LESS IS MORE IN INTENSIVE CARE

Less contact isolation is more in the ICU: not sure

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The debate over the use of standard precautions (SPs) versus contact precautions (CPs) for stopping the spread of multidrug-resistant organisms (MDROs) has been controversial for years [1–5] and still persists, despite recent high-quality cluster-randomized studies [6–9]. SPs are based on a universal (also called "horizontal") approach to all patients, whether or not they are known to be as MDRO carriers; SPs include compliance with hand hygiene and cleaning the environment. CPs with a so-called "vertical" approach still include compliance with SPs for all patients, additional control barriers for colonized patients, i.e. gloves and gown, and placement in a single room if possible. Identification of MDRO carriage through screening is frequently associated with CPs.

The introduction of alcoholic handrub (AHR) in the early 2000s has been a major step in improving compliance with hand hygiene in healthcare settings. Many studies have demonstrated that including AHR in a multifaceted strategy, based on education, observation and feedback, and other bundled measures, is necessary for effective AHR implementation. Since CPs and SPs both aim to interrupt transmission, SPs now including AHR (as compared to handwashing) show higher efficacy, likely closer to that of CPs, thus fueling the debate between CPs and SPs.

The epidemiology of MDROs is rapidly changing. MDROs comprise methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum betalactamase-producing enterobacteriacae (ESBL-PE),

vancomycin-resistant enterococci (VRE), carbapenemase-producing enterobacteriacae (CPE), and carbapenemase-producing Gram negative bacilli, *Pseudomonas aeruginosa* and *carbapenem-resistant Acinetobacter baumannii* (CRAB). In some countries, in the late 2010s, the latter, i.e. CPE, carbapenemase-producing Gram-negative bacilli, and VRE, were classified as extensively resistant.

In ICUs facing multiple endemic MDROs, placing a large proportion of patients to CPs may result in lower compliance for interrupting cross-transmission from each of these patients [10]. Priorities must be defined in order to select the most dangerous MDROs, in terms of the individual consequences of infection and the collective risk of dissemination, and thus the appropriate infection control practices can be selected.

This complexification of epidemiology and control measures, together with legal mandates issued in several countries, may have the effect of obscuring the central question relating to efforts to control the spread of MDROs: what is the most effective method of interrupting MDRO cross-transmission? Hospital epidemiologists are often faced with difficult choices, given that CPs have some benefits from the perspective of preventing the transmission of many MDROs, and the subsequent infections, but also have negative effects in terms of cost, environmental waste and healthcare worker dissatisfaction.

Many factors contribute to the mechanism of MDRO dissemination in the ICU, and these should be taken into consideration when designing a policy (Table 1). Some are of key importance:

- The particular MDRO in question and its local/regional and national epidemiology. Several MDROs can be more easily transmitted suggesting that CPs might be more appropriate for these bacteria: for example, non-*E. coli* ESBL as compared with ESBL *E. coli* [4, 11], or ESBL-PE (taken globally) as compared

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Table 1 Circumstances in which standard or contact precautions are likely to be effective

	In favor of standard precautions	In favor of contact precautions	Rationale
Patient			
Bacterial burden in the source patient	Asymptomatic	Diarrhea, UTI, wounds	The risk of cross-transmission and environmental contamination increases with the bacterial burden of the source patient, making CPs and use of a single room potentially more effective than SPs.
Care dependency, workload	Low	High	A higher workload and a higher level of care dependency increase the number of contacts with the source patient, and thus the risk of cross-transmission.
Patient's risk of infection	Healthy	Vulnerable	In has been ICU with patients at high risk of infection, e.g. transplant ICU or burn ICU, placing colonized patients to CPs is more likely to be effective and reduce the risk of (severe) infection.
MDRO epidemiology			
Local epidemiology	Endemic	Sporadic, outbreaks	It has been shown that the higher the number of patients placed on to CPs, the lower the adherence to control measures.
Type of MDRO	Multiply resistant	Extensively resistant	CPs are more likely to be effective against some extensively resistant MDROs in patients with difficult-to-treat infections than in patients at risk of infection with less resistant MDROs. In addition, adherence to a national policy, usually targeting more resistant MDROs, is crucial for success at national level.
Ease of transmission ("transmissibility")	Lower (e.g. ESBL *E. coli*)	Higher (e.g. ESBL non *E. coli*; CRAB)	The frequency of transmission depends on the type of MDRO.
Route of dissemination	Involvement of antibiotic selective pressure	Mostly by cross-transmission	The emergence of several MDROs variably depends on selective antibiotic pressure, e.g. ampC producing *Enterobacteriacae* and exposure to 3GC or several resistance mechanisms in *P. aeruginosa* being induced due to antibiotics. CPs may be less useful for patients with these MDROs.
Health Care Workers practices			
Compliance with hand hygiene	High (> 70%) or low (< 40%)	Intermediate (40–70%)	High compliance with hand hygiene forms the basis of efficacy of SPs. But in a situation where there is low compliance with hand hygiene, most efforts must target improving compliance before instituting CPs. The benefit of CPs may be higher in the presence of intermediate compliance.
Alcoholic HR consumption in the ICU	High (> 150 mL/Pt.d)	Low (< 100 mL/Pt.d)	AHR consumption is a useful surrogate of hand hygiene in an ICU, in addition to compliance with hand hygiene.
Resources			
Environment	Clean, spacious rooms	Crowded	Architectural, human and financial resources are critical to improve compliance with CPs.
Single room	Limited number	Available	Assigning all ICU patients a single room improves compliance with hand hygiene at room entry and exit, therefore increasing compliance with CPs.
Screening of patients	Limited	Available	For screening to be effective, active surveillance cultures are required in order to identify the whole reservoir of MDROs in patients to be placed to CPs.
Human workforce	Limited	Available	CPs are time comsuming for healthcare workers, who have to don and doff protective equipment.
Financial resources	Limited	Large	CPs require financial resources for the purchase of protective equipment.

