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Brief report

Low-hanging fruit for human factors design in infection prevention—still too high to reach?

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Human factors design interventions have been suggested to mitigate infection risk in health care. Among such solutions, many are easily identified and theoretically simple and quick to realize. These are called low-hanging fruit. We present a case of infection risk associated with syringe manipulation that could easily be solved by introducing user-centered design solutions. Yet, organizational complexity makes implementation of such solutions hardly reachable. We therefore advocate embedding human factors macroergonomic expertise on an organizational level.

Prefilled and ready-to-use syringes avoid the additional step of opening a vial to aspire 0.9% sodium chloride. These syringes are used to rinse vascular access ports before or after administering intravenous medication or after drawing blood. They are available in 2 forms—either fully sterile or sterile only inside the barrel (partially sterile). Fully sterile syringes are necessary for use on sterile fields or to prepare medication that comes in powder form: the solvent is injected in the vial with the powder, which dissolves, and the suspension is then aspirated. During this maneuver the plunger rod must not be touched because, once unsterile, it can contaminate the syringe contents via the inner surface of the barrel (Fig 1). For the same reason, syringes that are not fully sterile must not be used to dissolve then subsequently aspire medication. This rule is well known by nurses but perhaps less so by physicians.[1] Some syringes feature what is known in human factors engineering (HFE) as a forcing function. To prevent contamination of the plunger rod during use, the plunger travels all the way in, becoming level with the end of the barrel. In this way, if the plunger has been used once it cannot be withdrawn. This feature is called secure backstop.

Our infection control department was notified of a potential risk of confusion between sterile and partially sterile syringes in the institution because of similar packaging and look. Investigation brought to light that the purchasing department had recently changed models because of an attractive lower price opportunity. Upon identifying this risk, infection control department staff updated the corresponding standard operating procedure, attempting to prevent confusion; but effectiveness of this solution was questioned. Our infection control department also raised

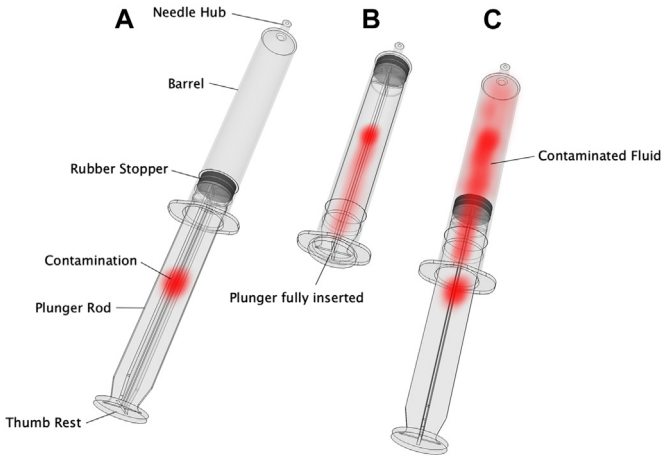

Fig 1. Contamination risk in syringe manipulation. (A) Plunger rod of prefilled syringe gets contaminated during manipulation. (B) When pushed in, the contaminated plunger rod contaminates the inside wall of the barrel. The plunger has traveled in fully, a forcing function to disable reaspiration. (C) Subsequently aspirated suspension gets contaminated by the inner wall of the barrel.

