8 The Uncertain Future of Antibiotics

Navigating Bacterial Presence in Hospitals amidst Antimicrobial Resistance

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Introduction

In recent years, antibiotics, one of the key pharmaceuticals of modern biomedicine, are increasingly a scarce good: rising resistances to the common substances and a dry antibiotic pipeline—a stalled development of new antibiotics—configure infrastructural uncertainties: the massive and far-reaching reliance on antibiotics for the function of not only modern biomedicine and but economies, security and modernity itself shape grim visions of a future without effective antibiotics (Landecker 2016; Chandler 2019).

In my research on antimicrobial resistance (AMR) in hospitals, I follow the uncertainties clinging to antibiotics and ask what this means for hospital staff in their everyday encounters with bacteria, infections, and growing resistances to antibiotics. Particularly, I look at hygiene practices as the old-fashioned and odd companion of the antibiotic era and argue that these practices play a central role in meeting and managing antibiotic uncertainties in times of AMR. Aligned with the volume's inquiry of how "hope and uncertainty take on particular meanings in the policing and managing of health, illness and wellbeing" I explore how hygiene practices shape the management of microbial encounters amidst antibiotic uncertainties. As part of AMR, these uncertainties are met with elaborate practices entailed in what is called hygiene management in German hospitals that give substance to microbiopolitics (Paxson 2008; 2012; 2014), where the governance of microbial presence is a key aspect of caring and managing individual and collective bodies. Approaching AMR through the meaning of uncertainty in the "policing and managing of health" opens a way to explore the multi-faceted nature of AMR: because AMR is a moving subject through scales, spaces and times, uncertainty figures on different layers, each layer telling us something about how we envision acting upon it as a health threat.

On a global scale, the uncertain future of antibiotics as effective substances against infections configures a looming global health issue that is both a present,

but an even more pressing issue in bleak anticipations of a future without antibiotics. Relatedly, on a small-scale, health professionals in hospitals and especially hygiene professionals, build the awareness inside hospital walls that enacts this global health threat in daily practices and ways of doing medicine and healthcare. Here, hygienists embody the large-scale uncertainties of AMR put into practice in daily hospital flows, meeting hospital pragmatics infused by historical, political, economic, and material spheres. Further exemplified on a microscopic level, these uncertainties materialize themselves in the openness of bacterial compositions that can mean so many different things and must be managed accordingly to the hospital environment. Here, hygiene figures as the management of uncertain bacterial presence, or to be more precise, the uncertain processuality of bacterial compositions (which very well might be a deadly one for humans) linking back to the large-scale uncertainties clinging to antibiotics as an effective substance to control these presences.

I want to show how the emerging uncertainties because of resistant bacteria and ineffective antibiotics give rise to hygiene regimes where barriers, walls and borders play a crucial role: hygiene is an ongoing negotiation and oscillation between the inside of the hospital and the outside. I am particularly intrigued by how actors construe "the outside", i.e., the social being and living outside of hospital walls as relevant for hygiene matters inside the hospital, and ultimately, for managing AMR. While hygiene is often assumed to follow universal protocols for sterility and cleanliness, hygiene work encompasses intricate processes of considering various aspects and processes of the "outside" and thus configure and work along localized and local microbiologies (Koch 2011; Yates-Doerr 2017). In this regard, a patient's skin and the hospital's walls both present specific barriers that require complex considerations when enacting hygiene measures. The orchestration of hygiene is thus a delicate, nuanced practice for managing human life alongside microbial encounters.

In the first part of this paper I map the relation between the hygienic hospital and antimicrobial resistance. I follow the historical contextualisation of microbial encounters and shifting epistemologies mirrored in the transformations from Pasteurian and post-Pasteurian approaches to trace how hygiene practices historically engender different ways of approaching microbial life in relation to human life. In the second part, I explore how hospital staff and patients make sense of bacterial presence based on my empirical material. The procedure of risk-adapted screening of patients in hospitals serves as a case to analyse the rationale of hygiene. Along screening as one of the key hygienic measures in German hospitals, I question the large-scale, societal implications of such hygiene measures when viewed through a microbiopolitical lens.

The empirical illustration of the governing of microbes in the second part is structured along the process of admission and discharge. Both the situation of entering and exiting the hospital highlight how hygiene practices constitute a me-

diation between the inside and the outside of hospitals walls. Within the hospital, the mediation continuous as one between humans, microbes, and materials, where hygienic risk is allocated to specific bodies, patients, wards, and to spaces both inside and outside the hospital. Whereas inside the hospital, hygiene practices aim to exercise control and management over bacterial presence and compositions, this scenario changes abruptly once outside the hospital. These are the tensions I intend to follow in this chapter, as they present themselves in my material, being especially remarkable in the experiences of a patient, Nina. Illustrating the situatedness of hygienic risk, I will switch between Nina's perspective, a patient diagnosed with drug-resistant bacteria during a hospital stay, and excerpts from interviews conducted with the hygiene management professionals I name Paul, Elli and Carl as well as Dr Andress, a hygiene physician.

