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# Pathways, Practices and Architectures: Containing Antimicrobial Resistance in the Cystic Fibrosis Clinic (PARC)

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Findings Report  
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## Contents

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Questions and objectives	4
Why cystic fibrosis and building design?	5
Methods	6
Key themes:	
'Segregation' and 'cohorting'	10
Journeys through the hospital: entrances and arrivals	12
Architectures of interaction: the atrium / lobby	15
Circulation spaces	17
Waiting	19
Flows and movement in and through the CF clinic	21
Handwashing - wash basins and hand sanitisers	22
Air: atmospheres and window design	23
Storage, fittings and equipment	26
Pre-antibiotic, antibiotic and post-antibiotic: The co-design of an exhibition	29
Summary of design issues	34
References	36

# Questions and objectives

*Pathways, Practices and Architectures: Containing Antimicrobial Resistance in the Cystic Fibrosis Clinic (PARC)* has compared different approaches to managing antimicrobial resistance (AMR) in the design, practices and architectural layout of three cystic fibrosis (CF) clinics. CF is one of many life-threatening respiratory conditions characterised by frequent infections and antibiotic treatment. Antibiotics may suppress infections without eliminating them, giving rise to resistant cross-infection between people with CF. Prevention increasingly depends on attempts to build containment and segregation (of people and pathogens) into the practices and material design of CF clinics. And yet, there are significant variations in the way lung infection clinics perform segregation and containment within the transitional space of the built environment. Clinics therefore have much to learn from each other, and much to offer the wider clinical community in limiting AMR.

PARC has asked the question: ***how are attempts to limit AMR through containment and segregation differently designed, performed and redesigned within outpatient lung infection clinics?*** Our primary objectives in this study are:

## ■ **Objective 1: Spaces and practices**

To make visible the competing design priorities around AMR of different key stakeholders including people with CF, clinicians, designers, hygiene personnel, asking: What is the policy history of segregation and containment in the CF built environment? How has the mitigation of resistant cross-infection evolved over time? What is the past and present architectural layout of the built environment in each clinic? What are the perceived challenges faced in designing AMR mitigation into clinics?

## ■ **Objective 2: Pathways, journeys and flow**

To comparatively map the differing 'real world' pathways and journeys through each clinic. To make visible discrepancies between material practice and what is intended. This involves an exploration into the way physical interaction, contact and exchanges are configured by the temporal and spatial layout of the clinics, asking: How are routes and pathways through the clinics materially controlled, restricted and resisted? How are clinics differently travelled and narrated? How are 'hot spots' of infection risk identified and resolved? How is AMR mitigation spatially and temporally performed?

## ■ **Objective 3: Imagining redesign**

To enable CF clinics and their users by articulating and documenting scope for redesign and constraints on the repurposing of clinical space, asking: To what extent is it possible to create opportunities for collaborative 'reflection and learning' (AHRC AMR call) and potentially disruptive innovation contributing to the mitigation of AMR?

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**Collaborators on the design of the exhibition:** Hamza Oza and Jonathan West, Helen Hamlyn Centre for Design at the Royal College of Art, London

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For information on further developments and publications, see: <http://parcproject.org.uk/>

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## The team



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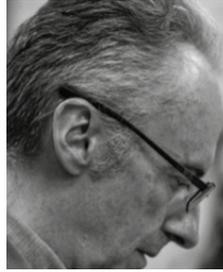
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## Why cystic fibrosis and building design?

The material practices associated with cross-infection control in CF are far from stable and have altered radically over the course of recent decades, evolving in direct tension with the buildings in which healthcare is delivered. Until the late 1980s most people with CF would have been accustomed to spending time together in the same buildings and spaces. Care would have been organised to facilitate interaction, sociability and mutual

support through games rooms, social events, summer camps, holidays and clubs. Having CF would have been organised around an embodied sense of mutual identification with others sharing the same condition and physical spaces. But by the early 1990s, clinical studies had established causal relationships between social contact and the circulation of cross-infectious bacterial 'epidemic' strains, for instance, variations of the *Burkholderia cepacia* complex (*B. cepacia*) such as the ET12 strain of *Burkholderia cenocepacia* (Govan et al. 1993). From the mid-1990s evidence emerged for the spread of transmissible strains of *Pseudomonas aeruginosa* (*Pseudomonas*), such as the Liverpool Epidemic Strain (Fothergill et al. 2012).

Reducing resistant cross-infection in CF and other contexts has therefore increasingly come to depend on rituals and architectures of physical isolation. This includes sophisticated choreographies of social distancing, restrictions on physical interaction and the avoidance of public spaces (waiting rooms, public transportation, lobbies, entrances, elevators and corridors, etc.). Preventing resistant cross-infection has gradually become a question of spatial layout, architectural design, signage, pathways and physical flow. Movement through space (of patients, visitors, clinicians, support workers, devices, etc.) therefore necessitates careful choreography to reduce AMR.

# Methods

The PARC Project used a range of qualitative research methods, including ethnographic and innovative visual approaches. Fieldwork took place across 3 CF clinics between September 2018 and August 2019. It included the development of a physical and virtual exhibition and the dissemination of findings in bespoke co-design workshops across fieldwork sites. Further details are given below.

## Summary of fieldwork:

Fieldwork for the project includes:

- 70 interviews with 55 participants (some took part in both graphic and walking interviews) – 34 hospital staff, 15 patients, 3 family members, and 3 architectural professionals:
  - 45 graphic interviews – mapping routes through buildings and perceptions of 'risky' areas
  - 25 walking interviews – following the routes of staff and patient
- 72 hours of targeted observations – observing 'flows' of staff, patients and equipment during clinics
- 3 co-design workshops – presenting our findings and exploring potential for change with each of the 3 clinics
- Sketch reportage – artist Lynne Chapman created *in-situ* illustrations of patient and staff interviews and walk arounds
- A physical and virtual exhibition presenting our findings, in collaboration with the Helen Hamlyn Centre for Design (HHCD), Royal College of Art (RCA), presented at:
  - European Cystic Fibrosis Society Conference (ECFS);
  - South West Network for Medical Humanities Regional Event;
  - British Sociological Association (BSA) Medical Sociology Conference;
  - The Helen Hamlyn Research Symposium 2019, Royal College of Art;
  - Social Research Association (SRA) *Royal Annual Conference Research Gallery* at the Royal College of Physicians.

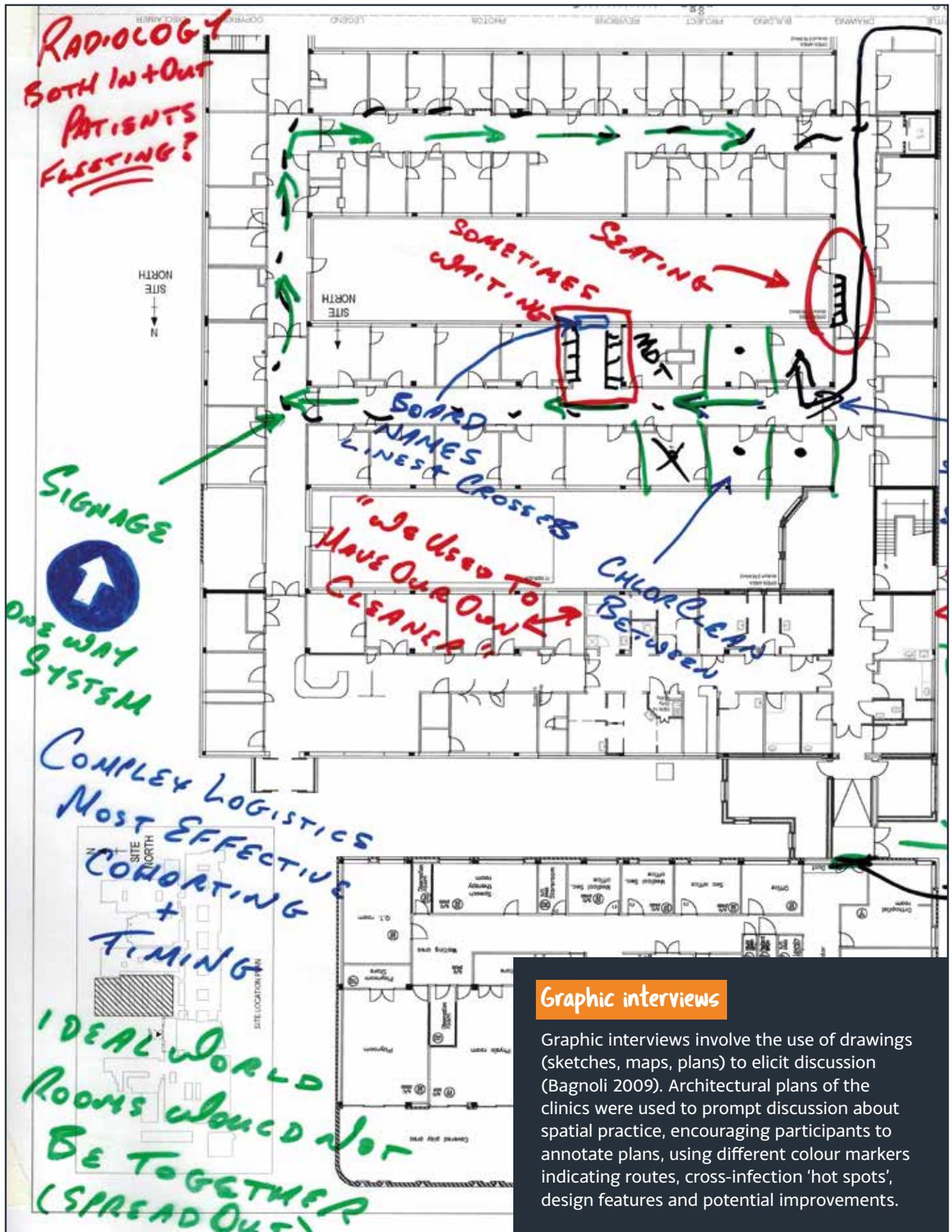
## Ethnographic observations

Ethnographic observations were undertaken in CF outpatient clinics, and in CF inpatient wards that included facilities for 'ad hoc' outpatient appointments. Observations focused on key areas including waiting areas, check-in points, corridors and hand sanitisers. Observations aimed to document the flows of patients, staff and equipment as 'circuits of hygiene' (Fox 1997). Incidental observations took place during visits to each site over a 9-10 month period, and we additionally conducted 72 hours of 'targeted ethnography' (Sage and Dainty 2012) observing the main clinic on separate days designated for different bacterial cohorts at each site (see p. 10).

