

Review Article

Draft on Hygiene and Infection Prevention in Outpatient Care for the Second Quarter of the 21st Century - An Europe- and German-centred Perception

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Abstract

Professional care and nursing for people in need of care in Germany faces a number of serious challenges. Due to the demographic development and the recruitment of nursing personnel and aides of different educational and professional background, an increasing number of people in need of diverse forms of care encounter a diversity of nursing personnel with a variety of language and professional skills.

A basic pillar of healthcare and nursing, hygiene and infection prevention, stands under high pressure. On the one hand, the concept of hygiene in a home environment is heavily person-bound and may widely diverge between person in need of care and nursing personnel. On the other hand, practice and interpretation of the recommendations for infection prevention of the leading healthcare institutes, as well as the basic learning contents, are highly variable, at times deficient or not present at all.

The perceptions of when hands or gloves are contaminated differ considerably. The touching of different surfaces and objects in the working environment during a workflow often does not agree with strategies to minimize the spreading of pathogenic germs. Also, wearing a protection mask is handled at will, at times covering mouth and nose, at times only the mouth, at times sitting under the chin.

This way of nursing practice meets a world of pathogens, in which the bacteria during the last 50 years underwent a genuine evolutionary change. Antibiotic-resistant bacteria now pose an over-size challenge for the current practice of home nursing and care for elderly. An adjustment in education, quality validation, and appreciation of hygienic competent work is of need.

Keywords: Pathogens, Antibiotic resistance, Home nursing, Asepsis, Infection prevention

Introduction

Over the past 150 years, life expectancy in our country has more than doubled [1], maternal and infant mortality have fallen to a fraction of what they were in 1872 [2], and the importance of infectious diseases as a cause of death has been almost entirely replaced by heart and circulatory diseases or malignant neoplasms [3].

In the mid-19th century, tuberculosis was the number one death angel in Germany, apart from times of war and years of severe cholera epidemics; today, the “tubercle bacillus” *Mycobacterium tuberculosis* plays hardly any role in Germany [4].

Due to an adaptation process of various bacterial strains to the rapidly increasing use of antibiotics following the enormous success of Penicillin G in field hospitals during World War II, the golden age in the fight against bacterial infections is at stake [5]. Strains of different bacterial species are establishing antibiotic resistances combined with high virulence, and are developing into pandemic threats [6,7]. They are responsible for a large share of deaths worldwide related to bacterial infections. National leading institutions point to an expected resurgence

of deaths from infectious diseases and call for general attention [8].

These infections have been closely monitored in hospitals, while outpatient settings and the general population are only gradually becoming aware of the situation. The permeability of the interface between inpatient care, nursing homes, and home care highlights a critical problem in this context [9]. It is questionable whether the hygiene standards found in current outpatient care at home or in shared living arrangements are sufficient to deal with this threat.

The Threat

In a comprehensive study, an inventory of deaths from antibiotic-resistant infections and their distribution across the continents was carried out for the year 2019 [6]. Modeling for the expected development up to the year 2050 shows an increase [7], which, even in the Western world, places death from infectious disease on an equal footing with death from cardiovascular diseases or malignant neoplasms. The seriousness of this situation is expressed, for those not directly affected, in the call for attention from national leading institutions and ministries [8].

Now, the grim reapers in the Western World are no longer *Mycobacterium tuberculosis*, but *Escherichia coli*, followed by *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa* [6] (Table 1). The organism described by the physician Friedrich Escherich in 1885, isolated from the rectum of a girl, ranges in appearance from a beneficial gut commensal to a highly virulent pathogen. Various *E. coli* strains are equipped with genes for different pathways of antibiotic inactivation or toxin production [10-12], thereby offering a high diversity of virulence mechanisms.