Theoretical approach

The chapter's argument builds on recent theoretical approaches in thinking about microbes: a microbiopolitical lens (Paxson 2008, 2012, 2014) allows me to analyse hygiene practices in their relation to and their entanglement with large-scale politics, social practices, and biology while acknowledging the situatedness of bacterial materiality through borrowing from Landecker's (2016) *biology of history* and wider discussions of *local microbiologies* (Koch 2011; Brotherton and Nguyen 2013; Yates-Doerr 2017).

The addition of *micro* to Foucault's concept of *biopolitics* extends the analysis of how populations are governed to how populations are governed by and through their microbial encounters. Hygiene management, therefore, can be viewed as a microbiopolitical approach, following Paxson's understanding of "the creation of categories of microscopic biological agents; the anthropocentric evaluation of such agents; and the elaboration of appropriate human behaviors in relation to microorganisms involved in infection, inoculation, and digestion" (Paxson 2008: 17).

To account for the sociomateriality of resistant bacteria the concepts of *local microbiology* and the *biology of history* has proven fruitful. They both deal, in different registers, with the difficulty of accounting for the ever-changing material (*biology of history*) and the situational (*local microbiology)* nature of biological agents such as bacteria. Landecker's (2016) proposes *biology of history* to capture the enmeshment of bacterial evolution alongside the production of knowledge: As AMR illustrates, producing knowledge about bacteria and their evolution that resulted in the development and use of antibiotics, altered the materiality of bacteria themselves. The altered materiality of bacteria displays in acquired resistance mechanism that give rise to a biology of history, a materialized form of sociohistorical processes.

The concept of *local microbiologies* (Koch 2011; Brotherton and Nguyen 2013), a contribution to the concept of *local biologies* introduced by Lock (1994) in the 1990s, stresses the implicit co-productive processes of social and biological records in human–microbial relationships (Koch 2011: 84). Building on Lock's attempt to denaturalize the universal biological body with attending to *local biologies*, Yates-Doerr (2017: 382f.) further argues to denaturalize the *local* and specifically ask for the performativity of local biologies. In this vein, I look at the microagents of local biologies, bacteria, to explore what the localizing of biology means in the context of managing AMR in hospitals: what version of localities are actualized in bacteria's biology through hygiene staff?

This process of doing the local, I argue, is neither self-evident nor objectively innocent, no matter how geographically formalized the local microbiologies in the hospital are construed with the screening schemes (or in all the geographically distributed AMR-data). The microbiopolitics of hygiene work display the ever-changing ontological status of bacteria in everyday life. Hygiene practices epitomize the essence of locality, through its means and ends, and the way in which hygienists produce the hygienic hospital in a specific (microbiopolitical) way through localizing and historizing biology.

Data collection and methods

At the core of this paper are questions about how living with—and being at odds with—bacteria give rise to practices around hygiene, health, and disease. What is done to act hygienic in view of the presence of bacteria? How is a hygienic hospital in times of AMR envisioned in Germany? These questions centre around a tension very central to my research on AMR in biomedicine: how hygienic risk in human-microbial encounters revolve around specific spaces, bodies, and materialities.

I conducted 13 semi-structured interviews in Germany that focused on either professional or personal experiences with diagnosed AMR. I visited four different hospitals in Hamburg, Germany's second largest city, and interviewed hygiene management teams, as well as physicians and nurses specifically trained in hospital hygiene who were responsible for hygiene issues across the entire hospital. In hospital A, I spoke with two hygiene specialist nurses (Elli and Carl); in hospital B, I interviewed one hygiene specialist nurse (Paul); in hospital C, I met with the hygiene physician (Dr Andress); and in hospital D, I conducted interviews with one infectiologist (Dr Krohn) and one microbiologist/infectiologist physician (Dr Spall), as well as a nurse from the intensive care unit.

In addition to the hygiene management teams, I interviewed professionals working outside the hospital, including a university scientist with a background in chemistry and microbiology who is conducting fundamental antibiotic research;

an expert at the municipal hygiene institute; two representatives of a company specializing in hygiene products; and three representatives of a city-wide network on multi-resistant bacteria, the Multiresistente Erreger (MRE) network. The MRE network essentially gathers participants in the health care sector, funded by the city's health departments, to discuss the issue of drug-resistant bacteria and its relevance to the working groups in hospitals, nursing homes, patient transport, and on an irregular basis, primary care. On the patient side, I interviewed one patient and one caregiver of an individual diagnosed with drug-resistant bacteria and was informally in contact with patients through online Facebook groups about drug-resistant bacteria, in addition to the methicillin-resistant Staphylococcus aureus (MRSA) patient organization in Germany. To guarantee anonymization, I use pseudonyms for the interviewees. There are 68 hospitals alone in Hamburg and I visited four of them. I only use interview excerpts that don't disclose any details about the specific hospital.

I analysed my material by applying *situational analysis* (Clarke et al. 2022) in conversations with constructivist *grounded theory* (Charmaz 2014). The *situational analysis* guided how I approached my data through mapping techniques, such as visualizing positions taken on hygiene, human–microbial relationships in hospitals, or risk-adapted screening. *Constructivist grounded theory* guided the coding of the data I analysed with MAXQDA, in which the core categories of human–bacteria relationships and hygiene management emerged along with the practice-oriented category of risk-adapted screening.