## Walking interviews

Patients and staff were invited to participate in 'walking interviews', guiding the researcher along their route(s) through the building, and using the built environment as a prompt for discussion. During walking interviews the researcher took photographs to document spaces, objects, signage that the respondent identified as significant.





### Graphic interviews

Graphic interviews involve the use of drawings (sketches, maps, plans) to elicit discussion (Bagnoli 2009). Architectural plans of the clinics were used to prompt discussion about spatial practice, encouraging participants to annotate plans, using different colour markers indicating routes, cross-infection 'hot spots', design features and potential improvements.



## Sketch reportage

Lynne Chapman is an artist who specialises in 'sketch reportage' – capturing everyday life through drawing. She created illustrations *in situ* during interviews to visually record patient and staff narratives and hospital journeys. Long strips of watercolour paper were used to create visual time-lines, and tell the interviewee's story of navigating clinical space and negotiating the practical aspects of cross-infection avoidance. Lynne also documented various clinical spaces, material objects and equipment that featured in interviews. This artwork is being used as part of dissemination in exhibition settings, to visually communicate patient pathways, experiences and concerns with clinicians, designers and researchers.



# Key Themes

Through the analysis of data generated during the PARC project a number of themes were identified. Key themes explored here include: segregation and cohorting; entrances and arrivals; architectures of interaction; circulation spaces; waiting; flows and movement; handwashing; air, atmospheres and window design; storage, fittings and equipment.

## 'Segregation' and 'Cohorting'

Within the constraints of available physical space, segregation within CF clinics involves scheduling clinical appointments at different times, on different days and sometimes in different spaces, thereby preventing different bacterial strains coming into contact with each other (resistant and non-resistant, transmissible and non-transmissible, etc.). Segregation, and therefore the whole patient experience, commences with bacterial diagnosis, and the classification of patients according to the 'bugs they grow':

**“ ... I classify patients according to their bacteria... I would have overall say of who would come to which clinic... We would aim to take a sputum sample ... on a regular basis... if they are not able to produce sputum we will try and get a cough swab... We get those sputum samples and then the laboratory process them and inform us what bacteria they have growing, and then we classify people... ”**

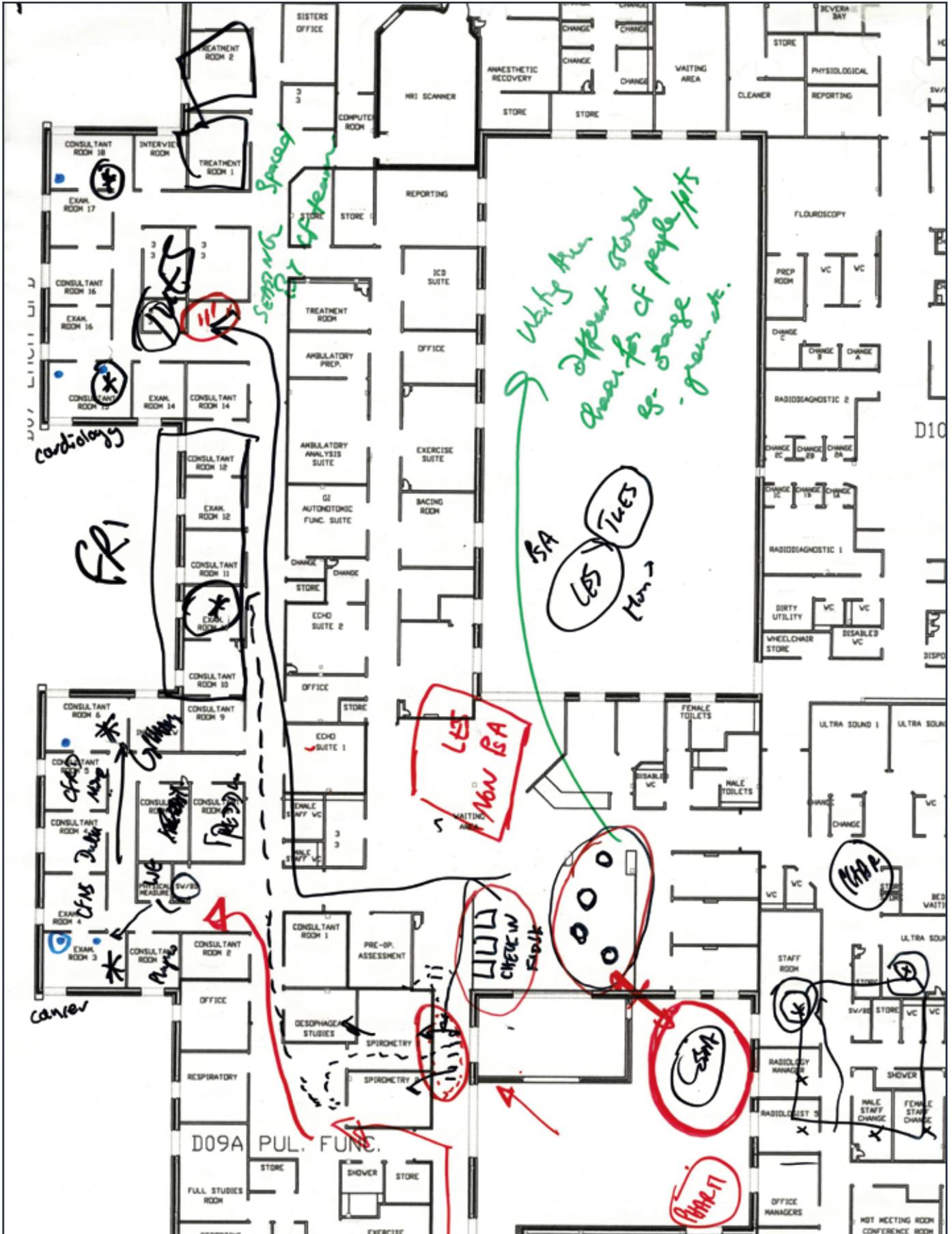
**Ellie<sup>1</sup>, consultant, site 1**

Classification underpins the construction of spatial divisions in hospital environments, facilitating practices of segregation and control (Prior 1992) and therefore shaping the construction of temporal and spatial boundaries between CF patients. Patients are 'cohorted' (Russo 2007) according to the bacteria that they have in common and scheduled to attend the clinic on this basis. In this sense, the bodies of patients and microbes become intricately entangled with one another. Everything depends on what it is that patients 'are growing' or what 'they grow' (CF clinicians).

### Segregation in practice:

The segregation of patients differs across clinics. While all clinics segregate patients infected with *B. cepacia*, cohorting patients with *Pseudomonas* varies: *Pseudomonas*/non-*Pseudomonas* (site 1); chronic *Pseudomonas*/intermittent *Pseudomonas*/*Pseudomonas* free (site 2); segregation of a transmissible strain of *Pseudomonas* (site 3). Two out of three sites segregate patients with non-tuberculous *Mycobacteria* (NTM) such as *Mycobacterium abscessus*, and one site cohorts patients with different variations of the *B. cepacia* complex (e.g. *Burkholderia multivorans*). This is shaped by local factors (e.g. number of patients, availability of clinic space, local strains of *Pseudomonas*), as well as different interpretations of research evidence. Staff report that it is impossible to cohort for all strains of pathogen.

<sup>1</sup> Staff and patient names have been replaced with pseudonyms for anonymity



# Journeys through the hospital: entrances and arrivals

In the design and management of CF clinics, it is important to consider the wider hospital journey. Staff report that they can 'control' what happens in the clinic area, but wider areas of the hospital are hard to monitor and manage.

## Arriving at hospital – vehicle parking and non-visible disability:

Car parks are a source of anxiety for some patients with CF, in terms of queuing for parking meters and touching buttons. Car parks can also bring to the fore issues of non-visible disability and stigma. The walk from the hospital car park to the CF clinic can be challenging for patients who are feeling breathless or unwell. However, patients are often reluctant to use blue parking badges because they 'feel like a fraud'. Patients who use a blue badge report getting 'dirty looks' and comments, and one patient had an unpleasant written note placed on her car. This relates to the invisible nature of CF:

**“** *...it's not something that you can visually see. The looks we get... because she hasn't got a walking stick, doesn't limp, the amount of comments...! But what they don't realise, for her to try and walk 30 metres in cold wind, cold air, it's going to rip her lungs to bits...they judge very quickly.*

Aled, family carer, site 3



## Entrances, doorways and thresholds:

There is an increasing emphasis in healthcare design on creating 'statement' entrances that are welcoming and inviting, breaking down the barriers associated with entering the hospital environment (Coad and Coad 2008, Van der Linden et al. 2016). Anthropologists demonstrate how entrances mark thresholds between safe/unsafe, clean/dirty spaces and can be a source of anxiety for those entering clinical space (Douglas 1966). Some patients are anxious about passing other people (potentially CF patients) in busy hospital entrances, although clinical staff regard these 'fleeting' encounters as low risk.

## Site 1 – entrance and revolving doors:

At site 1, most patients enter through the main hospital entrance. It is a busy entrance with lots of people waiting nearby. Some patients are worried about walking past smokers gathered outside the entrance, which can exacerbate difficulties with breathing. The revolving doors are also a concern because they necessitate entering an enclosed environment, and for people with CF, entering a warm environment from the cold can trigger a 'coughing fit'.

## Design features that improve the patient journey:

The CF outpatient services at site 2 are based in a small 1990s-built day clinic outside the city centre, originally the site of an infectious diseases hospital, built in the early 1900s. Patients report positive feedback about the building, and the hospital journey, which reflects certain features of the design and location:

- **Parking** – availability of parking spaces near the outpatient hospital.