Infections caused by *Escherichia coli* have long been clinically recognized, as they are responsible for a large proportion of

urinary tract infections (UTIs) (Table 1). In the HALT-3 surveys on nosocomial infections in long-term care facilities, UTIs were recorded as the greatest burden in Germany on a reference day in 2016, with *E. coli* being the most frequently detected bacterium [13]. In a cross-sectional study from 2019-21 on resistance rates in community-acquired UTIs, *E. coli* was detected in 75.4% of cases, with a significant number of resistances against various antibiotics [14]. The second most frequently detected bacterium was *Klebsiella pneumoniae*.

In the HALT-2 study, methicillin-resistant *Staphylococcus aureus* was still in the foreground as the first notable antibiotic-resistant pathogen in the German healthcare system [15]. Antibiotic-resistant *Staphylococcus aureus* are known for causing wound infections and

Table 1: Pathogen spectrum and antibiotic resistance in community-acquired and nosocomial infections

A) Urinary tract infections, pathogen prevalence, antibiotic resistance

Study objective	Pathogen spectrum	References
Pathogen spectrum uncomplicated cystitis	<i>E. coli</i> (70–80%), <i>Staphylococcus saprophyticus</i> (5-15%), . In individual cases, other enterobacteria like <i>Proteus mirabilis</i> , <i>Klebsiella spp.</i> <i>Enterococcus spp.</i>	[41] Wagenlehner et al. Urinary tract infections (UTI) Akt Urol 2014; 45: 135–146
complicated urinary tract infection	<i>E. coli</i> and other enterobacteria, enterococci <i>Pseudomonas spp.</i>	
Pathogens of catheter-associated urinary tract infections	<i>E. coli</i> (43,6%, ESBL-positive proportion 11,8%), <i>Enterococcus spp.</i> (23,0%), <i>P. aeruginosa</i> (10,7%), <i>Klebsiella spp.</i> (10,3%), <i>Proteus spp.</i> (9,6%), <i>Staphylococcus aureus</i> (3,2 %), <i>S. saprophyticus</i> (2.2 %)	[42] KRINKO at the RKI, Bundesgesundheitsbl 2015 · 58: 641–650 DOI 10.1007/s00103-015-2152-3
Nosocomial urinary tract infections and resistencies Urosepsis pathogens global in urology 70 countries ca. 30.000 participants (Prevalence Europe; Global)	<i>E. coli</i> (41%; 43%), <i>P. aeruginosa</i> (13%; 10%), <i>Enterococcus</i> (12%; 11%), <i>Klebsiella spp.</i> (8%; 10%) <i>Enterobacter spp</i> (6%; 6%), <i>Proteus spp.</i> (4%; 4%) <i>Staphylococcus aureus</i> (4:4) <i>Acinetobacter spp</i> (1%; 2%) 45% of <i>Enterobacteriaceae</i> and 21% of <i>P. aeruginosa</i> multidrug-resistant.	[43] Tandoğdu Z, Bartoletti R, Cai T, et al. Wagenlehner R, Resistance patterns of nosocomial urinary tract infections in urology departments: 8-year results of global prevalence of infections in urology study. World J Urol 2013;
Pathogen spectrum and resistance rates in community-acquired uncomplicated urinary tract infections Nationwide cross-sectional study in Germany 2019-21 2390 study participants	<i>E. coli</i> (70,5%), <i>Klebsiella pneumoniae</i> (5,5%), <i>Enterococcus ssp</i> (5,2%), <i>Proteus mirabilis</i> (4,6%), <i>Staphylococcus ssp</i> (4,8%) Resistance rates in <i>E. coli</i> depending on previous infections, with a single infection being <15%	[14] Klingeberg et al., Dtsch Arztebl Int 2024; 121: 175-81; DOI: 10.3238/arztebl.m2023.0267

B) Pathogen spectrum in nosocomial infections in healthcare facilities.