The changing nature of infections: Hospitals in the antibiotic era

Following the widespread introduction of antibiotics in the middle of the 20th century, the hospital came to be seen as a healthy environment (Gradmann 2017): a clean place and the "best place to get better" (Condrau and Kirk 2011: 390). However, with AMR on the horizon the hospital's image changed, being again more a threat to health than a curative place as the German term for resistant bacteria *Krankenhauskeim* (hospital germ) aptly mirrors. Hospitals and AMR became deeply intertwined toward the end to the 20th century, which fundamentally changed the image of the hospital as a potentially dangerous, infectious "hothouse" (Gradmann 2017). Returning to the last century, Gradmann (2018) interrogates the shifting perceptions of hygiene and infectiology from the optimism of mastering microbial encounters to more dystopian visions of the future. The promise for both a cure and disease control, which was influential in the first part of the 20th century, changed the status of hospitals, which were viewed as places that were healthier and more hygienic than those outside the hospital walls (Gradmann 2018; Condrau and Kirk 2011). Despite changing disease dynamics in hospitals, however, including

a reduction in cases of pneumonia or tuberculosis, an increase in other infections, particularly those acquired within the hospital setting, the promise of the hospital as a "beacon" of infection control vanished. Already during the 1950s, researchers complicated the promise of antibiotics for the elimination of infectious diseases with observations of how the widespread use of antibiotics drastically changed the nature of infections, including an increase in drug-resistant bacteria (Gradmann 2018: 107).

Landecker coins this changing nature of infections *the biology of history* because the materialization of socio-political processes of antibiotic use displays in the changing biology of bacteria as they develop resistances. Furthermore, the changing status of hospitals from "lighthouses to hothouses of infections" (Gradmann 2017) and inscribed visions of a controllable nature is paralleled by what Paxson (2008) elaborates on with her concept of microbiopolitics: the shift from Pasteurian to post-Pasteurian biopolitical versions of microbial encounters. While the Pasteurian approach to microbial encounters aimed at the elimination and eradication of pathogenic microbes, at controlling and mastering "nature", amid the buried dreams of a world without infectious diseases, a post-Pasteurian approach highlights the collaborative nature of human–microbial encounters and the situatedness of pathogenicity. As she notes, "post-Pasteurianism takes after Pasteurianism" in that it classifies microbes as good and bad, but the focus has shifted to make use of good microbes in dealing with the bad (2011: 118). Her examples of artisanal cheese making or the medical use of faecal microbiota transplantation (Lorimer 2020) illustrate this post-Pasteurian approach, as does the case of hygiene management in hospitals.

Post-Pasteurian approaches in German hospitals: The work of hygiene teams

Today, in Germany, these epistemological shifts display in the ways that matters of infection, of microbial encounters, are enacted in hospitals. My analytic focus of hygiene management brings into focus the all-encompassing, infrastructural work enabling the curative and therapeutic logic of the hospital. Here, post-Pasteurianism articulates in the hygienic endeavours to weigh in on the uncertainties aligned to the issue of AMR: to manage bacterial compositions and avoid infection. This is the space where hygiene teams operate, between acknowledging bacterial presence and their potential to turn or be pathogenic: microbes are not understood as inherently pathogenic but might turn out as such. Thus, hygiene work revolves around evaluating and managing this post-Pasteurian spectrum of bacterial presence. And all this against a backdrop of complicated and far-reaching uncertainties attached to the use of antibiotics, both theoretically and practically: On a global level, AMR is

discursively presented as a threat to global orders, and in daily personal encounters in hospitals, AMR materialises in patients who may already have resistance to substances and subsequently cannot be treated.

Every German hospital is required to have such a hygiene management team: a unit of their own that is concerned with all kinds of microbes and microbial encounters. Patients, materials, and health care professionals come with microbes, and it is the hygiene teams' tasks attend and make sense of them within the hospital setting. It is the hospital walls that give bacterial presence a specific relevance, and so does the entering body become something else: as Brown (2019) writes in reading Mary Douglas' *Purity and Danger* (1966), entering a building points to different entries, where "the bodies and buildings are awkwardly duplicated within one another, both symbolically and materially" (2019: 228). When entering the hospital, the patient's body mingles with the building, its logistics and flows, and its hygienic regime. This regime and its management entail a wide range of tasks and fields of activity. Paul, the hygienist, showed me how different the days might look like for hygiene teams: they document infections and antibiotic use on an Excel spreadsheet, adapt screening protocols or isolation plans, they carry out hygiene visits in different wards, train new staff, and advise colleagues on issues of hygiene, antibiotic use, and infection control. Every morning, Paul is responsible for scanning the data that the wards send to inform the teams' physician, who subsequently visits the wards and meets with the team there to coordinate and agree on appropriate antibiotic treatment, as well as the necessary hygiene measures. Hours later, Paul might need to monitor the flow and quality of water, the cleaning of technical equipment and the milk for new-born infants or might be called into meetings to discuss the planning and construction of a new ward.