“ I know different ways in and out of the hospital... but it's advertised as the main entrance and the only entrance... That's where I feel that the

biggest risk is for me, because you literally don't know who is in that area. And there are turnstiles and it can be busy, it's busy all the time, so I'm more wary - maybe

not of people that I see, but people who may have used it.  
Neil, patient, site 1

- Ease of access - the building is all on one level, with no lifts.
- Short journey - from the entrance to the CF clinic area, which reduces the stress and anxiety associated with hospital journeys.
- Wide corridors - next to the CF clinic, which reduces the risk of patients passing close to one another, and also allows room for the movement of trolleys and equipment.
- Surroundings - green surroundings and sense of 'fresh air', which has implications for feeling able to breathe - as one patient said 'the air feels nicer here.'



- Non-institutional - patients report that hospital does not 'look like a hospital' or 'smell like a hospital'.

“ ..there's a feeling of safety attached to this place. It's as much about the building as it is the team really...it's on the flat, it's very close to where you park the car...it's just really accessible.  
Amy, patient, site 2

## Reception desks / checking in:

Reception desks can be a point of congregation and queuing - CF clinics manage this through different strategies, depending on what is feasible for their clinic size. Site 3 has self check-in machines. At site 1, a small clinic, staff use text contact with patients to coordinate check-in. However, some patients

still assume they should report to the main outpatients check-in desk. This confusion is reinforced by general outpatient staff and posters directing patients to the main check-in desk. It can be challenging for patients to explain what CF is, and that they have been instructed by the CF team not to check in. This illustrates the importance of a shared awareness of CF throughout the hospital.

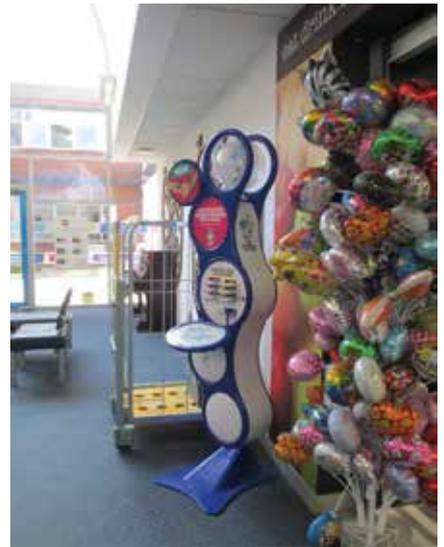
**“** If there's six [outpatient] nurses, I mean I'm not going to stand and explain to each nurse...When I do explain it to them, some of them look like they don't even know what that [CF] is. You know, so it's a bit of a tricky one. I just do as I'm told. You can't expect everyone to know what's wrong with you, they deal with hundreds of people a day I'm sure.  
**Karl, patient, site 1**



# Architectures of interaction: the atrium / lobby

Healthcare design is increasingly incorporating architectural features from retail and hospitality industries (Martin et al. 2015). Shops and cafes feature prominently in hospital atriums, creating spaces of sociability, and helping to induce a sense of 'normality' (Douglas and Douglas 2005). However, for CF patients and staff, social spaces are a source of anxiety, due to the potential for unknowingly sitting next to another CF patient.

Patients describe waiting in the hospital atrium – sometimes because they have arrived early for clinic, or they need to rest after their appointment, or to wait for a lift home. These areas can be very crowded, so patients use various strategies to create distance from others, who could potentially be other CF patients, or may have other harmful pathogens.



## Creating a safe 'bubble' in public space:

Tina sometimes has to sit in the busy hospital atrium to rest before or after clinic, or to wait for a prescription. She utilises the material environment to create a safe 'bubble', placing everyday objects around her seat to make an 'invisible barrier' :



*...it's just being in your own bubble...if you imagine sitting in a waiting room, and I've got my sandwich and my drink and my crisps and I've got my phone, and you draw a circle round, that's like your safety boundary, and if no-one crosses that you're alright. You've got that invisible barrier.*

Tina, patient, site 1

This reflects other research on social interactions, in which people use the placement of everyday things (bags, newspapers) to create privacy in public (Buse and Twigg 2014). Here these strategies are used to reinforce bodily boundaries to mitigate cross infection risks.

## Cafe spaces

Cafes are a source of concern for staff as a space where CF patients could potentially congregate, and might unknowingly sit close to one another. However, patients sometimes use cafes as an alternative waiting area away from the clinic. As part of strategies for maintaining distance from others, sitting at a table means patients feel they have more control over who they sit with.





# Circulation spaces

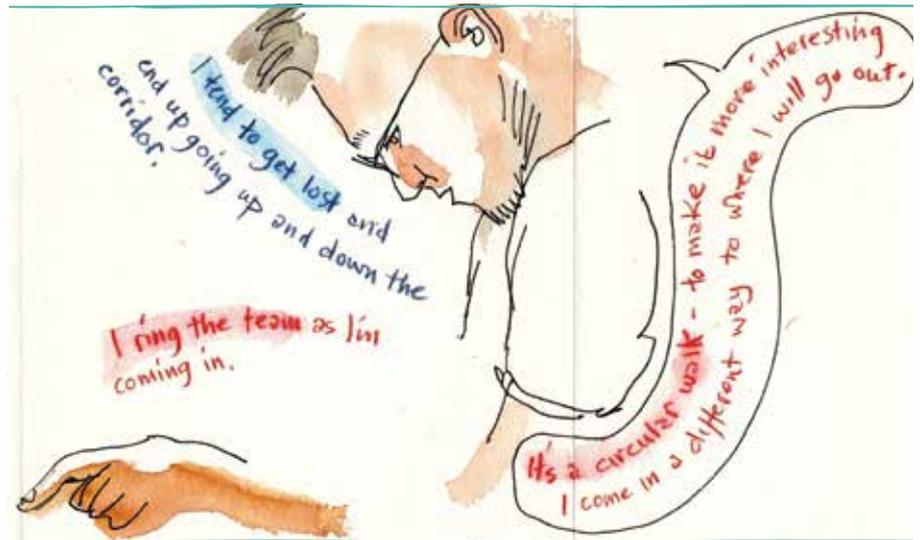
Circulation and communication spaces include hospital streets, corridors, lifts, stairs – spaces that provide access between hospital departments (Department of Health 2013a). In sociological literature they are regarded as liminal or ‘in between’ spaces that encourage movement and flow, but can also facilitate informal and chance encounters and interactions (Iedema et al. 2010). Although in design guidance these spaces are considered with regard to accessibility, they have received less attention in terms of infection prevention or AMR.

## Corridors

Some patients and staff are worried about the risk of CF patients passing or congregating in narrow corridors. As a fleeting encounter this is regarded by clinical staff as relatively low risk, particularly in wide corridors. Evidence is limited, but some research using air sampling has found traces of *Pseudomonas* remaining in corridor areas outside CF clinic rooms (Ferroni et al. 2008, Panagea et al. 2005). Recommendations for hospital design suggest that corridors should be wide enough to allow two users to pass easily, and that corridors for general traffic should be a minimum of 1500mm (Department of Health 2013a). However, this is less than the requirement in the US for a safe distance of at least 6 feet between patients (CF Foundation 2014).

“ *Minimise the distance you minimise the risk. Because obviously you're not walking by as many people. I don't know what other people have got. You know, I could be walking by another CF patient. They say you need to be six foot apart, well you know, them corridors are only just six foot wide...*

Karl, patient, site 1



Corridors are also often crowded with equipment, mobile workstations and notes trolleys. Wide corridors can be helpful for practical reasons, although there are challenges around efficiency, and maximising space for clinic rooms.

## Wayfinding

Corridors are also a challenge in terms of wayfinding (Baskaya et al. 2004). At one hospital (site 1) we observed patients frequently getting lost in the busy outpatient corridors. One patient describes frequently losing his way, sometimes texting the CF team for guidance to the correct area of the hospital:

“ *I always get lost, I always forget what corridor it is... I probably ring and text [the CF team] here and go 'what corridor is it?' Knowing me I will probably spend 5 minutes walking down here, trying to figure out which corridor it is.*

Rupert, patient, site 1

## Lifts

Lifts were described by staff and patients as a ‘risky’ area because they are an enclosed space, and patients entering the lifts from the ground floor do not know if another person waiting for the lift is a CF patient. Segregating lifts is difficult, often because lifts are not always in working order.



## Lifts and the patient journey:

In contrast to the quiet outpatients hospital at site 2 (see above p. 12-13), Amy describes the journey through the teaching hospital (where inpatient services are based) as 'stressful'. She worries about using the busy lifts and being 'trapped in' with other patients, and the lifts frequently break down. As a patient with *B. cepacia* she uses segregated lifts at the back of the hospital, and has to make a journey through another ward which is often locked. This is a 'decanting' ward (used temporarily while wards are being refurbished) so the staff frequently change, and therefore lack awareness of CF. She finds it hard to explain to them about CF and cross infection, and to convey why she needs to cut through the ward. Because Amy has *B. cepacia* she is in a separate ward away from the main CF ward, which she feels lacks the specialist care and facilities available to other CF patients.



