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The infected peripheral intravenous catheter : a degree of ignorance, neglect and indifference

D. Cozanitis (*) and P. Mäkelä (**)

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The anesthetist is first and foremost a physician. The care and safety of his patient should include measures to contain or curtail the ever-rising financial and human burden of infection caused by insufficient attention being given to hospital hygiene in general and that involving the peripheral intravenous catheter in particular. In this article an all out appeal is made to anesthetists to change their attitude regarding nosocomial infection and accept a greater role in combating this problem.

It is most disconcerting that in spite of today's modern technology and knowledge, a patient should succumb to a relatively benign case of gastroenteritis (1) ; the underlying cause being the infection of an object as seemingly insignificant as a peripheral intravenous catheter. This tragic event serves as a stern reminder to anesthetists, generally considered to be responsible "keepers" of such catheters, that their use and care should be given more than lip service.

The development of today's catheter (cannula)

Needles for intravenous use were made of hyperchrome stainless steel until 1945 when the first plastic devices were introduced. These were made of polyethylene tubing which was cut into lengths of 22 to 30 cm and disinfected by boiling for 20 minutes. Placement was through a needle into a vein in the antecubital fossa via an intradermal procaine wheal ; the entire procedure being carried out under aseptic conditions . The first reports of thrombophlebitis soon appeared as did accounts of septicemia incriminating the new device .The addition of a side- (injection-) port onto the cannula in the mid-1970's led to a surge of reports of infection as result of this component. These led to warnings being issued and even calls to abandon the ports. Subsequently, in a bench study within a busy and contaminated environment, 1 500 injections through the injection-port produced no bacterial growth when strict basic precautions were taken (2), allaying the earlier fears. Electron microscopy has shown that plastic catheters may present surface imperfections such as scratches, protruding material, troughs and/or adhering particles. Micro-organisms and infusates can thereby attach themselves to these defects and give rise to thrombophlebitis and/or infection (3). Cannulae of plastic are made of different polymer types and vary as to their tendency towards contamination.

The biofilm and its relevance

In nature and disease, microbes adhere tenaciously to surfaces, both inert and those of plant and animal tissues, by producing a highly organized matrix of tangled polysaccharides and glycoproteins, which all together constitute the biofilm. Originally known as bacterial glycocalyx, the biofilm provides shelter for existing micro-organisms and for the development of adjacent microcolonies. Within the biofilm lie water channels, nutrients and metabolically active cells which make proliferation possible. Biofilm can only be studied *in vivo* using special staining methods, microelectrode and fluorescent chemical probes, as well as highly sophisticated microscopy.

Dimitri Cozanitis, M.D., DTM&H, Docent ; Paavo Mäkelä, M.D., Docent.
(*) Department of Anaesthesia & Intensive Care Medicine, Helsinki University, Helsinki, Finland.
(**) Late Hospital Hygienist, Helsinki University Central Hospital, Helsinki, Finland.
Correspondence address : Dimitri Cozanitis, Department of Anaesthesia & Intensive Care Medicine, Helsinki University Hospital, Meilahti Hospital, 00290 HUS, Finland. E-mail : dcozanitis@yahoo.com

Although biofilms in nature have a number of beneficial effects such as removing contaminants in soil and water, it is the detrimental aspects of their formation which cause more concern as disease becomes implicated. Biofilm provokes dental plaque and caries and contributes to the development of silent slow-moving microbial infections in, among other organs, the lungs, intestine and urinary tract. Orthopedic appliances and prostheses, tracheal tubes and intravenous cannulae can be targets of the biofilm phenomenon.

The dilemma of biofilm formation, in the case of infection, is that the microbes within it are shielded and thus undisturbed by antibacterial agents, topical or parenteral antibiotics, and disinfectants. Although a variety of hypotheses has been offered as to how and why this occurs, the definitive solution is the removal of the infected object, which in the present context, is the infected catheter (4, 5).

Hands – the crux of the problem

Without question, hands through physical contact bear the greatest responsibility for microbial contamination. Hand cleaning and disinfection present their own problems. Briefly, from the age of twenty onwards, human skin begins to age due to the gradual decrease in the number of sweat glands with the ensuing loss of skin moisture. As a result, the normal (resident) microbial population may increase as do the (virulent) transient strains.