The threads of these various hygiene practices all come together in the hygiene management team, but many other actors are also tasked with the day-to-day maintenance of hospital hygiene. Nurses screen newly admitted patients and perform smear tests. They also wash the patients in cases of unwanted bacteria or infection. Physicians and pharmacists adjust antibiotic therapy; cleaning personnel take care of professional cleaning; and the lab analysis team reports to the hygiene team. The hygiene teams' direct contact with patients is rare, but they typically make rounds through the hospital and are on hand to advise when needed or to observe during rounds.

Hygiene practices aim to understand microbial presence and prevent infection. Hence, in hygiene management workflows from different areas of the hospital, including wards, laboratories, pharmacies, clinical practice, and antibiotic surveillance converge. The screening practices clearly sanction this assemblage of microbiological and pharmacological knowledge with clinical practice and the hospital site. As one hygienist put it, a key task is to comprehend and record what they call the "microorganism clientele", moving through the hospital. This is done through screen-

ing, detecting, testing, documenting, quantifying, and reporting bacterial compositions.

In the next section, I will look at the ways of managing the "microorganism clientele" which revolves in a post-Pasteurian fashion primarily around managing bacterial presence to avoid people getting sick of it.

"Preventing infection, accepting colonization"

In hospitals, hygiene is commonly perceived as a peripheral aspect to biomedical care, something that maintains the workings of the hospital, but that also interferes and disrupts the hospital's "real" medical work (Bose 2017: 49). Hygiene teams are often located in secluded areas in the hospital and both physically in their allocated space within hospital walls as well as from their social position within hospital hierarchies, they tend to act from the margins. As to not come off as the unpopular hospital police who just criticises ways of doing (like hand washing), besides the main task of negotiating human-bacteria relations a lot of effort goes into maintaining good relations to their colleagues.

It is often difficult for patients to grasp the processes of hygiene management and how it intertwines with care and therapy, as it is the task of physicians and nurses to consider the effects of biomedical interventions on microbial encounters. Thus, many interviewees working in hygiene shared a feeling for the specific responsibility of emotional labour as well. Thus, hygiene can be seen as a collective endeavour, where the care work encompasses relations to microbes as well as humans as patients and colleagues.

If a patient like Nina is admitted to the hospital, the medical staff must make sense of the patient in several ways. It may be important to know about any underlying medical conditions, the insurance number, or the weight of the patient, and in terms of hygiene, to evaluate the risks at stake: do they carry drug-resistant bacteria, which might lead to an infection? This evaluation is crucial and one of the first steps, because it specifies the flows, spaces, and practices a patient will find themselves in. As with Nina, the reasoning behind screening for drug resistant bacteria is two-fold: to secure the place and the patient.

In both admission and discharge, bacterial presence is crucial but with different implications: upon arrival, potential pathogenic and troublesome bacteria might enter with the patients, endangering the health of the patients and hospital flows. But not every patient's bacterial composition is relevant, and hygienic risk is distributed along specific criteria. These criteria play out in the decisions made about which patients are screened for drug-resistant bacteria and who is regarded as posing hygienic risk. These criteria also mirror a way of managing uncertainties about

hygienic risk, of which bodies are risky at the same time (for other patients and the hospital), and are seen as at-risk because of their bacterial compositions.

Admission: Situating human–bacteria relationships

> After weeks in a hospital abroad because of deteriorating health, Nina was transported back to Germany on a special flight organized by her insurance company. Her condition wasn't improving, and something had to be done. Admitted to a hospital in Germany with no diagnosis and vague symptoms, Nina was immediately isolated from other patients. Having returned from a non-European country, the reason for isolation stems from the concern that Nina might be carrying a contagious, "tropical" disease. The status of Nina as a patient and the reason for her ill health was yet unknown. Isolation was a means of practicing caution and providing safety not just for Nina, but for others as well, including other patients, the medical staff, and her family. A hospital is a densely populated place; thus, it was better to be "safe than sorry". Nina's isolation bought the physicians time to thoroughly investigate their microbial composition and the presence of possible pathogenic viruses, fungi, bacteria, or parasites without endangering other patients. (Field notes, Hamburg, 19.5.2020)

I analyse risk-adapted screening for drug-resistant bacteria as a standard hygiene procedure in German hospitals, using Nina's case. Screening, primarily done by nurses, serves to evaluate whether a patient should be tested for drug-resistant bacteria. Thus, upon arrival, the screening builds a basis for allocating hygienic risk. Although the screening protocols are provided by the hygiene management team, they are rarely executed by them. This screening process helps identify patients who might harbour resistant bacteria. If such a harbouring status is already known upon admission, if e.g., patient x was once discharged with a status of having resistant bacteria, the patient is immediately separated and isolated as hospital capacity allows. If the patient's bacterial composition is unknown, certain criteria point to the need of further clarification. It is exactly these criteria guideline that builds the risk-adapted screening protocol, which is practiced with a similar protocol across German hospitals. Ultimately, this evaluation aims to minimize two major risks: the ineffective use of antibiotics due to drug-resistant bacteria in patients and the potential risk that a colonized patient poses to other patients. Nurses decide based on a questionnaire defined by the Robert Koch Institute, the central administrative body of public health in Germany. In this process of risk-adapted screening, nurses working on the patient consider aspects of their medical but also non-medical biography and their reason for hospitalization: in some wards, such as the Intensive Care Unit, the screening criteria are broader, like wards with chronically ill or severely ill patients. In other cases, the specific bodily problem and the allocated

ward determine who is screened for which bacteria: certain drug-resistant bacteria primarily pose a problem in gastroenterology wards; therefore, screening for specific drug-resistant bacteria is considered particularly important in these wards. Evaluating the patient's biography for making sense of bacterial compositions may include information from their medical history, traveling activities, geographical locations, or their occupation.