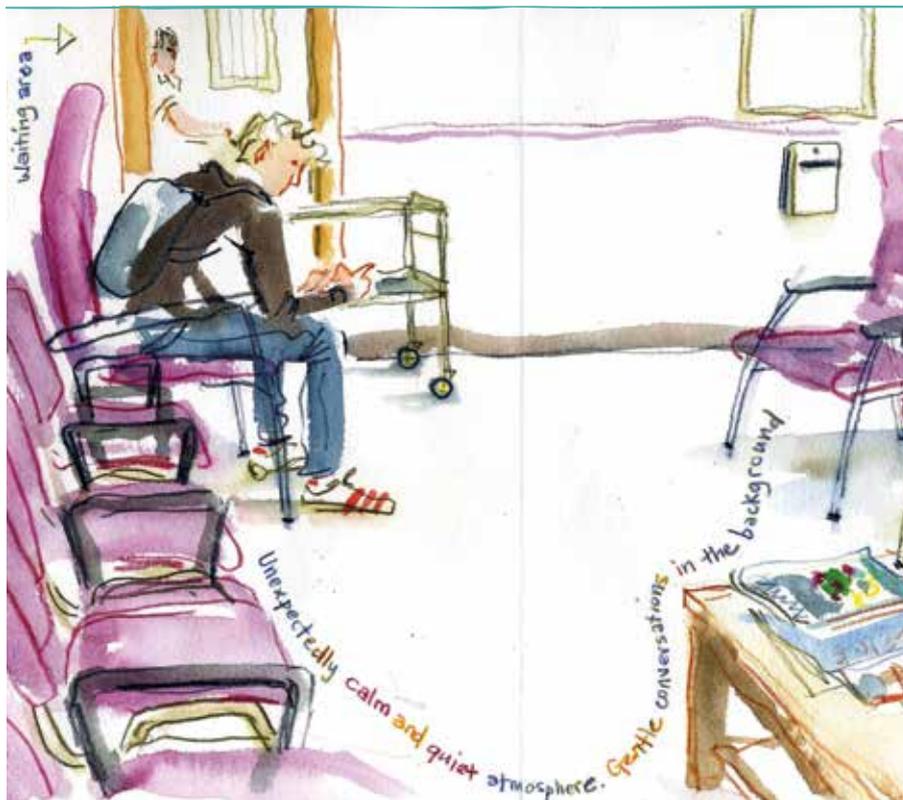
## Touch – lift buttons, handrails and door handles

Some patients are worried about touch and cross infection implications – lift buttons, door handles, push plates and handrails. However, microbiology research suggests that the survival time of *Pseudomonas* on 'dry surfaces' such as door handles is limited (Panagea et al. 2005). Patients use strategies such as putting their jumper over their hand to open a door, avoiding holding the handrail on the stairs, or asking their companion to open a door for them. Having hand sanitisers near to lift entrances and ward entrances helps to reduce these concerns. At one hospital (site 1) the estates department are now starting to roll out 'no touch' door sensors, which are also helpful for accessibility.

“...you are touching the buttons to call the lift, and then you're touching all the buttons on the inside...you cough into your hand, and you've touched the button, and then the other person touches the button. I think that's probably one of the most likely situations that would be a problem.

Abbi, patient, site 2





## Directed waiting:

In site 2, based at an outpatient hospital, there are three separate waiting spaces, and staff direct CF patients to sit so that they are spread out, one patient per waiting area. If these areas are occupied, they encourage patients to wait outside in their vehicle. The location of patients and the order they arrived in is noted on a whiteboard by the healthcare assistant or CF nurse, communicating the flow of patients across the CF team (Riley et al. 2007). This segregated waiting is only possible because of the availability of multiple waiting areas and nearby parking at this particular site.

## Waiting

The hospital waiting room is a liminal space, associated with experiences of ambivalence, anxiety, hope, and frustration (Cohn 2001). In the context of CF, episodes of waiting or having to linger in spaces shared or occupied by others can be an acute source of concern for patients. In graphic interviews using layout plans, clinical staff and patients identify waiting rooms as potentially risky areas.

Outpatient visits often involve the input of numerous specialists, sometimes leading to multiple episodes of waiting (within the clinic, but also at other departments including x-ray, phlebotomy and pharmacy). It is important therefore to ask how 'waiting' in hospital is performed (Strathmann & Hay 2009) and features in the design of AMR mitigation.

The material arrangements of waiting areas can be used to engender either sociability or segregation (Bell 2018). The Tuesday clinic at site 3 has only one waiting area, which is a small alcove in the corridor, adjacent to the clinic rooms. Instead of permanent seating there is a stack of plastic chairs. Before the start of each clinic, staff carefully set chairs out two metres apart, creating some degree of physical distance between patients. The materiality of the chairs is important. One nurse suggested the choice of 'little plastic chairs' is deliberate 'because we don't want to encourage people to be sitting there'. Comfortable seating invites rest (Bissell 2008), while CF clinic staff are keen to keep patients 'moving on'. The use of 'hard and cold' materials incites the 'body-in-waiting' to be 'alert and attentive', ready to move (Bissell 2008, 1705).

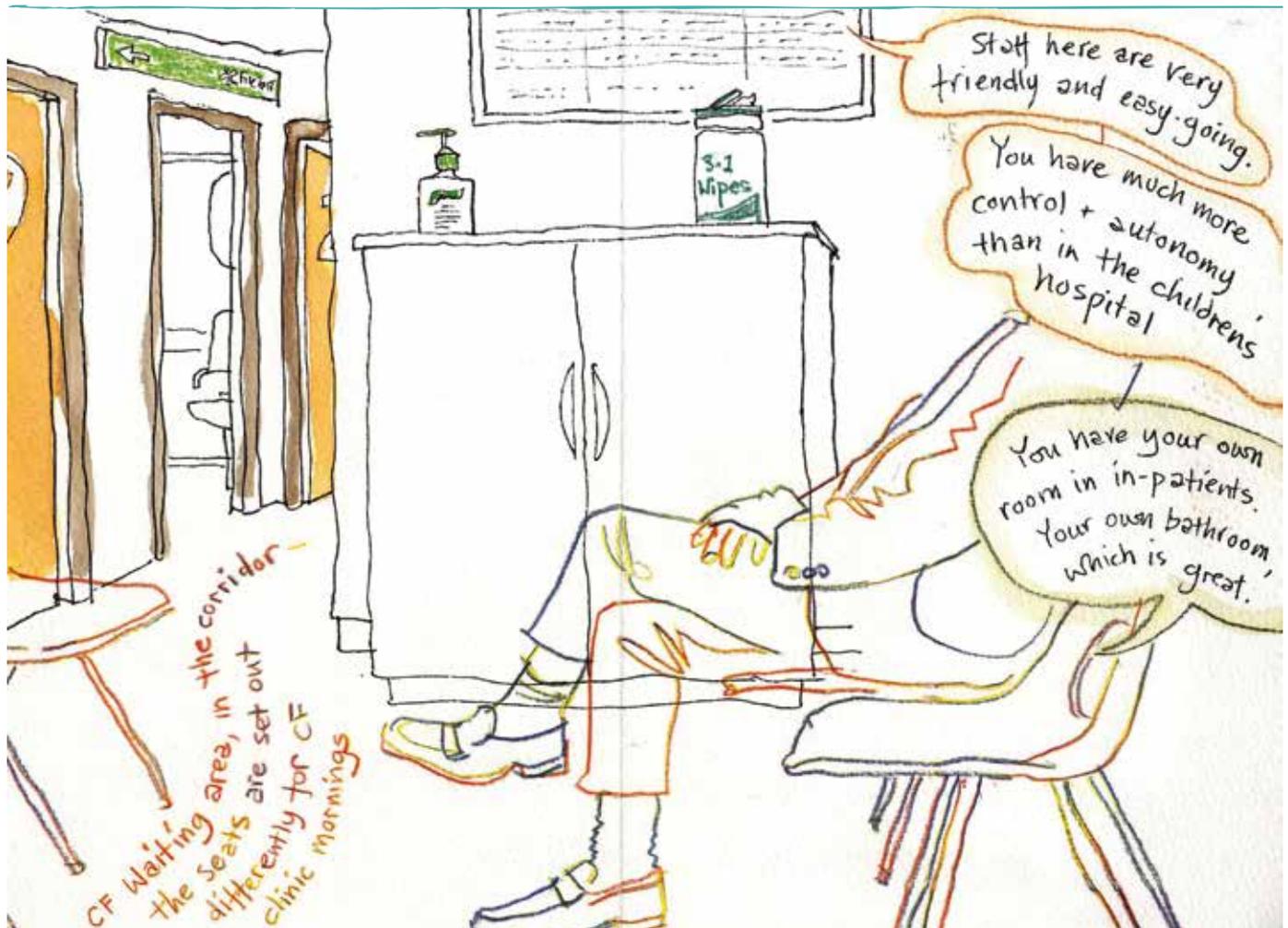
“...the biggest risk is flow... patients hanging around in the waiting areas, that's the issue. Because if you're one of the first seven patients into clinic, you're guaranteed into a room straight away, so that's not a problem. But from patient number eight onwards, they could be waiting any length of time for a room, because if you've got poorly people in...or you've got a glucose tolerance test, which would block a room for two hours...”

Irene, physiotherapist, site 2



## Stigma, waiting and public space:

Although the CF team try to organise appointments to minimise waiting, Isobel, a CF patient, sometimes has to wait in a large waiting room at site 3, shared with the wider outpatient department. She feels stigmatised and visible in this area: 'you get tutts, you get sighs because you are coughing all the time... people will physically move'. She normally comes with her husband which makes her feel less self-conscious. Isobel feels having their 'own CF clinic with its own waiting room' would remove these issues.



# Flows and movement in and through the CF clinic

## Managing patient pathways

Clinical staff actively manage patient pathways to discourage or minimise waiting, physically guiding patients through the building to their appointment, preventing them from 'hovering' or 'congregating'. The layout plans annotated by nurses and healthcare assistants showed movements back and forth, 'looking out' for patients in the corridors to 'guide them' quickly into their clinic room, discouraging them from sitting down.

## The 'carousel'

One technique used in two clinics (site 1 and 2) is referred to as the 'carousel' system, whereby a patient stays in a clinic room and members of the multidisciplinary team (MDT) go in to them in turn. In the smallest clinic (site 1) running outpatient surgeries of around six patients, this process was regarded as relatively unproblematic. However, in site 2 with clinics of up to nineteen patients, staff described the challenges of 'keeping things moving' so patients are seen on time and not 'hanging around'. As one consultant said, you are 'constantly trying to keep up'. Clinical staff expressed different views on the carousel approach - it may reduce the risk of patients crossing pathways, but appointments can take longer. It is also difficult to organise where there is a high number of patients relative to available rooms.

## Time, timing and scheduling

Staff at each of the clinics seek to maintain segregation through the 'staggering' of appointment times, with specific intervals (often fifteen minutes) between patient appointments. However, if a patient arrives late, or just as likely, too



early, they still risk 'bumping into' another CF patient. The meticulous sequencing of patients and their pathogens holds together only to the extent that patients arrive and depart on time, as one consultant at site 3 puts it:

**“ Consultant: So if they all turn up in their allocated time the dance works beautifully. They know they should come at their clinic time. They decide they do not want to come at their clinic time. We negotiate with them when we are booking an appointment, when's best for you, what time are you going to be.**

**Interviewer: But they don't come [on time]?**

**Consultant: Of course they don't. Andrew, consultant, site 3**

Staff at all of the clinics highlight problems with punctuality and timekeeping. However, clinics also run late, for instance, if there are difficulties taking a blood sample, or if a patient needs time to talk through an upsetting issue. Patients describe how on some days, if they are feeling unwell, getting ready and travelling to the clinic 'takes you twice as long' and they appreciate the flexibility offered by CF teams. On the other hand, this flexibility can be in tension with segregation practices.



