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Commentary

Directly observed hand hygiene — from healthcare workers to patients

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Despite the tremendous effort put into the promotion of hand hygiene for decades, hand hygiene compliance among healthcare workers and patients remains suboptimal. A novel approach is required to identify and address the remaining gaps despite the World Health Organization's Five Moments for Hand Hygiene. Directly observed hand hygiene (DOHH) may fill this gap and ensure 100% hand hygiene compliance during crucial moments outside the WHO's Five Moments. The concept of DOHH was inspired by directly observed therapy for treating tuberculosis, where drug compliance is of utmost importance [1] As the patient receives antituberculous medications under direct observation by a healthcare worker, the compliance of the patient can be ascertained. Similarly, when alcohol-based hand rub is delivered to the hands of healthcare workers and patients by a designated staff member at regular time intervals, their hand hygiene is under direct observation and compliance is ensured. Antituberculous medications are given once daily, while hand hygiene opportunities in healthcare workers and patients are numerous in clinical settings. Therefore, DOHH should be implemented in highly selected scenarios and moments as illustrated below.

Directly observed hand hygiene in healthcare workers and patients for outbreak control

DOHH was first implemented in a psychiatric facility with frequent nosocomial outbreaks of infectious diseases. When an outbreak of human metapneumovirus occurred in 2005, 4-hourly DOHH was instituted during the day for all psychiatric patients, who were lined up to receive alcohol-based hand rub [2]. Under the direct observation and supervision of healthcare workers, adequate rubbing time and thoroughness of complete hand disinfection were ensured. Rubbing time is critical as hand rubbing with alcohol-based hand rub for 15 s can achieve a 3-log reduction of hand microbial flora [3]. The 4-h interval was chosen to balance the workload of the healthcare workers (15 min per round) and the duration of survival of bacteria and viruses on patients' hands [4]. With regular and appropriate use of alcohol-based hand rub, the transmission of most potential pathogens in the psychiatric unit was interrupted, and the number of patients and staff involved in nosocomial outbreaks was reduced significantly after implementation of DOHH [2].

DOHH was also implemented for the control of a norovirus outbreak in an infirmary unit in an extended-care hospital where all infected patients were bed-ridden and required feeding via a nasogastric tube or percutaneous endoscopic gastrostomy tube. Despite ward closure to new admissions, thorough environmental cleaning, disinfection with sodium hypochlorite 1000 ppm, and cohort nursing with contact precautions of symptomatic cases in a designated area within the same ward, the outbreak continued until the implementation of DOHH by infection control nurses during high-risk patient care procedures, including changing of nappies and delivery of patients' feeds [5]. Norovirus is a non-enveloped RNA virus

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which is less susceptible to alcohol [6]. However, an in-vitro study showed that a 2- and 3-log reduction in virus titre could be achieved when 80% ethanol was applied for 30 s and 1 min, respectively [7]. DOHH ensured compliance with hand hygiene and alcohol contact time, leading to successful termination of the norovirus outbreak within this hospital [5].

Besides outbreak control, DOHH also served as an essential element for outbreak prevention, including those caused by respiratory viruses and gastrointestinal viruses. During the pandemic influenza A/H1N1 outbreak in 2009, 100 patients admitted to the study hospital within the first 100 days of the pandemic had laboratory-confirmed influenza A (from 1st May to 8th August 2009). This resulted in a total of 836 asymptomatic exposed persons (184 patients and 652 HCWs) requiring seven days of medical surveillance by the infection control nurses. With the implementation of DOHH and regular delivery of alcohol-based hand rub to patients and healthcare workers during the day, nosocomial transmission of influenza A/H1N1 was minimized among patients and healthcare workers, resulting in a secondary attack rate of 0.48% [8]. This was much lower than the rate of 10–45% reported in a review on hospital-acquired influenza [9].

Following the pandemic influenza A/H1N1 outbreak in 2009, DOHH was further incorporated into a strategic infection control bundle against norovirus in a hospital in Hong Kong between November 2009 and February 2010, when the average temperature was 16°C (range 14–20 °C) with relative humidity of approximately 70%. During that winter, norovirus outbreaks affecting approximately 25% of all public hospitals in Hong Kong were noted, involving all clinical disciplines from acute to chronic patient care areas. The implementation of DOHH resulted in zero nosocomial norovirus outbreaks and an eight-fold reduction in hospital-acquired norovirus infections compared with the previous year [10].