Nina's case was unambiguous: Having been transferred from a hospital outside of Germany, and even Europe, plus her unknown condition put her straight into isolation. Transfers from other hospitals always pose hygienic risks, so patients are automatically tested and, if possible, isolated. This routine serves also as a way for hospitals to demonstrate that the resistant bacteria was not acquired in-house but somewhere else. For Nina, screening for drug-resistant bacteria was just one part of the biomedical care she received and was not something she actively anticipated or was informed about.

This observation resonates with the situation of how hospitals deal with AMR in general and the often-drawn connection made by the interviewees between health status and drug-resistant bacteria. The situation where bacterial presence is regarded as relevant within hospital walls is build up through the patients, their whereabouts, their activities, and their wellbeing:

> What is inhaled outside, so to speak, is accumulated and amplified here [in the hospital]. Because this is where all the people come together. The big problem is that multi-resistant bacteria are above all a problem for people who are multimorbid. A healthy young person is usually not affected at all. (Interview Paul, hygiene specialist nurse: 479)

The hygiene specialist in the interview expresses a common argument, where resistant bacteria are problematic for specific bodies. The reasoning behind this framing is to grasp the complexities of the microbial spectrum, where the presence of drug-resistant bacteria does not necessarily indicate an infection. In healthy individuals, non-resistant bacteria usually out-compete or out-grow drug-resistant bacteria after a short time and are thus no longer detectable (though they may very well be there). For immunocompromised patients, however, the presence of drug-resistant bacteria might easily lead to an infection. Thus, an infection in such individuals can more quickly become a health threat. For patients, therefore, the hospital is potentially a threatening place, where care, therapy and recovery, the function of the place itself, might be endangered by the presence of drug-resistant bacteria.

Therefore, the exploration of bacterial presence in the hospital, relevant to certain patients in specific situations and within specific walls, allows for the detection of unwanted bacterial compositions in the first place (i.e., to identify a potential problematic bacterial presence). While usually the medical staff (e.g., nurses) carry

out the practical steps involved in patient interactions, these are typically guided, supervised, observed, and sometimes controlled during so-called hygiene visits by the hygiene management team. Thus, a central task for the hygiene management team is to strike a balance between detecting certain bacterial presences and avoiding infection, as well as to pass on the necessary processes to the medical staff working with the patients. One hygienist told me how he himself experienced a moment of epiphany in terms of making sense of his profession and his daily practices:

> So that was a bit of an "aha moment" for me, that the focus is clearly on avoiding infection (…). The primary goal of hygiene measures ultimately is the prevention of infections. Not the prevention of colonization. And that is a very important point that we always have to remember. Because colonization itself is usually a temporary thing. As I said, these germs typically disappear again with sensible nutrition, normal diet, and normal personal hygiene. (Interview Elli and Carl, hygiene specialist nurses: 118)

In contrast to above statements about a healthy, young person being "fit" enough to deal with a certain bacterial presence, the temporality of this presence is brought up by the hygienist. The hygienist Carl employs practices like "diet" and "normal hygiene" as key, as technologies of the self to meet bacterial compositions, to build up the body capable of overgrowing resistant bacteria.

Therefore, of crucial importance is the evaluation of bacterial presence and their relation to the potential pathogenicity (infection) of their presence: hygiene is all about acknowledging bacterial presence while at the same time considering its temporality. And all this also to ultimately avoid unnecessary antibiotic use: as hygiene specialists point out, defining and diagnosing a patient's bacterial composition can only be considered a snapshot. Even in a case of certain stabilization after identifying the bacteria, it is only partial insofar as bacterial presence is understood as temporal. Nevertheless, once diagnosed, the bacterial status remains attached to the patient and defines their role during the hospital stay and far beyond. To rid themselves of the status of being colonized, a patient must prove with three tests over a certain period that the bacteria are no longer detectable. As Nina told me, once she was diagnosed with resistant bacteria and moved outside the hospital, she had to prove on three different occasions that the resistant bacteria were no longer detectable. Otherwise, entering the hospital with a known status of drug-resistant bacteria requires immediate isolation, which, as one of the interviewees pointed out, can be accompanied by stigmatization and neglect by the medical staff (Interview Dr Spall, infectiologist physician: 28).