Nosocomial infections in long-term care facilities in 2016 German results of the HALT 3 study 131 facilities 10,556 residents	Infections of the urinary tract (31.1%) of the respiratory tract (24.3%) of the skin/soft tissue (23.7%) 21 microbiological diagnostics: 2 viruses, 1 fungus 6 <i>E. coli</i> , 3 <i>Pseudomonas aeruginosa</i> , 3 <i>Streptococcus pneumoniae</i> , 2 <i>Staphylococcus aureus</i> , 2 <i>Clostridoides difficile</i>	[13] Schmidt N. et al, Bundesgesundheitsbl. 2022; 65: 863–871 https://doi.org/10.1007/s00103-022-03566-3
Prevalence of nosocomial infections in German hospitals in 2016 218 hospitals 64,412 patients	<i>E. coli</i> (16,6%), <i>Clostridoides difficile</i> (13,6%), <i>Staphylococcus aureus</i> (12%), <i>Enterococcus faecalis</i> (6,9%), <i>Pseudomonas aeruginosa</i> (5,8%)	[44] Behnke M, Aghdassi SJ, Hansen S, Peña Diaz LA, Gastmeier P, Piening B: The prevalence of nosocomial infection and antibiotic use in German hospitals. Dtsch Arztebl Int 2017; 114: 851–7. DOI: 10.3238/arztebl.2017.0851

C) global impact and spectrum of antibiotic-resistant bacteria

Global burden of bacterial antibiotic resistance 2019 for 23 pathogens in 204 countries	the 6 leading pathogens associated with deaths related to antibiotic resistance <i>Escherichia coli</i> , <i>Staphylococcus aureus</i> , <i>Klebsiella pneumoniae</i> , <i>Streptococcus pneumoniae</i> , <i>Acinetobacter baumannii</i> , <i>Pseudomonas aeruginosa</i> responsible for approximately 929,000 deaths due to AMR and around 3.6 million deaths associated with AMR in 2019.	[6] Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022 Feb 12;399(10325): 629-655. doi: 10.1016/S0140-6736(21)02724-0. Epub 2022 Jan 19.
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respiratory tract infections [16]. For the years 2021/22, a declining incidence of antibiotic-resistant *Staphylococcus aureus* was reported in Germany compared to other regions in Europe [17]. A problematic MRSA strain, which was able to spread in the USA and evolved from a skin and soft tissue infection pathogen to a sepsis-causing pathogen, has not established itself in Europe [18].

The report from the German national reference center for Gram-negative hospital pathogens can be regarded as a proxy for the burden of antibiotic-resistant bacterial infections [19]. The increase in submissions of bacterial isolates for the years 2022–2023 by more than 7%, mostly for the investigation of reduced carbapenem susceptibility or carbapenemase activity, reflects an actual rise in resistance to beta-lactam antibiotics as used in hospitals. In addition to the Enterobacteriales *E. coli* and *Klebsiella pneumoniae* and others, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* are also strongly represented.

The worldwide occurrence of highly problematic strains of the species *Klebsiella pneumoniae* [20], *Acinetobacter baumannii* [21], and *Enterococcus faecium* [22] highlights the issue at stake. Together with viral pathogens [23], they confront healthcare with changing challenges. In particular, elderly care and care provision in nursing homes seem to be on shaky ground [24].

The Challenge

Clean and Uncontaminated - Incorrect Teaching and Basic Assumptions

In the patient's room, the geriatric nurse tells her student that "there are no bacteria in this clean room and no risk of contamination". She then continues, saying she "does not need to disinfect the hands anymore since she already disinfected them in the hallway earlier". After having changed her clothing, brushed her hair back with her hand, and touched two door handles after hand disinfection, 3 different ways of introducing germs, skin, hair, and cloths of care givers, but also surfaces in the patient surroundings, like door handles and bed control, since they are not freshly disinfected, are not recognized.

This kind of false communication in such a mixed teaching/nursing situation is one reason for the establishment of entirely wrong beliefs in nursing students on pathogen sources (Ernsberger, 2024, not published). Indeed, a significant portion of the nursing staff in outpatient care share the belief that hand disinfection upon entering the care area ensures clean hands throughout the entire stay. Similarly, a surprisingly large number of nurses assume that they can assess the degree of contamination in a care area with the naked eye (Ernsberger, not published).

