Multiple drug resistant organisms in healthcare: the failure of contact precautions

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Multiple drug resistant organisms (MDRO), predominantly bacteria that are resistant to one or more classes of antimicrobial agents, have spread in hospitals with increasing frequency (Center for Disease Control and Prevention, 2013a; Spellberg et al., 2008). The Centers for Disease Control and Prevention (CDC) has noted this alarming trend and issued a ‘threat’ warning (<http://www.cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf>) for hospitals and beyond. The reasons for hospital spread are multi-factorial but the primary strategy to prevent transmission is use of hand hygiene and barriers as part of contact precautions, previously called contact isolation (Siegel et al., 2007). Virtually all MDRO are spread by contact (Sandora and Goldman, 2012). Contact can be direct, e.g. by actual touching, or indirect, by contact with objects or the environment. Contact precautions include use of single room (when possible), hand hygiene, use of dedicated equipment and supplies, and wearing personal protective equipment (PPE) (gowns and gloves) for all interactions that may involve contact with the patient or potentially contaminated areas of the environment (Sandora and Goldman, 2012). The aim of this paper is to suggest that contact precautions are failing, suggest why they are failing, and recommend changes to improve their effectiveness, because failure to stop the epidemic of MDRO will affect every aspect of clinical medicine, including inpatients and outpatients.

Many experts recommend contact precautions for patients infected or colonised with MDRO (Muto et al., 2003; Siegel et al., 2006). Thus, active surveillance – screening of asymptomatic patients to determine colonisation – is often recommended (Huskins and O’Grady, 2011) to identify undetected reservoirs of MDRO. Colonised (or infected) patients are then placed in contact precautions, usually until screening is negative (Shenoy et al., 2013). However, use of screening and contact precautions has been shown to be ineffective for preventing transmission of methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococcus (VRE) in ICU in a large cluster-randomised trial (Huskins et al., 2011). Even universal glove and gown use in ICU did not prevent

acquisition of MRSA and VRE (Harris et al., 2013), even though gloves, gowns, and hand hygiene are the backbone of contact precautions (Siegel et al., 2007).

Much like for MRSA and VRE, asymptomatic carriers of *Clostridium difficile* account for nearly as much cross-transmission as those who are clinically infected, suggesting that surveillance screening may have a role in preventing transmission (Curry et al., 2013). Use of surveillance screening for other MDRO clearly identifies more patients that require contact precautions than does relying only on clinical cultures (Muto et al., 2003) and therefore is likely to increase the use of contact precautions. However, not only is the evidence of effectiveness minimal, as currently practiced, contact precautions have also been associated with a number of adverse events (Stelfox et al., 2003). Given the cost of such active surveillance, the lack of proven efficacy, and the potential for adverse events, its use should be re-evaluated at least for MRSA and VRE for which active surveillance has been studied and failed (Edmond and Wenzel, 2013). Universal decolonization for MRSA with chlorhexidine bathing has proven more effective than targeted MRSA surveillance and contact precautions in the ICU (Huang et al., 2013). These studies suggest that alternative strategies to contact precautions may prevent transmission and be preferable for some MDRO, being both more effective and more acceptable (Huang et al., 2013; Milstone et al., 2013).

Many studies have shown reduction of transmission of MDRO with enhanced and enforced contact precautions during epidemics. Such studies usually also include a number of