Hygiene management is the solid ground upon which hospital business operates. Implementing risk-adapted screening, a rather complex process, as well as a dynamic field of developing knowledge, requires time and skilled personnel. How-

ever, at a time when care and hygiene practices are often outsourced or fragmented for economic reasons, practicing proper hygiene can easily become complex:

> The most common problem is actually the issues around screening. We have poured all this information into various standards and work instructions. But nevertheless, I can also understand that there are nurses on staff who are only here three or four times a month, because they have a part-time job, or only work in the middle of the night if there is an admission. They get this piece of paper, then they are supposed to interpret these crosses or checkmarks. And then they have to think about what do I do now? Do I have to swab the front, back, top, or bottom, perform a rapid test, PCR? And what do I actually need to do right now? It becomes more and more complicated over time. Because you simply learn more and more about these microorganisms. And it goes on and on: "Oh, we can make another special regulation." And that is also totally understandable and important from a technical point of view. But for the colleagues on the ward, exactly this kind of implementation can be super complicated, sometimes. (Interview Paul, hygiene specialist nurse: 371)

Standardized protocols and screening schemes cannot conceal the fact that hygiene is a complicated decision-making complex and involves an entanglement of practices of care based on attending to bacterial presence. Thus, hygiene management interferes with hospital architecture, everyday care, human-bacteria relations, systemic issues of organizational care, and patients' health conditions.

For example, a central aspect of hygiene management is concerned with the location inside the hospital where human-bacteria encounters unfold. The type of hygiene practiced depends on the vulnerability of the patients on the ward and the underlying causes for such vulnerability. In an intensive care unit or in transplantation wards, hygiene practices in general, and the bacterial threat in particular, are afforded more relevance than in other wards where less vulnerable patients are located. Hygiene management is a daily practice that involves negotiating multiple categories of relevance that are bound to hospital logistics and architecture, to the practices and resources of care and specialized wards, and to the bacteria and the patient. In addition, hygiene management depends on the patient's disease pattern, the type of ward, the bacteria in question, and which part of the body is the best location to swab for infection. This daily negotiation helps to configure the human-bacteria relation; the relation may become stabilized due to diagnosing a specific bacterial presence (as MRSA), but the diagnosis remains a temporal snapshot of a bacterial presence that is open to multiple outcomes, including infection, sepsis, death, disappearance, or overgrowth.

From the perspective of hygiene management, the evaluation of bacterial presence follows one important credo: accept colonization, prevent infection. As one hygienist emphasized, hygiene is not about preventing colonization and thus bacte-

rial presence, rather it involves accepting bacterial compositions as a normal process and as part of the human condition. Hygiene practice includes the process of coming to terms with bacterial presence that informs the management of it. Risk-adapted screening is one example of how this management takes place in practice, approaching bacterial encounters on a spectrum (Huttunen et al. 2021) rather than by the dualistic classifications of good versus bad bacteria, which a screening questionnaire might suggest at first glance. This speaks to a post-Pasteurian microbiopolitical approach, where the bacterial composition is worked with and evaluated instead of just eliminated with antibiotics. While this certainly hints to a more generous encounter with microbial presence, it is also important to keep in mind that these elaborate practices of post-Pasteurian approaches are born out of a sense of necessity, of desperation and of the fear of a shortage in antibiotics.

Discharge: Calibrating human–bacteria relationships

> After Nina had undergone countless tests, the period of isolation and hospitalization ended after a few days. Without a medical explanation for her illness, Nina was prepared for discharge from the hospital. Shortly before she left her room to exit the hospital, she was informed that resistant bacteria had been detected. This new information about her bacterial status, which Nina was told in passing, was unsettling: she was unsure if this is the diagnosis, the explanation for her ill health. On the way out, Nina was given some limited information about how to manage her drug-resistant bacteria and how to get rid of the status as a carrier. She should pay attention to her hand hygiene, and she should avoid contact with older or immunocompromised persons, as well as pregnant women and children. Nina could not make sense of this information if she is contagious and dangerous to others or herself. She was wondering why she is released despite this diagnosis. Already shaken by the experience of her illness and the lack of biomedical explanation for it, this new status of "being someone with something" in biomedical terms, further irritated Nina as she was released to the outside world. (Field notes Hamburg, 19.5.2020)

In Nina's case, a characteristic example of how hygiene proceeds, processes such as screening, testing, washing, or isolation are a peripheral aspect of care practices. The reasoning behind these practices is often unknown to the patients, as was the case with Nina. Swabs were taken from her skin, her nose, and the rectal area, but these appeared to be procedures like the others. Only upon leaving the hospital was she informed about her bacterial status, a diagnosis without a disease, an unstable bacterial condition:

> I remember, when I was discharged, that was also one of those moments; I was in an isolation room the whole time, you have a corridor, a showerhead for washing, a small room where the staff change clothes and disinfect everything, and I was just behind it. I am isolated and supposedly a danger emanates from me. The next day, when I was discharged, I was allowed to walk through the corridor without wearing a mask or gloves, which I found totally strange. Because a few hours before I was still in the isolation room, but now I was suddenly allowed to walk through the corridor, and touch the door handle, the light switch, the pen. (Interview Nina, patient: 9)

The immediacy and relevance for Nina of carrying drug-resistant bacteria was put into context and relativized by the medical stuff by associating it with her young age and overall health status. What was of utmost relevance inside the hospital was already changing as she left her room and headed for the exit. As the patient moves on to the outside, leaving the hospital walls behind, so does the bacterial composition: it becomes something else, and so do the hygiene practices. The practices of hygiene management are clearly bound to the hospital setting. For the patient this clear-cut division is often irritating and confusing. The professionals however argue for the temporal relevance of bacterial presence along giving a pragmatic picture of the patient concerning the overall health status and age:

> That is also the reason why in everyday life, where you don't have much contact with very sick people, you don't have to isolate yourself, for example. The need to be isolated is irritating for many patients here. They are isolated, almost like lepers, I would say, even though this is an exaggeration. Though you can only get into the isolation ward with a face mask and protective gown and everything. And then one day, the patient is discharged. They are put into the cab and take part in life again normally, just like that. Because the bacteria identified in their body are actually not dangerous for a healthy person. (Interview Paul, hygiene specialist nurse: 488)

This point is often exemplified in reference to people working with animals, whether in factory farming or as a horse trainer: Working alongside animals leaves an individual susceptible to drug-resistant bacteria, but at long as you are healthy or young or both, carrying drug-resistant bacteria is not likely to cause harm. Nina and other patients diagnosed with drug-resistant bacteria experience this situation as an ambivalent one. In the hospital, diagnosis with drug-resistant bacteria is considered highly relevant and is managed through various hygienic measures, such as screening, swabs, isolation, disinfections, and protective clothing. The way a patient is treated and cared for if diagnosed with drug-resistant bacteria differs materially, spatially, and therapeutically from other patients. With the departure from the hospital, this special role as a patient disappears, as does the relevance of the bacte-

rial composition harboured by the patient, thus modifying the human-bacteria relationship.

A diagnosis, but not a disease

Nina's confusion about harbouring drug-resistant bacteria—a diagnosis, but not a disease—points to the difficulty of integrating these hospital-bound practices, in conjunction with and against bacteria as contextual practices in an individual's everyday life and concerns about one's own health, body, fellow humans, and nonhumans (such as pets).

From the patients' perspective, hygiene practices often seem opaque. The patients may be screened, undergo smear tests, and are perhaps isolated and rigorously washed, but these are supplementary practices of the biomedical care that brought them to the hospital in the first place. They may receive an unlikely diagnosis: a diagnosis that not necessarily indicate a disease or pathology but nevertheless necessitates several hygiene measures. What follows is by no means simply "a fight against" bacteria. Hygiene management is a nuanced consideration of what might happen, and an anticipation of future harm caused by drug-resistant bacteria alongside local microbiologies.

By questioning, screening, and diagnosing, the vulnerability and ultimately uncertain meaning of being colonized by drug-resistant bacteria is evaluated and tried to be contained by isolation, protective clothing, hand washing, close monitoring, and sanitation. Isolation is a drastic intervention that cuts off the patient form physical contact and social closeness and ultimately covers the intricate processes at play to deal with bacteria. But in all that weighing of bacterial possibilities, the post-Pasteurian approach of exploring and managing instead of killing is strongly supported by the notion of healthy, adaptive bodies that are in a good position to fend off encounters with bacteria (Martin 1994; Brown 2019). One interviewee, a hospital-based physician for microbiology and hygiene, noted that the number one credo of hygiene in current practice is "to preserve the patient's own flora." Patients arrive at the hospital with their own bacterial diversity and this diversity, she emphasized, must be protected (Interview Dr Andress, hygiene physician). Hospital staff need to remain "neutral" in this regard, so as not to endanger the flora of the patients. And for this purpose, she argued, simply as it may sound, it is primarily about "hands, hands, hands, hands. Because the hand is the most important infection transmission site in medicine".

Hygiene practices like handwashing are necessary for the hospital to keep running smoothly, to allow for the flow of care, interventions, and therapy, in cases where AMR poses a major risk for this uninterrupted flow of care. The patient's body

is biographized along their bacterial compositions and managed in its capability of position itself in microbial encounters and as microbial being.

Risk-adapted screening is one example of how hygiene management takes place in practice, approaching bacterial encounters on a spectrum (Huttunen et al. 2021) rather than by dualistic classifications of good versus bad bacteria, which a screening questionnaire might appear to suggest at first glance. This speaks to a post-Pasteurian microbiopolitical approach, where the bacterial presence is worked with and evaluated instead of just eliminated with antibiotics. While this certainly hints to a more generous encounter with microbial presence, it is also important to keep in mind that these elaborate practices of post-Pasteurian approaches are a necessity, configured through despair and fear of having no antibiotics, hence no thoroughly Pasteurian substance, at disposition.

The biology of history (Landecker 2016) is of large-scale induced bacterial evolutions—such as antimicrobial drug resistance—entangled with humans operating in the world as travellers, migrants (Kamenshchikova et al. 2018), farmers, and the chronically ill. These entanglements become meaningful in the hospital setting through localizing specific microbiologies such as bacteria. Locality here is done by mobilising specific types such as geographic, professional, or bodily locality that signify hygienic risk. The microbiopolitics at play rely heavily on the rationalities of creating an individual and collective body capable of embracing bacterial diversity. Hence, hygiene practices outside the hospital setting are far less rigid, in contrast to the potential menace of a healthy self and healthy environment. Health is not the absence of bacteria, but the equilibrium of the bacterial composition in and around the individual. Leaving behind the Pasteurian approach and a top-down *one-size fits all* concept in hygienic practices, the case of hygiene management demonstrates a post-Pasteurian microbiopolitical regime in the face of AMR, which emphasize bacterial diversity, the bacterial spectrum, locality, and situatedness over sterility and the killing of microbes as inherently pathogenic.