Hospital personnel with chapping skin or chronic skin conditions such as atopy and dermatitis are particularly affected and thus may avoid washing their hands even with plain water. Frequent hand washing (which can be as often as 100 times per 8-hour shift in neonatal units) may cause drying, cracking and wounding of the skin especially during cold and dry winters. The consequent damage results in the development of multi-resistant stains of both resident and transient micro-organisms (6).

Physiological parameters such as transepidermal water loss, skin impedance and pH have been evaluated in assessing the effects of repeated washing on the skin condition of hands and the microbial count. In several investigations, hands were washed with plain water, plain or medicated soaps (bar or liquid), ethyl or isopropyl alcohol, hexachlorophene, chlorhexidine, and iodine solutions. Washing with plain water alone may reduce the number of microbes, but the alcohols were most effective. However, transient pathogens were not all similarly influenced. For instance, on dry surfaces, Pseudomonas and Klebsiella populations diminished more readily than Staphylococcus aureus. After washing, fewer bacteria remained on the palms of hands than on finger tips. A solution containing ethanol, glycerin and chlorhexidine was found preferable to others since dryness and chapping were prevented while the hands of individuals tested remained soft (7). In order to allow recovery of the skin's physiological status, hands should be washed no less than every 10 minutes (8). Alternatively, disinfection and if needed, the use of gloves is recommended but these must be changed before and after each contact regardless of this being a patient or procedure.

Besides bacteria, mycoses, *e.g.*, Candida may also contaminate the cannula. A sobering report is that of blindness and even death in patients whose catheters harbored Candida (9). Moreover, the hands of the anesthetist might well become soiled with viruses found on tracheal tubes following surgery (10) ; consequently, these organisms could be passed on to the catheter and enter the patient`s blood stream.

Apart from the hands, the infection of the cannula by air, albeit to a lesser extent, may pose problems. Skin scales are constantly shed from unprotected areas of personnel and patients. These scales may shelter commensals and/or pathogens that are then transported and deposited by omnipresent dust particles in the air which serve as vehicles. The particles of dust carry an electrical charge and thus attract one another forming bacteria-carrying particles resulting in sedimentation which settles on to the oppositely charged cannula prompting contamination.

When the electrostatic force of various objects used in patient care was measured, those of plastic materials carried a greater charge thereby attracting more dust particles, especially skin scales which harbor bacterial colonies. If the plastic devices were first treated with an antistatic solution of the quaternary ammonium compound benzalkonium chloride and allowed to dry, the electrostatic charge was reduced, as indeed was the subsequent bacterial count. The action of the benzalkonium is attributed to its antistatic property rather than to any disinfectant activity (11). Germs may also be dispersed in air by speaking, coughing and sneezing, thus underlining the purpose and proper use of face masks (12). It is well known that a single sneeze may expel some 20 000 droplets each of which may contain pathogens, with some of these droplets covering a distance of over five meters.

Awareness, education and compliance

The methicillin-resistant Staphylococcus aureus strains found in the epidural abscess due to blood borne infection were identical to those isolated from the site of the patient's infected cannula (1). This situation is not unique as septic discitis and other complications have been described with bacteria having been displaced from a contaminated catheter (13).

Apparently anesthetists give less attention to good hygiene practice than do their surgical colleagues (14). In two surveys, 42 and 48 percent, respectively, of American anesthetists admitted to using the same syringe for administering drugs to numerous patients (15, 16). This practice is a serious breach of aseptic technique but unfortunately it does not seem to be uncommon (17). An Austrian study noted that 80 percent of individuals placing catheters did not disinfect their hands before the procedure (18). In England, an investigation revealed that 63 percent of persons who inserted cannulae wholly disregarded hand hygiene while 13 percent inadequately cleaned the patient's skin before piercing it. During that year, 19 cases of Staphylococcus aureus septicemia were registered, the origin of which involved the catheter. The authors stress, that most probably more of these complications occurred but simply failed to be entered (19).

Contemporary guidelines and proposals for good practice involving catheters are available, mostly in journals of hygiene. Guidelines in themselves are of little value unless they are followed by a very high degree of sustained compliance. Nevertheless there is good agreement amongst these projections which include, for example, the use of alcohol to disinfect the skin and allowing it to dry without any further palpation. The bore of the cannula to be inserted should be proportionally narrower than the vein so that there is no impingement on the vessel wall. The cannula must be well fixed to the skin to prevent any movement. There is, however, contention as to how often the cannula should be replaced : the limits range from 48 h to more than 96 h. Nevertheless it is agreed that the longer the catheter remains *in situ* and especially in the presence of inadequate asepsis, the greater is the risk of infection. The cannula must be immediately removed when no longer needed ; the excuse of maintaining it "just in case" is unacceptable (20).

