to verify the results.

The traditional ward typology classification may not be the best predictor of healthcare outcomes. We will continue to explore spatial layout metrics similar to visibility because such a refined method will allow us to compare three different racetrack typologies. This may lead to a different ward classification which is not based on pure architecture shape.

Healthcare outcomes are influenced by multiple factors which should be taken into account.
WHAT DO YOU THINK?

Can this evidence be used to inform future design guidelines?