Conclusion

Hygiene practices are an integral part of hospitals and multiple hospital workflows meet through the questions about care and therapy, of cleanliness and contamination, of design and architecture, of equipment and instruments, of construction, and of transportation or mobility. What does this specific mediation through hygiene work between the inside and the outside, spatially, and physically through walls, as well as bodies, tell us about the governance of microbes and bodies in general?

Returning to the eye-opening moment one hygienist shared about how hygiene management is not about having no bacterial compositions, but about avoiding in-

fection: following Paxson's diagnosis, this approach marks a post-Pasteurian understanding in which good hygiene management is not a war against microbes but a balance act of making visible and thus managing bacterial presence. Still, there are such things as "bad" microbes, but only in relation to the humans: it is the human that needs to contextualize in face of bacterial presence. This in turn marks another remarkable observation: that post-Pasteurian approaches govern microbial encounters along with construing capable bodies: microbes are not necessarily bad; they are only bad if the human is ill-equipped to encounter them.

Like recent discourses about the danger of COVID-19 (for whom, or for which bodies?), a central category in situating microbial presence for anticipating their potential harm is that of healthy bodies. Certain bacterial composition remains a temporary status for the healthy body. "Healthy" in this case relates to the anticipated potential of the body's bacteria to out-compete drug-resistant bacteria, as the hygienist in the interview excerpt mentions, through "sensible nutrition, normal diet, and normal personal hygiene" (Interview Elli and Carl, hygiene specialist nurses: 118). The bodies in these narratives of drug-resistant bacteria are in Emily Martin's sense (Martin 1994; Brown 2019) pictured as "flexible", where the immune system works under the skin and inside the body to regulate bacterial balance and, therefore, good health. Martin's analysis of the ways in which metaphors and meanings of the body and the immune system have changed over time is helpful here because the "flexible body" of today is very much articulated in the foundation of hygiene management work: detecting bacterial presence and avoiding infection are key factors, as is mastering unstable and adaptable bacterial compositions created through the process of microbial balance.

I have shown how in Germany hospitals work alongside growing uncertainties about antibiotics and concern over AMR, hygiene staff enacts local microbiologies through the screening process. This can be understood as an effort to meet the growing uncertainties of antibiotics and the meaning of bacterial presence with partial control and manageability. These localizing practices and the construction of local microbiologies come with implications. Coming back to Yates-Doerr (2017) approach of denaturalizing the local the same ways anthropologists tend to do with the biological body, I want to conclude this chapter with following up on these implications. For example, situating the bacterial presence in medical staff is not considered necessary according to official guidelines. Moreover, medical staff may display their own local microbiology due to their workplace and daily work with patients with diverse bacterial compositions. But no one can manage these relationships. A diagnosis of an infection with drug-resistant bacteria is not considered an illness; however, it could endanger other patients, and medical staff with patient contact would have to stop working immediately without being able to take sick leave. Again, a diagnosis of harbouring drug-resistant bacteria stipulates a certain risk, but it is not a disease. This situation constitutes a legal grey area and exemplifies how bacterial

presence is embedded in wider socio-political matrixes, and that human–microbial relationships are indeed a question of governance.

Research on AMR is often touted as a flagship effort for bringing together different disciplines in the fight against a global health threat, as expressed in a research program titled *One Health* (Hinchliffe 2015; Kahn 2017). Indeed, hygiene management practices typically incorporate multiple sites and localities, as the screening schemes show. However, this strategy carries the risk of naturalizing locality in local microbiologies and inscribing evaluation patterns in biological materiality. Thus, the locality in local microbiologies, as in certain bacteria, are handled not only as a matter of geography, but also as a matter of diseases and professions, or of all three taken together. While acknowledging the immensely important and delicate work hygiene management teams do on the frontlines of AMR, I also like to see this analysis as a point of departure for thinking critically about the underlying assumptions articulated in the localizing practices of hygiene work (and AMR practices more broadly).

Hygiene management is a microbiopolitical practice that connects the hospital arena to a broader vision of managing human life vis-à-vis microbial life. I have shown how the everyday negotiation of what hygienic action requires fits into the post-Pasteurian approaches to encountering microbes: the effort to identify risk in and for patients is focused on evaluating local microbiologies, how they are composed, and which locality needs to be actualized to be manageable. Thus, a local microbiology is a never-finished, partial, and temporary snapshot: Which local microbiology is actualized in any given moment depends on the hygiene regime established at a particular hospital.

Moreover, hygiene management also shows how so much of post-Pasteurian microbiopolitics rely on unhinged notions of the healthy body that is in itself capable of living the good life with microbes. But more often, it is not a choice, and humans are enmeshed in socio-political necessities that are neither microbe-free nor always healthy. It is these ramifications we should pay attention to in organising the healthcare system, in livestock farming, in our modes of production, and in the way we extract resources from humans and nonhumans alike.

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