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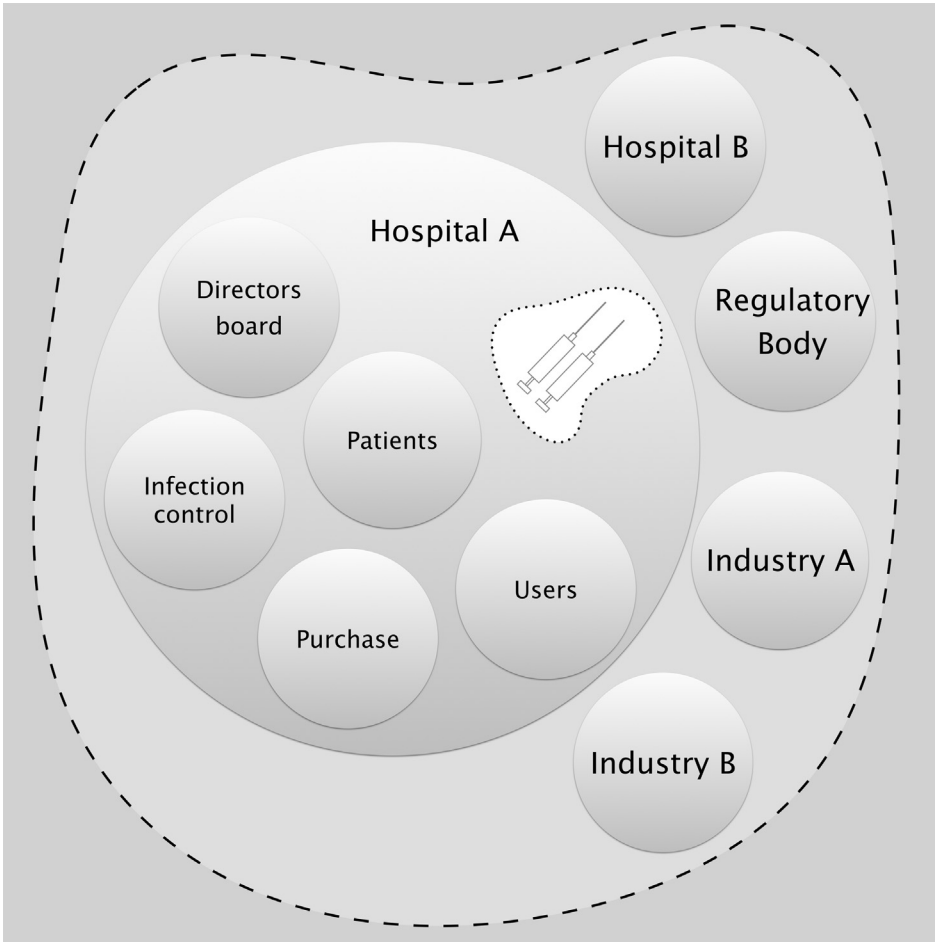

Fig 2. Isolated versus systems view of the syringe problem. Dotted line indicates restricted problem view. Dashed line indicates systems view. The systems view of the involved parties in the syringe case: the purchasing department, whose primary goal is to achieve cost-efficiency; the industry that struggles to standardize color-coding across competing enterprises; nursing staff who prefer the convenience and versatility in a single product type; infection control departments, whose task is to mitigate infectious risks; and others.

concern with the purchasing department but a solution is still pending.

As a consequence, health care workers are now presented with a choice of 2 prefilled syringes, a partially sterile model that must not be used for aspiration and a fully sterile model that could be used for aspiration. Both feature a secure backstop to prevent reaspiration. For the fully sterile type, this feature is of no added value.

DISCUSSION

HFE is the scientific discipline that takes a systems approach to understanding and optimizing the interactions among humans and their work system. Until now, such HFE expertise has remained largely external to health care institutions.[2] Our situation lends itself to discussing the issues at hand.

The risk of confusion of 2 lookalike devices or medication containers is a well-known safety risk. When 2 devices have similar appearance and configuration, but require different user actions, habits established with the use of 1 device can induce handling errors with the other.[3] Although written standard operating procedures are an important means of standardizing procedures in an institution, our case demonstrates that they might only serve as a patch on a system problem. The hierarchy of intervention effectiveness suggests that technological, system-focused interventions (eg, forcing functions and automation) are more effective than those relying on changes in human behavior.[4] Great work has been done, for example, in medication packaging design, applying the HFE principle of avoiding homogeneity among items with different functions to prevent their confusion.[5] It would be straightforward to do the same in our case by modifying the syringe design; for example, through distinct colors. Another novel design solution would be alteration of the surface texture between the 2 syringes, thereby introducing additional haptic feedback to the user. Once identified, HFE design solutions such as these seem intuitive, and theoretically easy to implement, thus appearing to be low-hanging fruit. However, several challenges arise.

First, concerning the prefilled, fully sterile syringe, nurses and technicians recognize that there is no added value in the backstop feature and have found a workaround (using their fingernails to withdraw the disabled plunger and thereby contaminating it). Here, a powerful human factors safety design principle, forcing function, ironically increases the risk it tries to prevent.

Second, the procurement department was not optimally organized to detect the 2 aforementioned safety risks when deciding for the bid. This is a huge challenge among health care organizations, which are characteristically intractable due to constantly evolving frontline activities that are only partially covered by written procedures.[6]

Third, once an ergonomic solution is found, cross-industry adoption and standardization are far from being guaranteed.

Our case demonstrates that the complexity of current organizational structures and processes, as well as limited coordination