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other interventions such as staff education, enhanced surveillance, or introduction of new hand hygiene products making it impossible to sort out independent effects of a single component of the intervention. Even if they are effective during epidemics, however, contact precautions as currently practiced are not a fully effective strategy for controlling the problem of endemic infections when there are no epidemics to enhance compliance with all precautions. MDRO and mobile genetic elements continue to be transmitted, sometimes despite comprehensive use of contact precautions (Aboelela et al., 2006; Centers for Disease Control and Prevention, 2013; Eyre et al., 2013; Huskins et al., 2011; Snitkin et al., 2012; Vlek et al., 2013). Failure of contact precautions does not appear to be due primarily to a flaw in our understanding of disease transmission but rather, at least in part, to poor compliance with hand hygiene and PPE (Centers for Disease Control and Prevention, 2009; Huskins et al., 2011; Larson et al., 2013; Weber et al., 2007). Compliance with PPE during isolation is as low as 29% (Larson et al., 2013). However, in one study, even when PPE were worn universally in the ICU, MDRO were transmitted as readily as when full PPE were used only for patients in isolation (Harris et al., 2013). The failure of universal glove and gown precautions implies that increased compliance with PPE alone will not solve the problem of the failure of contact precautions. Despite the problems with contact precautions, such precautions are still needed to prevent transmission from highly infectious patients and those with MDRO associated with high mortality, especially in the ICU (Malani, 2013; Siegel et al., 2006; Vlek et al., 2013), and contact precautions should be strengthened, not eliminated.

Because of the frequent ineffectiveness of contact precautions, CDC has recommended expanded precautions for carbapenem resistant enterobacteriaceae (CRE) (Centers for Disease Control and Prevention, 2013b). Surveillance screening for colonisation and cohorting of infected or colonised patients with dedicated staff are recommended in addition to contact precautions. Such comprehensive and expanded precautions were needed to end a lethal epidemic of CRE at the Clinical Center of the US National Institutes of Health (NIH) (Snitkin et al., 2012). Only physicians were allowed to move between those patients in the cohort and all other patients. Similar expanded contact precautions were needed in Israel to end a large outbreak of CRE; contact precautions failed to stem the outbreak (Ben-David et al., 2010; Schwaber et al., 2011). It appears that contact precautions, colonisation screening, and cohorting of infected or colonised patients may be effective for controlling some lethal outbreaks in which the MDRO is spread by contact. It is possible that transmission precautions, including contact precautions, are most effective when the specific MDRO is not endemic and when the problem is addressed early. Success of early interventions includes the containment of vancomycin resistant *Staphylococcus aureus* in the United States, MRSA in the Netherlands, and

severe acute respiratory syndrome (SARS) worldwide (Sievert et al., 2008).

Lack of compliance with contact precautions may not be the only cause of apparent failure of isolation. Many MDRO infections that become clinically apparent in hospitalised patients are actually from the patient's own bacterial flora and not from transmission (Eyre et al., 2013; Malani, 2013). Some other sources of transmission include the hospital environment and inadequately disinfected medical equipment (Centers for Disease Control and Prevention, 2014; Snitkin et al., 2012). Contact precautions may frequently fail to prevent infections acquired by these sources. Environmental reservoirs are most obvious for MRSA, VRE, *Acinetobacter baumannii*, *Clostridium difficile*, and norovirus (Weber and Rutala, 2013). Use of hydrogen peroxide vapor and ultra violet light disinfection has been shown to markedly reduce environmental contamination of hospital rooms (Weber and Rutala, 2013). Such room disinfection may need to be a standard part of room disinfection after isolation (Snitkin et al., 2012), but this remains to be proven.

Contact precautions are not designed to prevent MDRO infections transmitted from contaminated equipment and bacteria that survive routine cleaning. Thus, rigorous disinfection of equipment and the hospital environment is also needed (Center for Disease Control and Prevention, 2014; Snitkin et al., 2012; Weber and Rutala, 2013). Eliminating MDRO from hospital rooms may require sporocidal disinfection for all rooms, rather than just those used for contact precautions. This may be seen as a major burden for environmental cleaners. However, it is clear that many patients are colonised and can transmit MDRO but are not identified. Instead, active screening could be done to improve the identification of patients with MDRO but this would create a complicated 'vertical' method of determining room disinfection method compared to the 'horizontal' approach of universal sporocidal cleaning of patient rooms (McDonald, 2013). Vertical interventions are designed to reduce colonization or infection due to a single pathogen. Horizontal interventions are applied universally and are aimed at controlling all pathogens, such as all MDRO. It is clear that room contamination from one patient with MDRO can spread to subsequent patients and this can be greatly decreased by sporocidal cleaning with hydrogen peroxide vapor (Passaretti et al., 2013).