# Handwashing – wash basins and hand sanitisers

Handwashing practices are regarded as fundamental to mitigating healthcare associated infections (WHO 2009). The placement of alcohol gel dispensers and sinks within buildings has important implications for encouraging regular handwashing (Department of Health 2013b), and for the visible 'performance' of hand hygiene.

## Hand hygiene and the performance of infection prevention

Handwashing is part of performing cross infection prevention (Jackson et al. 2014) – clinical staff said it is important to wash their hands in front of patients, to show that they are 'taking cross infection seriously'. On the other hand, some staff are worried that washing their hands in front of patients (e.g. immediately after shaking their hand) might suggest that the patient is 'dirty'. The visible performance of hand washing therefore has implications for stigma, as well as reassurance.



## Patient biographies and handwashing

During walking interviews, patients frequently use alcohol gels as they are walking through the hospital corridors, and before and after entering wards, or touching lift buttons. Some bring their own alcohol gel with them. For younger patients, this is described as second nature, something that they have 'grown up' doing and is 'routine' or 'automatic'.



**“** ...growing up, dad always said just always sanitise your hands... when you come into hospital, so I just do it ... unconsciously...you come in, you sanitise.

**Rupert, patient, site 1**

Interviews and observations on the CF ward at site 2 suggest that visitors and patients tend to use the alcohol gel dispensers, rather than the sink on the ward corridor. Sinks are sometimes 'halfway down the ward', and as one housekeeper said 'you can get stopped numerous times before you even get to the sink' and then forget. As other studies have suggested, hand washing using alcohol gel is quicker (Pittet 2001), and easier to do 'on the go'. For patients and visitors, using a sink on the ward corridor may be inhibited by a lack of 'ownership' of the space, and feeling unsure if they are 'allowed' to use certain facilities.

### Wash basins – unintended consequences:

At site 2, staff report that following guidance on the importance of handwashing with soap and water for mitigating *Clostridium difficile* (*C.diff*), the hospital trust installed additional wash basins on ward corridors. A microbiologist at the trust said this led to 'unintended consequences', wherein the difficulties of retrofitting the new sinks into the 'ancient plumbing' on some wards created 'dead legs' in the drainage system, which has implications for *Legionella* (Department of Health 2013b). This required further interventions and testing of the water, leading to additional costs.

## Air, atmospheres and window design

AMR mitigation strategies largely focus on tangible objects, surfaces and interactions. However, CF clinics have become increasingly concerned with airborne cross-infection and the design of airflow (ducting, ventilators, windows, airtight doors, etc.). Studies highlight the potential for airborne transmission of certain pathogens, and the importance of good ventilation for improving air exchange rates (e.g. Clifton et al. 2010, Schaffer 2015). This focus on the air also raises important questions about how the unseen threat of air is made tangible in CF clinics through the everyday 'air practices' of staff (Hauge 2013) e.g. window opening and 'resting' rooms between patient appointments (see below).

**“** I just imagine the atmosphere in that room full of bacteria... when somebody's in a room for a long time, and then leaves... and then the next person goes in immediately ... You go in and you breathe it all in.... it's this time between patients and better ventilation I think a lot of the time .... you don't know what they've breathed out. So, we normally just... open all the windows... let it get a bit of air...

**Rachel, physiotherapist, site 1**



## Windows

Most contemporary clinical buildings are hybrid environments with a mixture of sealed and openable window designs. As one consultant describes when complaining about the un-openable windows: 'I do worry that affects the airflow... someone coughs in the room, is that sticking around longer...?' (Rob, site 3). If he requires a patient to produce a sputum sample, he will sometimes send them to 'cough up' in the 'physio room' instead which has an openable window.

When the site 1 hospital was originally built it was possible to fully open its sliding aluminium windows allowing for generous ventilation. However, safety legislation now requires window openings in healthcare buildings to be restricted to 100mm (Department of Health 2013c). This reduces airflow, and can result in an uncomfortably warm atmosphere, increasing the need for air conditioning and mechanical ventilation. This was an intractable problem until the estates department at site 1 came up with the solution of installing horizontal bars on the sliding windows on many of the hospital's wards. This allows the restrictors to be removed and the windows to be fully openable once again, while meeting the regulatory requirements.

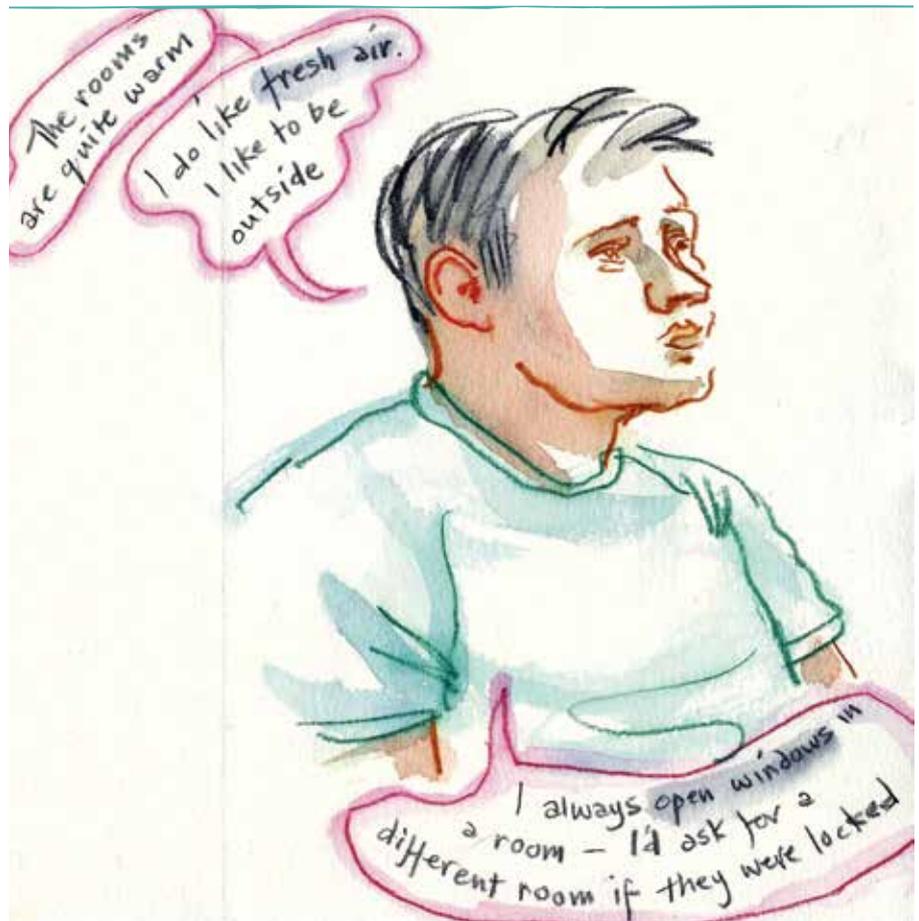
### Patients and the sensory experience of fresh air:

For patients the sensory experience of fresh air is important. Rupert talks about 'his window' in the clinic room, that staff always have open for him when he arrives. The desire to be beside a window was linked to fears about cross infection, and perceptions of hospital air as 'dirty'. For him, 'fresh air' is associated with 'freshness' and 'health' and the sensory enjoyment of air blowing through the room. Participants also talk about being near an open window as a 'lung thing'. CF makes people feel congested, so it is about feeling 'able to breathe'. However, this is limited by window restrictors in hospital buildings (see below).



*'I don't like hospitals; I'm big on fresh air, so any room I will always go nearest the window...they're [CF team] always so nice about opening it, because they know what I'm like...they know I like the air.'*

Rupert, patient, site 1





### 'Resting' rooms and 'settling' the air

Managing the risk of airborne transmission is entangled with the choreography of appointment timings. Where possible rooms are 'rested' between appointments to ensure 'there was no contamination in the air' (nurse, site 1). Staff at site 3 operate a 'forty-five-minute rule', leaving longer (several hours) between patients with certain bacterial strains.

### Nebulised antibiotics

Air can carry nebulised antibiotics, with implications for antibiotic resistance. Expiratory filters are recommended when using some nebulisers to prevent environmental contamination, and stop people nearby from breathing in the antibiotic (Daniels et al. 2016). However, the 'correct' use of nebulisers in the domestic environment is a contested aspect of 'patient compliance' (see also Prout 1996). Although physiotherapists advise patients on using filters, they are unsure if patients use them correctly when they are at home.

Studies also highlight issues with adherence when using nebulised antibiotics (see CF Trust 2017a). Some patients describe difficult experiences with using nebulisers, for instance, Tina (patient, site 1) told us how she felt traumatised by the experience of nebulised antibiotic treatment in childhood. The device was, she said, a big noisy 'black machine' with ventilation pipes trailing out of the window. This remains a source of anxiety for her.



## 'Dirty air':

On the CF ward at site 2 patients and staff won't open the windows facing the front of the building because it is directly above a spot near the hospital entrance where patients gather to smoke. The hospital has put notices up asking people not to smoke, and erected a shelter to draw people away from the main entrance, but both measures are largely ineffective. Patients talk about the smell rising and the implications for being able to breathe. Air practices as part of cross infection management are situated within local constraints and the entanglements of buildings and everyday practices, as well as the wider context of funding constraints in the NHS.



*'If you are in one of these three rooms here...this is your entrance [below].... so everyone like hangs out here, smoking... I won't have my windows open if I'm in there, because the smoke just comes up...'*

Abbi, patient, site 2

## Storage, Fittings and Equipment

Department of Health (2013b) guidance stresses the importance of adequate storage for infection prevention. However, clinical staff, cleaners and infection prevention personnel report that there is 'never enough storage', particularly on inpatient wards. Architects and estates managers say that storage often gets cut during the design process, to make room for other facilities or design features. This creates 'clutter', with equipment stored in corridors, bathrooms, stairs and gyms, and means that areas are harder to clean and maintain. Clutter can be defined as 'matter out of place' (Douglas, 1966), disorderly objects that 'disrupt the flows of everyday life' (Cwener and Metcalfe 2003).