Indirectly at least, there is a trend to involve the general public in the problem of hospital hygiene. An article in the British lay press reported defects which appeared in a survey carried out by the Healthcare Commission that included over 200 000 employees of the National Health Service. The shortcomings noted were insufficient training resulting in limited knowledge of the spread of infection and difficulties in the availability of such basic items such as alcohol, disinfectants and hand washing facilities (21). Based on the experience from Geneva, "clean-your hands" campaigns have been initiated in several English hospitals where alcohol-based antiseptics are placed near the patients. Badges, aprons and posters that read, "It's okay to ask" are evident as are pamphlets which encourage the patients to ask staff members if they have washed their hands. As a result of these efforts, there was a decrease in infection within the collaborating hospitals (22).

In 1973, Maki *et al*., sweepingly stated, "the insertion of a catheter should be considered a minor surgical procedure, and sterile gloves and drapes should be used when feasible" (23). But their recommendation has been forgotten, perhaps because the placing of catheters has become so routine, almost automatic, with little attention being afforded to it and possible infections from them commonly overlooked. However, there exists a growing laxity or disorientation within the confines of what had previously been routine hospital hygiene. Nurses, for instance, in some intensive care units work with their hair uncovered although there is clear evidence that hair is an avenue of infection (24). Similarly, despite data to the contrary (12), many anesthetists in the operating theatre feel that facemasks are unnecessary.

The anesthetist should attempt to maintain the same level of hygiene as that of his colleagues on the opposite side of the anesthesia screen. The introduction of bacteria - even commensals such as Staphylococcus epidermidis (the insidious invader) – in small numbers through the cannula's side-port may well jeopardize the outcome of a "clean operation". These may originate from the hand of the patient or anesthetist or from the unsterile hub of a syringe.

The authors feel that each trainee anesthetist should undergo sound training in hospital hygiene emphasizing practical clinical issues as an integral part of his/her education. The degree of assimilation of that teaching would be assessed within the scope of the candidate's qualifying examination.

It is most disturbing to read the study of anesthetists in England where only 35 percent of them wore facemasks in the operating theatre or washed

their hands between cases (25). Demonstration of bacteria-forming colonies grown on contact agar plates from the ten finger tips of hospital personnel before and after disinfecting their hands can create awareness provided that the findings be shown to the participants. Periodic unannounced sampling of the hands could also be of value for promoting compliance. Natural reluctance is probable with some individuals running to disinfect their hands when realizing that such a check of this nature is in progress while others might completely refuse to collaborate. In any case, opposition to such efforts is expected under the ever fluttering banner of "economics" even though in the final analysis these programs would undoubtedly prove cost-effective.

Unquestionably, the importance of compliance is paramount. This does not rest on the initiatives of a selected few but instead it is dependent on a team effort involving each and every individual, for one single break in the rules of good hygiene can deliver a pernicious outcome. Total and unequivocal compliance with the many facets of infection control can certainly never be reached, but every attempt towards that goal must be made. No effort should be spared to ensure that awareness and education is always ongoing within a highly accountable prevailing team spirit which focuses on the patient. The key tool to modifying behavior patterns towards good hygiene would be the well established psychological phenomenon of reinforcement.

The anesthetist has the moral as well as the obvious ethical obligation to apply the highest standards of hygiene to the ostensibly innocuous cannula. An editorial reflection (26) in the New England Journal of Medicine concerning an article on septicemia from intravenous solutions states, "asepsis must be maintained with near religious fervor, that there are no foolproof systems that permit the disregard of meticulous technic". That comment of over a generation ago still remains relevant today.

In conclusion, the anesthetist should assume a more responsible position in the insurmountable battle of hospital infection by bearing in mind the rules of good hygiene when inserting and/or caring for the peripheral intravenous catheter. The anesthetist as well as all individuals who are involved with the care of patients must become an integral part of the team engaged in hospital hygiene. Education, awareness and compliance should be ongoing in order to somehow reach a state where nosocomial infection is brought onto some level of control.

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