Infectious illness prevention and control methods and their effectiveness in non-health workplaces: an integrated literature review

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Abstract

Background: Infectious illness in the workplace places a substantial cost burden on employers due to productivity losses from employee absenteeism and presenteeism.

Aim: Given the clear impacts of infectious illness on workplaces, this review aimed to investigate the international literature on the effectiveness and cost-benefit of the strategies non-healthcare workplaces use to prevent and control infectious illnesses in these workplaces.

Methods: MEDLINE, CINAHL Plus with Fulltext and Business Source Complete were searched concurrently using EBSCO Host 1995–2016.

Findings: Infection prevention and control strategies to reduce workplace infectious illness and absenteeism evaluated in the literature include influenza vaccination programs, use of alcohol-based hand sanitiser and paid sick days. While the reported studies have various methodological flaws, there is good evidence of the effectiveness of influenza vaccination in preventing workplace infectious illness and absences and moderate evidence to support hand hygiene programs.

Discussion: Some studies used more than one intervention concurrently, making it difficult to determine the relative benefit of each individual strategy. Workplace strategies to prevent and control infectious illness transmission may reduce costs and productivity losses experienced by businesses and organisations related to infectious illness absenteeism and presenteeism.

Keywords

Infectious illness, absenteeism, presenteeism, productivity cost, infection prevention, influenza vaccination, hand hygiene, paid sick days

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Background

There are limited recent data on infectious illness impacts in the workplace; however, those sources that are available indicate that employers have become increasingly aware of the cost burden of employee absenteeism and presenteeism (Berger et al., 2001; Brandt-Rauf et al., 2001). Absenteeism is defined as missed work days (Poston et al., 2011), while attending work while ill is termed presenteeism (Skagen and Collins, 2016). Feeney et al. (1998) estimated

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that 50–60% of all workplace absenteeism was caused by respiratory disorders or gastroenteritis. Globally, annual influenza incidence rates have been estimated at 5–10% in adults (World Health Organization, 2014). In workplaces, influenza incidence rates have been in the range of 12–23.7% (Mohren et al., 2005; Schanzer et al., 2011) depending on the timeframe being audited. Approximately 70% of employees with influenza are absent from work during their infection, which can result in an average loss of 3% of annual work hours (Mohren et al., 2005; Schanzer et al., 2011).

According to the Centers for Disease Control and Prevention (CDC) and Bureau of Labor Statistics (BLS), almost 26 million employees in the United States of America (USA) were infected with H1N1 during the 2009 pandemic peak (Drago and Miller, 2010); 18 million took sick leave, eight million did not. As each employee with influenza who attends work is estimated to infect an additional 0.9 co-workers (Lovell, 2005), an estimated seven million H1N1 infections occurred due to presenteeism (Drago and Miller, 2010). Approximately 16% of influenza transmission is estimated to occur in the workplace (Edwards et al., 2016).

Annually, approximately 500 million non-influenza viral respiratory tract infections occur in the USA, resulting in 70 million lost workdays (Fendrick et al., 2003), while in the Netherlands, the incidence rate over three years was 50% and almost 30% of these took sick leave (Mohren et al., 2005). There is considerably less literature regarding gastroenteritis as a specific cause of absence. In the Netherlands, the gastroenteritis incidence rate was 10.1% during 1998–2001 and the absence rate was 45.3% (Mohren et al., 2005).

Infectious illnesses have considerable impacts on workplace productivity and costs. For example, in France and Germany, lost productivity related to infectious illnesses in the workplace cost an estimated \$US10–15 billion per year (Lynd et al., 2005; “Economic and social...,” 2006). Associated costs due to influenza were \$87.1 billion in the USA in 2003; \$6.2 billion were attributed to productivity losses (Molinari et al., 2007). Lost productivity due to acute respiratory illness (ARI) in the USA accounts for as much as 75% of the total economic burden (Palmer et al., 2010). A 2003 study estimated that non-influenza viral respiratory illness resulted in an economic impact of \$40 billion in the USA annually (Fendrick et al., 2003). For each influenza-like illness (ILI) episode, an average of 23.6 and 23.9 work hours were lost during the 2007/2008 and 2008/2009 influenza seasons, respectively (Tsai et al., 2014).