*...you never have enough storage. Seems to get sacrificed, and then when you move in, you get clutter...it's difficult to keep places clean*

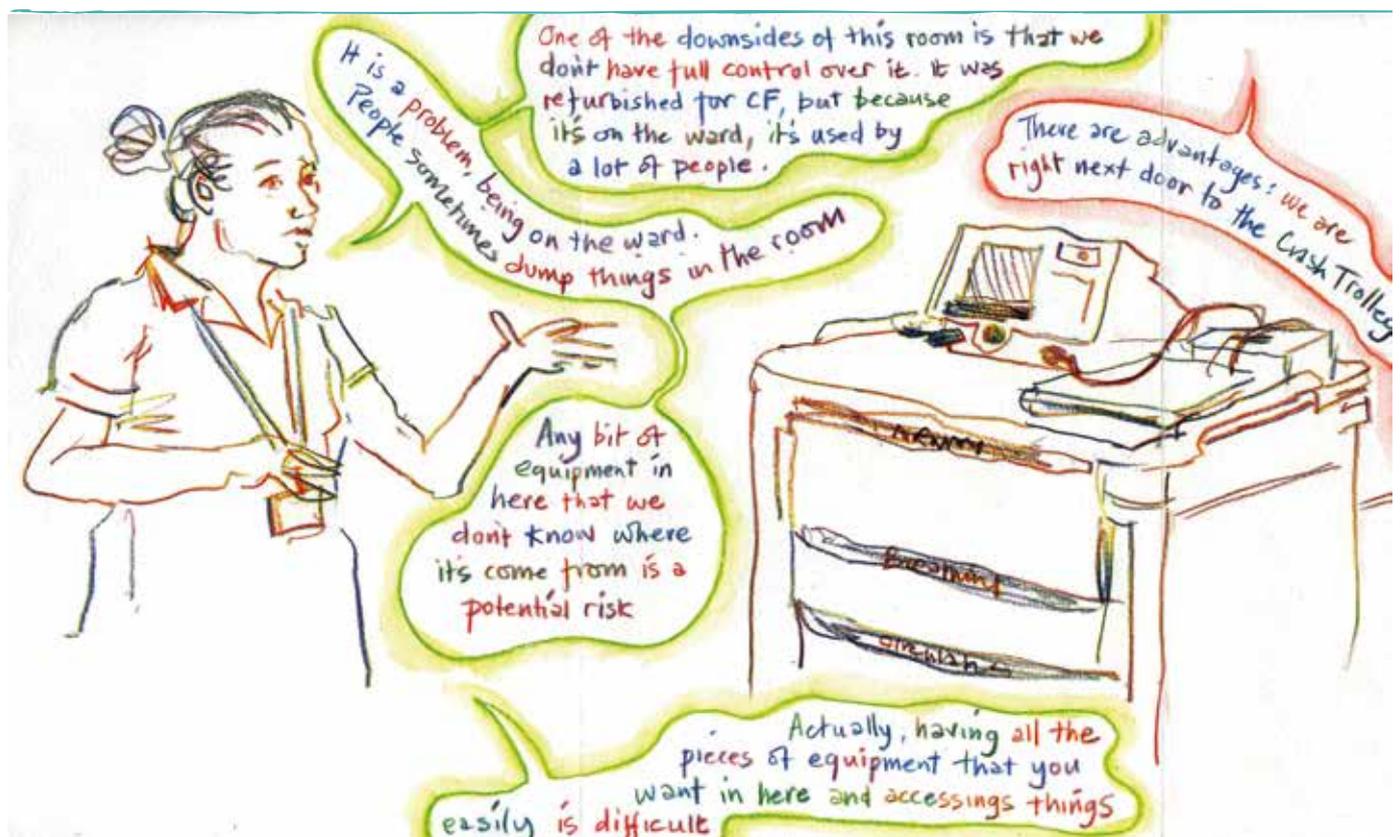
Ivor, microbiologist, site 2



## Storage, control of space and 'stray' equipment:

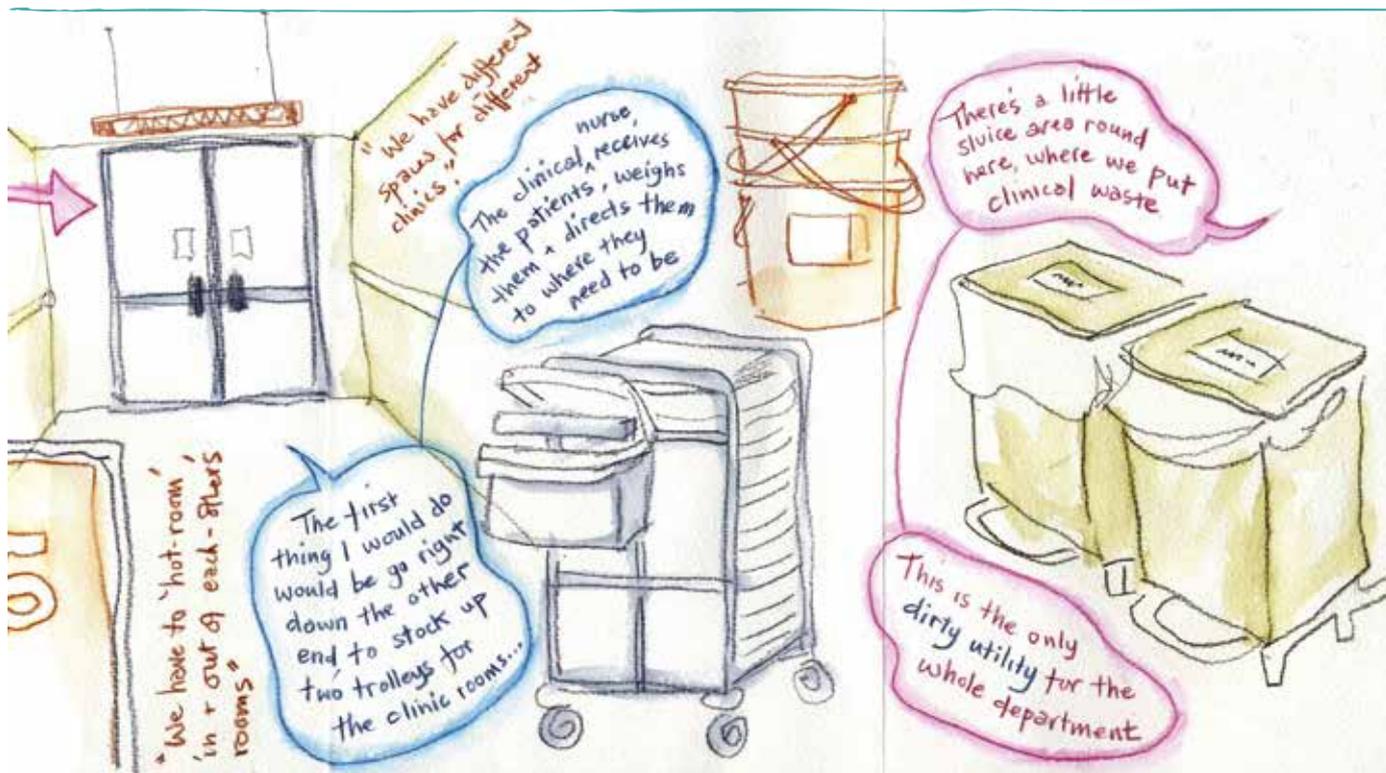
Site 1 do not have their own CF unit or ward. CF inpatient facilities, and an outpatient room for 'ad hoc' appointments are situated on a busy respiratory ward. Storage on the ward is limited, and sometimes the team find that other people's equipment (drip stands, trolleys) ends up in their outpatient room. This is an issue in terms of cross infection, because they do not know who has used the equipment or whether it has been cleaned.

The clinical team also feel that more storage would enable them to have additional physio equipment (e.g. an additional exercise bike). This would mean that patients do not have to wait their turn to use exercise equipment in their inpatient room, and also allows more time to rest and clean equipment between patients, in keeping with recent CF Trust (2017b) guidance for NTM.



## Storage and managing flows of clean and dirty materials:

In site 3, there is only one equipment store and one sluice at the far end of the outpatient department. Nurses and physiotherapists start their day by walking down to the end of the corridor to stock up their trolleys. This has implications for staff time and efficiency – as one member of staff said there is a lot of running 'backwards and forwards because someone might need something that you find isn't on your trolley.' This is a shared outpatients department, so control over the space is limited. Some of the consulting rooms do not have clinical waste bins, which means that staff have to walk down to the sluice at the far end of the corridor to dispose of clinical waste. Staff were concerned about the implications of this for cross infection.



### Competing discourses of design – home/hotel/hospital

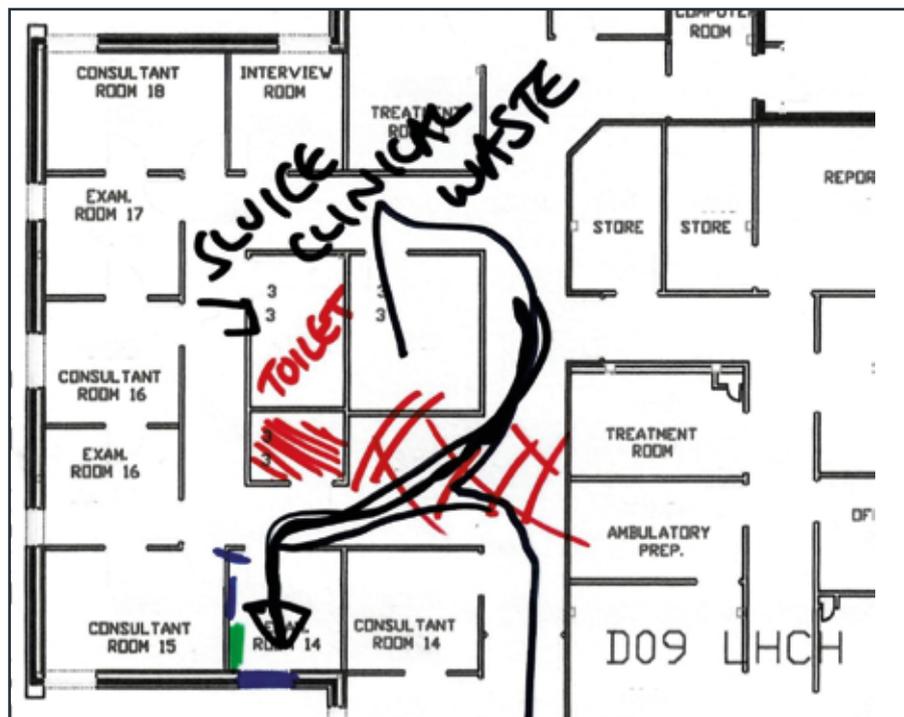
Tensions around storage, fittings and equipment reflect competing design models of home/hotel/hospital (Buse et al. 2018, Martin et al. 2015). Being able to bring belongings from home is important to CF patients for making their inpatient room 'homely', but can mean it is more difficult to clean.