A striking example is the assurance by a senior managing caregiver that the urine in this drainage bag looks clear and clean. In fact, a few days earlier, laboratory tests had confirmed stable colonization with *Pseudomonas aeruginosa* in this urine at a density of >100,000 colony-forming units [25]. The colonizations that are reliably recognized as such by the outpatient care staff are in urine with clouds of bacteria aggregated in flakes. This corresponds to bacterial cultures in a senescent growth phase, which have gone hours or days beyond their exponential growth phase.

In these frequently observed cases in outpatient care, serious misjudgments by numerous caregivers become apparent. The knowledge that microscopy and time-intensive observation under suitable laboratory conditions were necessary to allow Robert Koch, for the first time 150 years ago, to make bacteria visible to the eye [4] is largely unknown. Equally unknown is the understanding of the historical development of concepts on the nature of infectious diseases and the germ theory of infection causation [26].

These case studies demonstrate how failures in teaching and evaluation may misguide nurses to decide for a non-appropriate safety level and disinfection regime for a planned workflow.

Hand Hygiene – A Surprisingly Demanding Matter

The "five moments of hand hygiene" defined by the WHO and specified in national guidelines [27,28] are considered the most effective single measure for preventing the spread of germs and the most useful means to reducing nosocomial infections. However, their full application to essential nursing routines, such as emptying a patient's urine drainage bag and assisting with elimination, is not sufficiently followed by many outpatient care workers [24].

Deficient hygiene practice, inadequate training, and the lack of continuing education programs among outpatient care workers in a residential long term care facility, associated with the spread of MRGN4 *Acinetobacter baumannii*, highlights the scale of the problem [9]. Due to problems in hygiene competence, there is currently not sufficient protection against the spread of viral or bacterial pathogens in many home care settings.

In outpatient care, the WHO recommendations on hand hygiene, the section D [27], summary on the use of gloves, is most frequently violated. The section "D. When wearing gloves, change or remove gloves in the following situations: during patient care if moving from a contaminated body site to another body site" [27-30] is often not followed, and if followed, only efficient when the workflow is well structured. Especially when assisting with excretions, there are many opportunities for cross-contamination when both hands are involved [24]. Confusion of left and right hand will easily result in the spread of Enterobacteriales and Enterococci.

Focusing the work of one hand on tasks in contaminated areas, such as removing feces or operating the drainage port of the urine bag, and the other hand on tasks to be performed cleanly, such as supporting the patient, selecting hygiene papers, or operating the bed control, requires good preparation and high concentration (Table 2). Maintaining such a strict workflow for both hands, and not switching between sides, is not easily achievable for many caregivers. Errors at this time have the potential to transfer *Enterobacteriaceae* or *Enterococcaceae* from stool and, possibly, *Pseudomonas aeruginosa* from bacteriuria into the bed environment, the bathroom sanitary installations, hygiene paper storage areas, or even clothing via contaminated disposable gloves [31].

Pathogens, Their Nature, and Their Means of Transmission – An Underrated Subject in Care

Conversations about hygiene and causes of infection with nursing

Table 2: Common misjudgments and hygiene violations and affected pathogens.