Associated costs of preventable illnesses typically exceed treatment costs (Fendrick et al., 2011; Goetzel et al., 2004). In the USA in 2003, the direct healthcare costs associated with influenza were \$10.4 million, while the costs due to lost earnings and employee deaths were \$16.3 million (Molinari et al., 2007). For the common cold in the

USA during 1997, healthcare costs were \$17 billion while economic costs were \$22.5 billion (Fendrick et al., 2003).

The impact of, and costs associated with, presenteeism are also significant (Johns, 2010; Mohren et al., 2005). Sick employees demonstrate decreased reaction times and alertness, and increased anxiety, which decrease their efficiency at work (Smith et al., 2000; Smith et al., 2004). Ill employees assess their own efficiency at up to 45% lower than usual (Keech et al., 1998). The consequences of presenteeism include later serious and chronic illness, which could subsequently increase absenteeism (Hansen and Anderson, 2008; Johns, 2010; Kivimäki et al., 2005). A study by Bramley et al. (2002) found that the work hours lost and costs due to presenteeism exceeded those due to absenteeism and every cold resulted in an average loss of 8.7 h, 5.9 of which were due to presenteeism; costs related to the common cold for employers in the USA were \$25 billion annually, \$16.6 billion due to presenteeism.

Health-related workplaces such as hospitals are aware of the potential consequences of infectious illnesses, both to employees and patients, follow strict guidelines to prevent infection (National Health and Medical Research Council, 2010; Pratt et al., 2007) and have robust evidence-based infection prevention and control programs. Non-health workplaces are not bound by such guidelines and are less well informed on workplace infection prevention (Hansen et al., 2017). Given the clear impacts of infectious illness on workplaces, this review aimed to investigate the international literature on the effectiveness and cost-benefit of the strategies non-healthcare workplaces use to prevent and control infectious illnesses in these workplaces.

Methods

An integrative literature review (Whitmore and Knalf, 2005) was used to investigate these topics. While there are multiple approaches to reviewing the literature including systematic reviews, qualitative reviews and meta-analyses, ‘the integrative review method is the only approach that allows for the combination of diverse methodologies (for example, experimental and non-experimental research)’ and therefore is useful in evaluating the strength of the scientific evidence and identifying research gaps when there are few randomised controlled trials (RCTs) to review (Whitmore and Knalf, 2005, p 546).

Ethical approval for this review was not required. MEDLINE, CINAHL Plus with Fulltext and Business Source Complete were searched concurrently using EBSCO Host, which eliminates duplicates. Inclusion criteria were any English language articles published between 1995 and 2016 pertaining to human adults. Any non-health workplaces and infection control measures were included in the review. Non-health workplaces were defined as workplaces that did not offer healthcare as their primary product. Search terms are listed in Table 1. Articles were selected

Table 1. Literature search keywords.

List 1	List 2
glandular fever	absenteeism
influenza	work loss
common cold	productivity loss
gastro*	sickness absence
respiratory infection	worker absence
communicable disease	health absence
infectious illness	presenteeism
viral illness	work*
respiratory tract infection	
diarrhoea	

*Wildcard symbol, to find words starting with the same letters.

that included at least one keyword from the two lists shown in Table 1. Reference lists of selected articles were also searched for additional relevant sources. Only research papers and reviews were considered for full text retrieval. Figure 1 presents the PRISMA flow diagram for the search results.

Quality assessment was performed after the papers were collected. Each paper was examined for methodological flaws that potentially induce bias (supplementary material appendices 1–4). Although not numerically weighted for scientific rigidity, papers were still described and compared accordingly.

Results

Twenty-five articles matching the search criteria were found. Seven pertained to hand hygiene and cough etiquette (supplementary material appendix 1), 17 examined influenza vaccinations (supplementary material appendices 2–4) and another theoretically examined paid sick leave as a method of preventing the spread of infection (Kumar et al., 2013). Comprehensive cost-benefit analyses were only performed for influenza vaccinations. Specific details of study design, sample size, findings and limitations are provided in supplementary material appendices 1–4.