At site 3, the redesign of the outpatient department and the CF wards was influenced by the hotel model of design, with the design brief suggesting the space should 'look like a hotel, but function like a hospital'. However, some cleaning staff and estates managers feel that the hotel image is not in keeping with materials and fittings that are durable and easy to clean. One example involved the use of stainless steel fittings in bathrooms – these fittings soon became rusty, preventing them from being properly cleaned.

“ So we go on all the project groups and advocate for types of material. Sometimes we're listened to, and sometimes we are not. We do need materials to be washable, not wipeable. It's a hospital, it's not a hotel. And

sometimes, as much as we want it to be lovely and everybody to be comfortable, there is that safety aspect that if we can't clean it correctly then there's an issue.

Helen, domestic services manager, site 3





## Pre-antibiotic, antibiotic and post-antibiotic: the co-design of an exhibition (PAD)

# Pre-antibiotic, antibiotic and post-antibiotic: the co-design of an exhibition (PAD)

## Objectives

The objectives of the PAD project were to design and develop a physical and virtual exhibition to visualise and communicate findings from the PARC project, and to encourage knowledge exchange across different audiences (architects and designers, CF clinicians and other healthcare practitioners, researchers, patients and families). A key challenge was creating an exhibition that is accessible to people living with CF, in light of cross infection issues which mean they are unable to attend a physical exhibition. The virtual version of the exhibition enables us to communicate the project findings to people living with CF, and translate them to a wider audience.

The exhibition highlights how practices of segregation and infection prevention vary across clinics, and over time historically. The exhibition aims to facilitate dialogue around current design and practice, and explore potential for change, drawing on past, present and future examples of design for mitigating cross infection and AMR. Both the real and virtual exhibition include building models of CF clinics and hospitals for infectious diseases.

The models illustrate movement and flows through these buildings using pathway animations, and highlight key design features or challenges through vignettes and examples from the PARC research.

## Physical exhibition

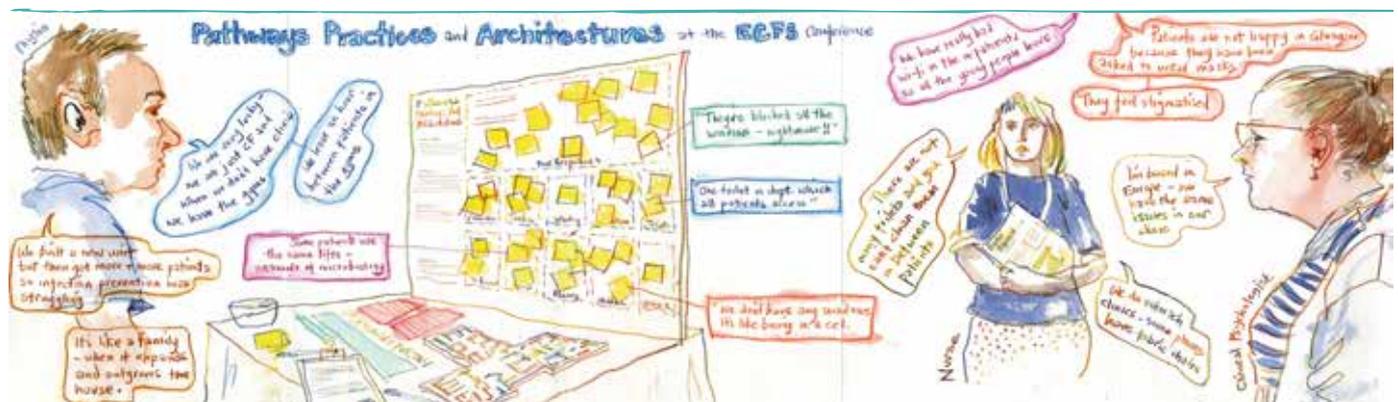
The physical exhibition included two building models onto which pathway animations of flows, and quotations and visual images from the research were projected. Lynne Chapman's artwork was integrated within these animations, and her concertina sketchbooks were also displayed separately as part of the exhibition. The exhibition included a backdrop displaying questions and issues for discussion, where visitors were encouraged to add post-it notes, sharing their own experiences. Lynne also sketched 'live' next to the exhibition, to capture discussions, and draw visitors to the stand.

The exhibition was presented at key events across the UK and has been seen by an estimated 2000 visitors combined. These were:

- European Cystic Fibrosis Society Conference (ECFS)
- South West Network for Medical Humanities Regional Event

- British Sociological Association (BSA) Medical Sociology Conference
- The Helen Hamlyn Research Symposium 2019, Royal College of Art
- Social Research Association (SRA) Annual Conference Research Gallery at the Royal College of Physicians.

Visitors to the exhibition included: cystic fibrosis clinicians (nurses, physiotherapists, consultants), relatives of people living with CF, representatives of third sector organisations, designers, microbiologists, researchers and academics. The exhibition acted as a prompt for discussion, encouraging visitors to share experiences, and describe similarities or differences from their own CF clinics. Participants commented on the way the models helped to visualise the spaces and interactions in the research, through the use of pathway animations. As one visitor (historian) to the stand said, architectural plans can be 'difficult to interpret' and the models 'really help bring the building plans to life'. Another visitor (medical sociologist) remarked that it is 'it is far more powerful to see the findings in a visual way'.





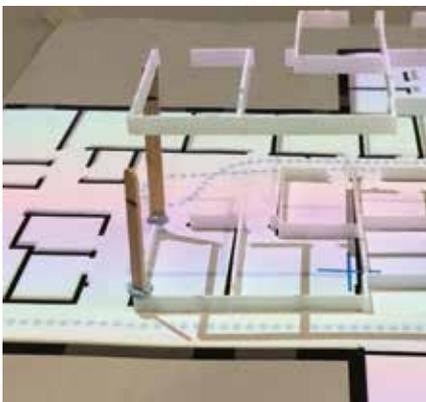
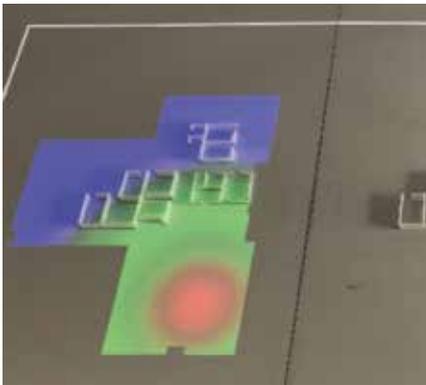
**Physical exhibition development and setup:** The exhibition designer Hamza Oza created sketch models and prototypes, experimenting with different ways of constructing the building models and projecting images and pathways, testing out the interplay of different structures with light and shadow. The final



setup equipment for the physical exhibition included a projector-mounted system, flatwork, models and accessories. Keynote templates were created for the animations. These were mapped onto laser cut models allowing additional edits and updates. The result is a flexible and portable



suite of exhibition materials including five framed panels displaying the artwork of Lynne Chapman. This can be used for ongoing dissemination beyond the project, for instance, for display in the hospital environment or additional exhibition spaces and conferences.



## Virtual exhibition

The virtual exhibition is an interactive platform, which includes examples of 'past, present and future' design for mitigating infection and AMR. There are three models of 'present' CF clinics, based around the design issues, practices and challenges in the three clinics where our research took place. The platform also includes 'past' and 'future' design models of hospitals for infectious diseases. The virtual exhibition enables the visitor to 'walk through' these spaces, and click on 'hot spots' illustrating key design features and challenges. It also includes a 'participate' tab, with a short survey where CF clinicians, relatives and patients can take part in and share their experiences, creating opportunity for ongoing dialogue and knowledge

exchange. This interactive resource can potentially be used for the continuing professional development of architects and practitioners beyond the life of the project.

The virtual exhibition is accessible both on mobile devices and a standard PC interface. It will be made available via the PARC website <http://parcproject.org.uk/>.

## From the Pre-antibiotic to the post-antibiotic

The intellectual background to the exhibition materials is drawn from a historical analysis of the relationships between healthcare architecture, infections, the availability of antibiotics in the second half of the twentieth century, and the more recent AMR crisis (Brown et al 2019).

## The 'Pre-antibiotic era'

Prior (1992) traces the way miasmatic theories of contagion became architecturally embedded in the classic 'fresh air wards' of the nineteenth century. Maladies are seen to arise from zymotic gaseous chemical processes, the decaying decomposition of plant and faecal substances. Resulting vapours and stagnating fumes must move, be dispersed, circulate and refresh.