It is time we admitted the failures of standard contact precautions, studied the reasons for failure, and devised an improved contact precautions to effectively address the antimicrobial resistance threats that are here to stay (Centers for Disease Control and Prevention, 2013a). The following are recommendations to improve and to evaluate contact precautions.

What can be done to improve contact precautions:

- 1) Monitor compliance with contact precautions including use of personal protective equipment and

hand hygiene and work to continuously improve compliance. Such efforts can be successful (Mernelius et al., 2013). Contact precautions and use of PPE should be monitored and enforced throughout all travels within the hospital or institution, not just in the patient room. Ancillary departments, such as radiology, are likely fertile areas for breakdown of barriers and transmission of MDRO.

- 2) Limit the use of contact precautions for patients colonised or infected with MRSA, VRE, and extended spectrum beta-lactamase producing gram negative rods (Tschudin-Sutter et al., 2012). Such efforts should allow infection prevention efforts to concentrate on other MDRO that are more of a threat and cannot be controlled by other 'horizontal' efforts to prevent transmission. If healthcare workers believe that contact precautions are unnecessary and overused, they may ignore these precautions (Dhar et al., 2014).
- 3) Use active screening of patients for prolonged outbreaks of MDRO or those associated with a high mortality, and place colonised and infected patients in the same geographic areas with dedicated equipment and hospital staff (cohorting).
- 4) Study the efficacy of active screening of endemic and epidemic gram negative MDRO. CDC recommends active surveillance for CRE (Malani, 2013). However, other experts instead recommend active surveillance for carbapenemase-producing *Enterobacteriaceae* (CPE), which is preferred, because this subclass of CRE is the most virulent and associated with high-mortality outbreaks (Sandora and Goldmann, 2012; Savard et al., 2013; Snitkin et al., 2012). Not all CPE produce a carbapenemase (Sarvard et al., 2013).
- 5) Use sporocidal cleaning of rooms and equipment after each patient in contact precautions. Consider using universal sporocidal cleaning between all patients, such as using dilute bleach for cleaning. Such cleaning should be thorough and monitored periodically. The use of hydrogen peroxide vapor and ultraviolet light sporocidal disinfection of all patient rooms and equipment is being studied (Passaretti et al., 2013; Weber and Rutala, 2013), and such research should be expanded.
- 6) Evaluate chlorhexidine bathing and other 'horizontal' methods to prevent transmission of MDRO between patients for CRE and other gram-negative MDRO and for all high-risk patients, not just those in the ICU. Chlorhexidine bathing appears to prevent transmission of MRSA and VRE and to prevent bloodstream infection from many pathogens (Huang et al., 2013; Milstone et al., 2013).
- 7) Target for decolonisation and eradication those MDRO that cause severe and deadly epidemics (Saidel-Odes et al., 2012; Sievert et al., 2008).

- 8) Mandate private rooms for patients infected or colonised with CRE. Private rooms are preferred for all other MDRO infections, especially if there is evidence of ongoing transmission.
- 9) Conduct surveillance screening of healthcare workers only when there is epidemiologic evidence of transmission.
- 10) Provide explicit description of recommended precautions to accompany patients colonised or infected with MDRO who are transferred between units or facilities or who are readmitted. Hospitals receiving patients upon transfer should also be alert to possible MDRO and the need for containment (Sandora and Goldmann, 2012).

Antibiotic resistance threats are increasingly more dangerous and deadly (Centers for Disease Control and Prevention, 2013a). Six of 18 patients infected with CRE died of infection in the NIH outbreak (Snitkin et al., 2012), and there are few therapeutic options for many MDRO (Spellberg et al., 2008). We need to confront the failures of contact precautions before the MDRO 'threat' becomes the MDRO nightmare.

Declaration of conflicting interest

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