Adapted from Kirkland [1]

UTI, urinary tract infection; CPs, contact precautions; SPs, standard precautions; ICU, intensive care unit, MDRO, multidrug-resistant organism; ESBL, extended-spectrum betalactamase; CRAB, carbapenem-resistant *Acinetobacter baumannii*

with MRSA [8]. Others may spread rapidly, e.g. VRE and CRAB, partially owing to their environmental reservoir; such organisms therefore require enhanced environmental cleaning.

- National policies, strictly enforced by all health care facilities (HCFs), have resulted in several success stories relating to the control of MDROs, such as CPE in Israel [12], and MRSA in Northern European countries and, recently, in the UK and France as well [13]. Statistical modeling and regional surveillance of VRE and CPE showed that some HCFs may be hotspots for acquisition with subsequent dissemination in many other facilities, thus demonstrating the role that might be played by a policy enforced in all HCFs [14]; many of these national policies involved the use of active surveillance and CPs in their control measures.

- This is especially true at the beginning of an epidemic, when extensive active surveillance of cultures and strict control measures including CPs have the highest chance of being effective. In contrast, an endemic situation with high prevalence at ICU admission can only be curtailed, and SPs may be preferred in this situation. Ideally, any strategy implemented should be evaluated, by performing admission and discharge screening.

- Actually, compliance with hand hygiene in the context of SPs and CPs is lower than that measured through auditing, due to a Hawthorne effect [15]. The first objective in low compliance/low AHR consumption ICUs should be to improve hand hygiene practice, before implementing CPs.

- Resources are critical for effective implementation of any precaution, including the availability of a single room for implementation of CPs. In ICUs in developing countries, it may be decided first to improve compliance with hand hygiene, while reserving CPs for the most aggressive MDROs.

As regards to Table 1 parameters to be considered before deciding a control strategy, we suggest that each ICU could implement its own policy, tailored to local epidemiology and resources. Leadership and effective implementation of recommended measures are crucial for success. For example, two multicenter ICU studies focusing on efforts to control MRSA were published simultaneously in 2011 [6, 7]. Both studies used essentially the same control measures, and both had methodological issues, yet their impact, in terms of controlling MDRO, differed. The successful intervention was conducted using a behavioral approach, with performance feedback and resolution of local challenges, in addition to technical measures consisting of screening and CPs.

This illustrates the importance both of leadership and of involving health care workers (HCWs) in conducting such interventions.

CPs and SPs do not include measures for cleaning the environment. There is growing evidence that both dry surfaces and humid areas may be reservoirs of MDROs. This has long been demonstrated for VRE and CRAB, and to a lesser extent for MRSA. Recent publications have shown that Multi-drug resistant Gram-negative bacteria (MDR-GNB), including CPE, may persist in humid reservoirs, responsible for outbreaks [16]. Any strategy, SPs or CPs, to control the spread of MDROs should include thorough environmental cleaning.

Although MDRO epidemiology varies across ICUs, it is of critical importance to adhere to a regional and national strategy. That said, evaluation of the local situation may help efforts to select targeted MDROs against which CPs have the best chance of being effective, and identify other MDROs that might be better tackled with SPs, having taken into account a maximum number of patients to be placed to CPs for higher efficacy.