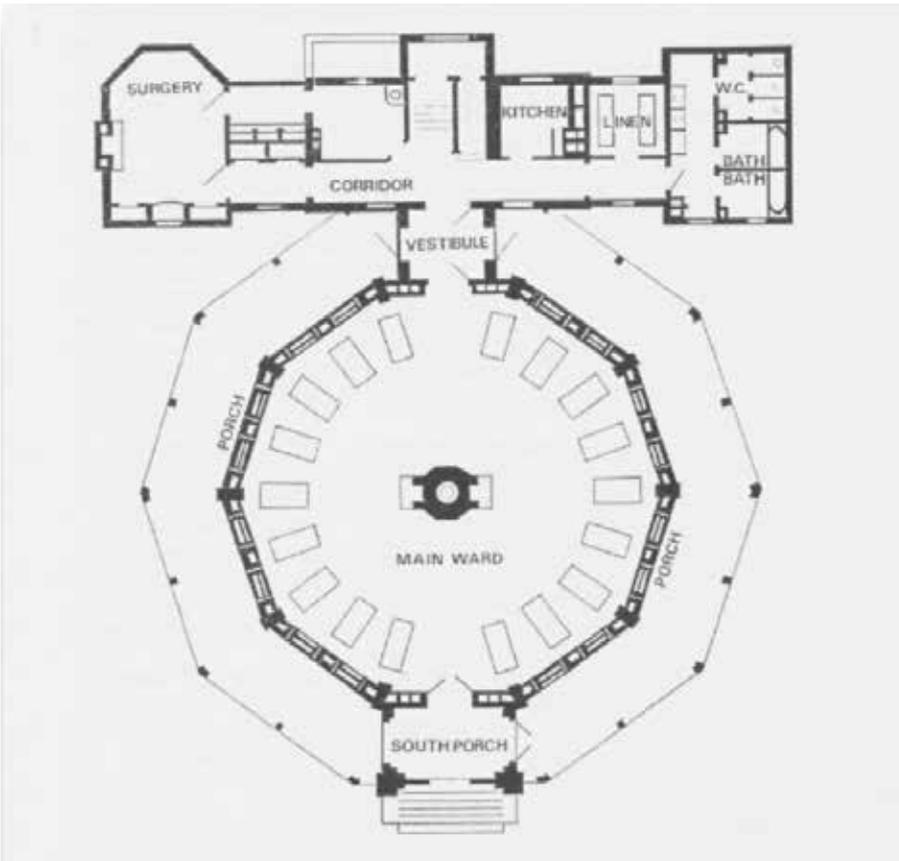
The architectural expression of miasmatic discourse is the 'pavilion' or 'fresh air' hospital. Ventilation is used to separate the bodies of the sick into neatly divided atmospheres. The pavilion ward 'spatially isolated everything from everything by oceans of fresh natural air' (Kisacky 2005, 20). A central fireplace would draw air in to be evacuated up and out at the apex of a vaulted roof. Beds would be wheeled outside to surrounding balconies and gardens for 'air bathing' (Gauvain 1933). The classic Nightingale ward would be south facing, glazed floor to ceiling. Well into the mid-twentieth century, 'fresh air cure' architectures were the mainstay of tuberculosis treatment in the 'pre-antibiotic age' (Jones 2016, 267).

The shift from miasma to germ theory and later the widespread use of antibiotics from the late 1940s articulates with fundamental changes in the configuration of clinical space. Hospital design '... shifted from the pavilion-ward ideal of keeping everything spatially separated to the functionalist ideal of interconnecting spaces in the service of operational efficiency' (Kisacky 2005, 3).

## The 'antibiotic era'

Antibiotics made possible new concentrations of healthcare delivery within ever more efficiently compact architectural designs (Bud 2007). Treating infections with





chemical compounds rather than air and sunlight fundamentally changed the spatial and environmental dimensions of the biotic. Antibiotics became 'infrastructurally' (Chandler 2019) enmeshed in a way of life whereby infections have become a matter for pharmacology rather than aerography. The '... introduction

of drug therapy at the close of World War II' essentially constituted a 'dramatic break' with any semblance of the pavilion atmosphere (Adams *et al.* 2008, 913). Antibiotics arguably meant that hospitals '... turned away from Nightingale's principles, closing their windows and shutting out the sun' (Swain 2013, 35).



### The 'post-antibiotic era'

Over the last decade however, AMR has prompted critical thinking on the interdependence of hospital architecture and antibiotics, and in turn, a renewed attention to the air. A recent Swedish hospital commission describes itself explicitly as an architecture for the 'post-antibiotic era' incorporating spacious isolation rooms and wrap-around fresh-air balconies (Holmdahl and Lanbeck 2013). 'Perhaps we can prepare for the looming post-antibiotic era' writes Swain, 'by taking some lessons from the pre-antibiotic age?' (2013, 35). Kembel *et al.* (2014) point out the relatively ignored inter-connectedness of architectural design and microbial ecology, reframing the buildings as 'multi-species ecosystems'. Natural ventilation through windows turns buildings inside out bringing the external biotic life of the environment into the internal space of the building. There is a growing interest therefore in microbiology on external fresh air as a beneficial means of 're-wilding' indoor atmospheres. Windowless air-conditioned hospitals, it is argued, are overpopulated with pathogens, compromising the healthy biodiversity of building ecology, allowing resistance to flourish uncontested (Smith *et al.* 2013). Perhaps, suggests one commentator, we're coming 'full circle in hospital design' (Escombe *et al.* 2007)?

# Summary of design issues

Areas of concern	Potential design implications
<p><b>Lifts</b> – lifts are an area of concern because they are an enclosed space, and patients entering the lifts from the ground floor do not know if another person waiting for the lift is a CF patient. Segregating lifts is difficult, because lifts are not always in working order.</p>	<p><b>Ground floor access</b> is important in designing new clinics, to avoid problems with lifts.</p> <p>Some clinics have <b>segregated lifts</b>, but this does not always work, as <b>lifts break down</b>, and alternative lifts may be inconveniently located.</p>
<p><b>Toilets</b> – shared hospital toilets are an enclosed space that is often poorly ventilated. One patient may use the toilet after another without realising, creating potential for cross infection. Although clinic rooms may be cleaned between patients, toilets are not.</p>	<p>Some new clinics (e.g. Nottingham) have <b>en suite rooms</b>. However, this is <b>costly to retrofit</b> into existing buildings, and there are resource implications in terms of <b>cleaning</b>.</p>
<p><b>Waiting areas</b> – although clinics try to eliminate or minimise waiting, patients sometimes arrive early or late, and appointments can take longer than expected.</p> <p>There are various <b>points of waiting throughout the hospital journey</b> that are hard to manage e.g. <b>pharmacy, phlebotomy, X-Ray</b>, or waiting for transport by main entrances.</p>	<p>Some new clinics are being designed <b>without waiting areas</b>, but it is difficult to remove waiting from the hospital journey.</p> <p>At site 2, <b>segregated waiting areas</b> (one patient in each waiting area) are used to manage the risk of waiting.</p> <p>Site 2 has a <b>'priority' system in X-Ray</b> – appointments are booked electronically, then CF patients are given a paper priority ticket to hand in.</p> <p>Approaches used in other European CF centres to manage queuing in <b>pharmacy</b> include: an <b>electronic order system; texts</b> when prescriptions are ready; a <b>segregated waiting area</b> in pharmacy for individual CF patients (although this might not work for larger clinics); <b>home delivery</b> of prescriptions.</p>
<p><b>Entrances and Exits</b> to wards or hospitals are points where pathways can cross. Patients express concern about waiting to be buzzed onto a ward, touching buttons, door handles, or proximity with other patients in entrances with revolving or double doors.</p>	<p>Some clinics in the UK have a one-way system, where signage directs patients to come in and out via separate routes. However, people do not always move through buildings as directed, and may just <b>take the shortest route</b>.</p> <p>An infectious disease hospital in Malmo, Sweden has separate entrances to each inpatient clinic room from the outside of the building. However, this is <b>challenging to retrofit</b> into existing hospital buildings, and has <b>implications for security and maintenance</b>.</p>
<p><b>Lack of storage on wards</b> means that other spaces have to be commandeered to store equipment (e.g. bathrooms, gyms, corridors, stairs) and can become <b>'cluttered'</b>. For cleaners, this makes their job more challenging, with implications for mitigating cross infection.</p>	<p><b>Adequate storage space</b> being built into the design of inpatient and outpatient services.</p> <p>Storage is often cut in the design process.</p>



Areas of concern	Potential design implications
<p><b>Ventilation</b> – outpatient CF areas (and sometimes inpatient wards) in our study do not have specialist ventilation, although most clinic rooms have openable windows.</p>	<p><b>Negative air pressure</b> is recommended for the design of inpatient facilities to manage the risks of NTM (CF Trust 2017), but the <b>cost can be prohibitive</b>, and clinicians expressed different views about the relative benefits.</p> <p>Patients enjoy the <b>sensory experience of being next to a window</b>, but sometimes windows cannot be opened in rooms overlooking outside areas where people smoke nearby.</p> <p><b>Regulatory requirements for window restrictors</b> in hospitals (e.g. see Health Building Note 00-10) limit window opening. At site 1, the estates department had created a 'work-around', with horizontal bars on windows set out 100mm apart so large sliding windows could be opened fully, while meeting regulatory requirements.</p>
<p><b>Corridors</b> – patients and staff are concerned about the potential for pathways crossing in narrow corridors, particularly if patients come in and out the same way. There's also a lot of equipment (trolleys, observation machines, mobile work stations) that has to fit into and move through corridors</p>	<p><b>Wide corridors</b> are important to avoid close proximity between patients, and to accommodate equipment and trolleys.</p> <p>Are there ways of reducing the journey from the entrance to the CF clinic room, to limit the risk of patients passing?</p>
<p><b>Cafés and restaurants</b> – staff are concerned about patients using cafés and the potential for queuing or congregating together. However, patients are often careful when visiting cafés to sit at a distance from other people, and to avoid busier times where possible.</p>	<p>Site 1 uses <b>food vouchers</b> to encourage patients to use the larger <b>canteen, rather than the coffee shop</b>, which is more spacious, with tables and chairs spread out.</p> <p>Specialist CF clinics are being built <b>without café areas</b>, but patients might still use the cafés in the main hospital.</p> <p>Being able to access refreshments can make outpatient hospital visits <b>more pleasant and 'hospitable'</b> for patients and relatives – is there a way to provide this while avoiding the risks of shared café areas?</p>
<p><b>Parking</b> – patients report difficulties accessing nearby parking spaces, and negative responses when they use blue badges, due to the 'invisible' nature of CF. This is particularly challenging for patients who visit their CF clinic alone. Parking during long inpatient stays can be expensive. Touching buttons on parking meters was also a concern for some patients.</p>	<p>Site 1 offers stamped parking permits to CF patients for free parking.</p> <p>Site 2 has three dedicated CF parking spaces for inpatients, but there is still a lot of competition for parking.</p>



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