Directly observed hand hygiene for conscious hospitalized patients before meals and medications

To combat against the growing threat of multi-drug-resistant organisms such as vancomycin-resistant enterococci (VRE), DOHH targeting conscious hospitalized patients before meal and medication rounds was initiated, in addition to the active surveillance culture, extensive contact tracing, environmental cleanliness and antimicrobial stewardship programme as proactive infection control measures [11]. Hand hygiene before meal and medication rounds was thought to be important as VRE can be acquired via the contaminated hands of patients, especially during concurrent use of antibiotics with anaerobic activity that promotes high-density colonization of VRE in the gastrointestinal tract, which further contaminates the environment [12,13]. The implementation of DOHH before meal and medication rounds may help to reduce oral acquisition of VRE in hospital, and minimize nosocomial transmission and outbreaks due to VRE. Between 1st July 2011 and 13th November 2013, of the 78 reported nosocomial VRE outbreaks in Hong Kong, only one (1.3%) VRE outbreak occurred in the study hospital [11]. Following the success of DOHH in controlling nosocomial transmission of VRE at the study hospital, DOHH before meal and medication rounds for all conscious hospitalized patients is now promoted and practised in all public hospitals in Hong Kong. Since then, the rising VRE incidence of 16.5% per month ($P < 0.001$) has reverted to a reduction of -9.8% per month ($P < 0.001$). The outbreak rate reverted from an increasing trend of 10.5% per month ($P < 0.001$) to a decreasing trend of -13.3% per month ($P < 0.001$) between January 2011 and October 2015 [14].

DOHH-based infection control measures not only helped to control VRE, which was emerging but not yet endemic in Hong Kong, but also facilitated control of the endemic strain of multi-drug-resistant *Acinetobacter baumannii* (MRAB) ST457. The incidence of MRAB bacteraemia reduced from its peak of 1.86 (14 cases) per 100,000 patient-days to 0.77 (one case) per 100,000 patient-days during the first six months of DOHH implementation ($P < 0.001$) [15].

'Hand hygiene ambassadors', who are designated healthcare assistants, were appointed and assigned to perform DOHH before meal and medication rounds in clinical areas in every ward. They were responsible for delivering alcohol-based hand rub to all conscious hospitalized patients at critical times (i.e. just before a patient takes any food, drink or medications). A 15-min talk was given to each healthcare assistant at the bedside to explain the significance of patients' hand hygiene in infection control. To emphasize the importance of their role as hand hygiene ambassadors, they were given the opportunity to meet with the infection control officer, the hospital chief executive and/or the professor of microbiology, and the senior nurses from the respective wards. A formal certificate was also presented to them at the official appointment ceremony [16]. The beauty of the hand hygiene ambassador programme is that a specific staff member is empowered to deliver hand rub and ensure full compliance with hand hygiene practice before meal and medication rounds for all conscious patients. In this analysis, the overall audited compliance of ambassador-initiated DOHH was 97.3% (428/440 episodes), which was significantly higher than patients' self-initiated hand hygiene via a patient education programme (37.5%, 218/582 episodes, $P < 0.001$) [16].

The role of hand hygiene ambassador has extended from hospitals to residential care homes for the elderly (RCHE) in Hong Kong. From July to August 2017, a cluster randomized control study was conducted in 10 RCHEs (five intervention vs five non-intervention controls), where 2-hourly DOHH was performed during the day before meal and medication rounds by a trained nurse in each intervention RCHE. The volume of alcohol-based hand rub consumed per conscious resident per week was three times higher in the intervention arm compared with baseline and the non-intervention arm during the study period. Serial environmental specimens in the communal areas also revealed a significant reduction in environmental contamination by MRSA and carbapenem-resistant *Acinetobacter* spp. in the intervention arm compared with baseline and the non-intervention arm during the study period [17].

The way forwards

DOHH improves hand hygiene practice and breaks the chain of infection through the prevention of oral ingestion of multi-drug-resistant organisms by patients. DOHH also helps to control and prevent hospital outbreaks due to epidemiologically important bacteria and viruses when it is incorporated into the other infection control measures. DOHH does not replace the WHO's Five Moments for Hand Hygiene, but enriches hand

hygiene practice by bridging potential gaps. The presence of healthcare workers or hand hygiene ambassadors to deliver alcohol-based hand rub at regular time intervals at the bedside may increase hand hygiene awareness among healthcare workers and patients. Further innovative ideas to improve hand hygiene compliance among healthcare workers and patients are urgently required. For instance, could the abbreviated three-step hand rub technique be advocated [18]? What is the threshold of hand hygiene compliance required among healthcare workers to halt the transmission of pathogens [19]? What is the targeted hand hygiene compliance among patients? These questions warrant further investigation.

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