Hygiene violation or misjudgment	Affected activities or items	Affected or spread pathogens
Misjudgment of cleanliness	Contaminated disposable gloves from assistance with excretions assistance with urine from bacteriuria or urinary tract infection surface not freshly disinfected for temporary storage	alle germs from previous activities <i>Escherichia coli</i> , <i>Enterococcus spp</i> , <i>Klebsiella spp</i> , <i>Proteus mirabilis</i> , u.a. <i>Escherichia coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Enterococcus spp</i> , <i>Klebsiella pneumoniae</i> u.a. poorly defined microbial mixture from the patient's environment
Incomplete preparation	Too little hygiene paper Disinfection aid supplies forgotten No suitable disposable gloves	During a hasty trip to the storage area, door handles, cabinet handles, and supply depot packages became contaminated with germs from the excretions (see above) due to wearing contaminated gloves
Inadequate hand hygiene	Dirty hands perform tasks that need to be kept clean when assisting with excretions when emptying the urine bag Fingernails and jewelry	With assistance with excretions; pathogens (see above) transferred to bed, control devices, surfaces, and in the storage area urine drops and splashes pathogens (see above) transferred to bed, control devices foreign pathogens
Inadequate training	No employee notes	With inaccurately remembered and shortened workflows, hygiene-relevant steps are forgotten from memory.

Table 3: Training and further education deficits in the face of highly virulent bacterial and viral pathogens.

Poor hygiene knowledge and awareness	Too often a lack of interest in questions about the biology and clinical aspects of pathogens too often a lack of interest in clinical microbiology the importance of hygiene for infection prevention remains unclear	Knowledge of the nature and distribution of viral and bacterial pathogens is very limited the design of aseptic work routines is too often inadequate [39] hygiene is often considered a nuisance, and its central importance for personal and public health is not clear
Lack of awareness about the pathogen load of lifestyle accessories	Jewelry, necklaces, bracelets fingernails and hair	Transfer of germ profiles between/from patients, staff, and personal surroundings including pets, also directly into the patient's bed Germ reservoir strongly dependent on prior activity, personal hygiene, in particular <i>Staphylococci</i> , <i>Enterococci</i> , and <i>Enterobacteriales</i>
Deficits in the use of personal protective equipment	Putting on the mouth-nose protective mask too late and taking it off too early, removing it temporarily taking off contaminated disposable gloves too late	Transmission of bacterial and viral pathogens in droplets and aerosols Transmission of all germs from the area of activity and work, including <i>Enterobacteriaceae</i> , <i>Enterococci</i> , <i>Pseudomonas</i> , <i>Staphylococci</i>
Insufficient knowledge of asepsis and lack of aseptic work routines	The necessity to always disinfect surfaces in new care situations or after contamination is often not recognized. The point at which disposable gloves become contaminated is not recognized. The classification of work areas and procedures according to an ANTT [39] often seems unfamiliar.	This way, germs from previous care procedures can be carried over into new workflows. Pathogens from assistance with excretions and emptying urine are spread in this process (see above). Often, unclean, open areas are chosen for temporary placement, and contaminations already present there are carried further.

staff in outpatient care, unfortunately, often fizzle out very quickly. Language skills play a role, given the increasing number of nursing staff from countries with highly different language background. Personnel from countries with highly diverse language and cultural backgrounds shall be reached by educational and Informational texts on the nature, ways of transmission, and clinical pictures attributed to different pathogens [32].

Providing short and easy to read texts in the native language of nursing staff (arabic, amharic, english, german, serbo-croatian, vietnamese) has a 2-fold intention. On the one hand, they shall explain the reasoning behind certain hygiene protocols in light of the different transmission pathways of the different classes of pathogens. On the other hand, the hope is to spark interest by addressing caregivers in their mother's language, and to sensibilise for the challenge set by the transmission pathways used by antibiotic-resistant bacteria.

A significant factor here is the commitment of the nursing management and the quality of training in the nursing service. However, it, unfortunately, is common practice that clients or patients of nursing

services are not informed about continuing education activities, and they are also not announced on the nursing services' websites.

Risk in Both Directions - The Correct Use of Personal Protection Equipment

The transmission of germs in outpatient care is not a one-way street. The spread of bacterial germs through contact and smear infection, coughing, or cuts and puncture injuries transmits pathogens both toward the care recipient and the caregiver. Similarly, the transmission route of viral pathogens through aerosols, coughing, or smear infection is initially open in both directions.