In this very complex field, there are good arguments on both sides, that support the use of either SPs or CPs for controlling the spread of MDROs [1, 17]. There is, however, some solid evidence. CPs should be enforced only if compliance with hand hygiene is high enough, e.g. > 40–50%, otherwise the first objective should be to improve it. Conversely, implementing CPs may be futile in the presence of already very high compliance with hand hygiene. Moreover, given its potential drawbacks, the use of CPs is probably less appropriate for endemic situations. Local resources should be devoted to the most cost-effective measures, based on local epidemiology, whilst respecting national guidelines.

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Compliance with ethical standards

Conflicts of interest
JCL and BG have no COI.

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References

1. Kirkland KB (2009) Taking off the gloves: toward a less dogmatic approach to the use of contact isolation. Clin Infect Dis 48(6):766–771
2. Morgan DJ, Wenzel RP, Bearman G (2017) Contact precautions for endemic MRSA and VRE: time to retire legal mandates. JAMA 318(4):329–330
3. Rubin MA, Samore MH, Harris AD (2018) The importance of contact precautions for endemic methicillin-resistant *Staphylococcus aureus* and vancomycin-resistant enterococci. JAMA 319(9):863–864
4. Tschudin-Sutter S, Lucet JC, Mutters NT, Tacconelli E, Zahar JR, Harbarth S (2017) Contact precautions for preventing nosocomial transmission of extended-spectrum beta lactamase-producing *Escherichia coli*: a point/counterpoint review. Clin Infect Dis 65(2):342–347
5. Marra AR, Edmond MB, Schweizer ML, Ryan GW, Diekema DJ (2018) Discontinuing contact precautions for multidrug-resistant organisms: a systematic literature review and meta-analysis. Am J Infect Control 46(3):333–340
6. Jain R, Kralovic SM, Evans ME, Ambrose M, Simbartl LA, Obrosky DS et al (2011) Veterans affairs initiative to prevent methicillin-resistant *Staphylococcus aureus* infections. N Engl J Med 364(15):1419–1430
7. Huskins WC, Huckabee CM, O'Grady NP, Murray P, Kopetskie H, Zimmer L et al (2011) Intervention to reduce transmission of resistant bacteria in intensive care. N Engl J Med 364(15):1407–1418
8. Derde LP, Dautzenberg MJ, Bonten MJ (2012) Chlorhexidine body washing to control antimicrobial-resistant bacteria in intensive care units: a systematic review. Intensive Care Med 38(6):931–939
9. Harris AD, Pineles L, Belton B, Johnson JK, Shardell M, Loeb M et al (2013) Universal glove and gown use and acquisition of antibiotic-resistant bacteria in the ICU: a randomized trial. JAMA 310(15):1571–1580
10. Dhar S, Marchaim D, Tansek R, Chopra T, Yousuf A, Bhargava A et al (2014) Contact precautions: more is not necessarily better. Infect Control Hosp Epidemiol 35(3):213–221
11. Gurieva T, Dautzenberg MJD, Gniadkowski M, Derde LPG, Bonten MJM, Bootsma MCJ (2018) The transmissibility of antibiotic-resistant enterobacteriaceae in intensive care units. Clin Infect Dis 66(4):489–493
12. Schwaber MJ, Carmeli Y (2014) An ongoing national intervention to contain the spread of carbapenem-resistant enterobacteriaceae. Clin Infect Dis 58(5):697–703
13. Stone SP, Fuller C, Savage J, Cookson B, Hayward A, Cooper B et al (2012) Evaluation of the national Cleanyourhands campaign to reduce *Staphylococcus aureus* bacteraemia and *Clostridium difficile* infection in hospitals in England and Wales by improved hand hygiene: four year, prospective, ecological, interrupted time series study. BMJ 344:e3005
14. Slayton RB, Toth D, Lee BY, Tanner W, Bartsch SM, Khader K et al (2015) Vital signs: estimated effects of a coordinated approach for action to reduce antibiotic-resistant infections in health care facilities—United States. MMWR Morb Mortal Wkly Rep 64(30):826–831
15. Srigley JA, Furness CD, Baker GR, Gardam M (2014) Quantification of the Hawthorne effect in hand hygiene compliance monitoring using an electronic monitoring system: a retrospective cohort study. BMJ Qual Saf 23(12):974–980
16. Kizny Gordon AE, Mathers AJ, Cheong EYL, Gottlieb T, Kotay S, Walker AS et al (2017) The hospital water environment as a reservoir for carbapenem-resistant organisms causing hospital-acquired infections-a systematic review of the literature. Clin Infect Dis 64(10):1435–1444
17. Septimus E, Weinstein RA, Perl TM, Goldmann DA, Yokoe DS (2014) Approaches for preventing healthcare-associated infections: go long or go wide? Infect Control Hosp Epidemiol 35(Suppl 2):S10–S14