Personal protection equipment (PPE) [33], disposable gloves and mouth-nose masks provide tools that should protect the staff, i.e., caregivers, reliably. However, the effectiveness of these aids in protecting personnel depends on correct handling (Table 3). The proper handling of PPE also plays a central role when it comes to disposable gloves. Here, timely donning, as well as timely removal or changing, is of central importance (Table 2).

The example of a caregiver (Ernsberger, unpublished), who attends to clients scattered throughout the neighborhood with one pair of gloves, is an example that hardly ever comes to public attention or legal scrutiny. This stands in reprehensible contradiction to the WHO recommendations 'C. Remove gloves after caring for a patient - do not wear the same pair of gloves for the care of more than one patient.' [27]. Such behaviour risks to deposit bacteria and other pathogen collection of unknown composition in the environment of a person in need of care and the caregiver himself.

This is an example to illustrate how important continued education is for the knowledge of hygienic principles in outpatient care, not only in Germany, for the sake of Infection prevention and well-being of the people in need of care and the caregivers.

Final Considerations

Hygiene Violations - Poor Planning and Execution on Various Levels

For an observant person in need of care, it becomes apparent how many problems arise from incomplete work preparation (Table 2). A rushed walk of the caregiver in the middle of assistance with excretions to the supply rooms is often because not enough hygiene papers were prepared for assistance, or because the disinfectant spray was forgotten during urine disposal. Here, the careful, thoughtful preparation makes a decisive difference.

Of a different nature are two levels of hygiene violations: knowledge that should be present from recommendations and learning content issued by leading institutes for healthcare.

For the classical task of emptying urine drainage bags, examples include the height of the urine bag to remain below bladder level, preventing drips at the drainage port, and disinfecting wiping of the same [34]. In assistance with fecal excretion, it is changing gloves before transitioning from wiping to putting on a new incontinence pant [35].

A new level seems to be emerging with the development of antibiotic-resistant bacteria. It appears that many caregivers are aware that such a problem exists, but not that it could occur in their outpatient work. It appears that education and training "providing information about the nature and occurrence of pathogenic germs" could form a foundation for care in the coming decades. This should be complemented by a detailed examination of the surfaces in the work environment and their potential germ colonization.

Asepsis and Antisepsis – A Puzzling Relationship for Many Home Caregivers

The aseptic non-touch technique (ANTT) [36], is not well established in outpatient care in Germany. The division of a work environment into areas that must strictly be kept clean and free of contamination, the distinction between areas with different levels of cleanliness or microbial load, and the planning of workflows to prevent contact with contaminated areas during steps that need to remain clean, is too often inadequate. The question of infection prevention

and its monitoring in home care arises only late and has only become a subject of serious consideration after the COVID-19 pandemic [37].

Unfortunately, hygiene and discussions centered around this topic, pathogens, and the nature of infectious diseases are often perceived as unnecessary or disruptive in the usual care context. The legacy of Semmelweis, Pasteur, Lister, and Koch has not made the impact here that it did in general hospital care and particularly in surgery [38,39]. Looking at the massive damage caused by the SARS-CoV-2 pandemic in residential facilities [40], the question arises how a genuine interest in this health care pillar can be triggered, in particular to promote the development of evidence-based infection prevention in home care

Conclusions

Currently, too many working routines in outpatient care are not suitable for containing the spread of bacterial strains via contact infections, droplets, or aerosols.

One aim is a better education, verification and training, combined with appropriate reward and recognition. The establishment of antibiotic-resistant bacterial reservoirs in the environment of people in need of care, due to inadequate structuring of nursing routines, lack of knowledge about asepsis, or wearing hygienically inappropriate lifestyle accessories and jewelry, must be strictly avoided.

Demanding outpatient care services to document their level of training and certified continuing education in hygiene, aseptic work practices, the use of PPE for staff and clients, as well as knowledge in clinical hygiene on their websites provides a way to link an obligation for hygiene training and continuing education with an information duty towards clients

Conflict of Interest

The author, UE, states that there is no financial conflict of interest.

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