Hand hygiene and cough etiquette

The seven hand hygiene studies used a variety of related interventions, including handwashing or the use alcohol-based hand sanitiser (ABHS), and education about, and/or reinforcement of, regular hand hygiene and respiratory etiquette (Hammond et al., 2000; Hübner et al., 2010; Mott et al., 2007; Savolain-Kopra et al., 2012; Stedman-Smith

Figure 1. PRISMA diagram of search results.

et al., 2015; Uhari and Möttönen, 1999; van Camp and Ortega, 2007) (supplementary material appendix 1). These studies included three cluster RCTs, two prospective interventional studies, and two with a pre-post design. Six examined infectious illness incidence rates and seven examined absenteeism rates following the introduction of hand hygiene measures. Those that examined infectious illness incidence found a significant reduction in incidence in the range of 6.7–31% overall and 11–50% for specific infections. Changes in absenteeism rates were not as consistent. For example, Mott et al. (2007) found a 44% reduction in absenteeism rates while Uhari and Möttönen (1999) found a 15% increase. Several studies demonstrated methodological inadequacies resulting in potential biases for example limited study duration, lack of blinding, insufficient sample recruitment and significantly different demographics between intervention and control groups (supplementary material appendix 1).

Influenza vaccinations

Studies evaluating the effect of influenza vaccination on workplace absenteeism were more common than hand hygiene studies. Nine studies—including two RCTs, four prospective and two retrospective observational studies, and one with a pre-post test design—found that influenza vaccination significantly decreased absenteeism demonstrating either a 0.15–3.0 day reduction in absences per employee or a 26–43% reduction overall depending on how the findings were presented (Abbas et al., 2006; At'kov et al., 2011; Leighton et al., 1996; Mixeu et al., 2002; Nichol et al., 1995, 2009; Olsen et al., 1998; Samad et al., 2006; Santoro et al., 2004) (supplementary material appendix 2). Three studies—including two RCTs, one prospective observational

study and one prospective interventional study—yielded mixed results, finding significantly fewer absences due to one condition or in one season but not another (see supplementary material appendix 3) (Bridges et al., 2000; Campbell and Rumley, 1997; Nichol et al., 1999). Five studies found non-significant differences in absenteeism (Cohen et al., 2003; Dille, 1999; Millot et al., 2002; Morales et al., 2004; Spurzem, 1996) (supplementary material appendix 4). The direction of the non-significant differences was towards a reduction in absenteeism with one exception.

A number of the studies also examined influenza incidence. Eleven reported 24–79.9% fewer episodes of influenza and ILI compared with the unvaccinated group (Abbas et al., 2006; At'kov et al., 2011; Bridges et al., 2000; Dille, 1999; Leighton et al., 1996; Mixeu et al., 2002; Morales et al., 2004; Nichol et al., 1995, 1999, 2009; Santoro et al., 2004). Conversely, four found no significant differences in ILI incidence (Bridges et al., 2000; Millot et al., 2002; Morales et al. 2004; Spurzem, 1996).

Eleven studies also conducted cost-benefit analyses, nine of which (Abbas et al., 2006; Campbell and Rumley, 1997; Cohen et al., 2003; Dille, 1999; Morales et al., 2004; Nichol et al., 1995; Samad et al., 2005; Santoro et al., 2004) found influenza vaccination to be cost-effective (supplementary material appendices 2–4). Cost savings per vaccinated employee of €2.13–5.43, 200 Argentinian pesos and US\$6.40–83.34 were reported. Conversely, one study found a net cost of US\$11.17–65.69 across two seasons per employee compared to placebo even though the vaccine matched the circulating viral strains (Bridges et al., 2000). Nichol et al. (2003) concluded in their study that the mean break-even cost for the vaccine and its administration was US\$43.07 per person vaccinated. Overall, these results suggest that worker vaccination programs may result in significant cost savings for employers in non-health related workplaces.

Paid sick leave

A simulated modelling study examined the effect of access to paid sick days (PSDs) on infectious illness incidence, presenteeism and absenteeism (Kumar et al., 2013). This study found that in a simulated influenza epidemic, 11.59% of influenza infections were due to workplace transmission and that 72% of these were due to presenteeism. Access to universal PSDs reduced workplace infections by 5.86% in this model; allowing employees with influenza to take one or two PSDs reduced workplace influenza infections by 25.33% and 39.22%, respectively (Kumar et al., 2013). This study however, was purely theoretical and made many simplifying assumptions, for example that employees are physically evenly dispersed and racially and sexually heterogeneous through the workplace. However, research has shown that this is generally not the case (Danon et al., 2012; Read et al., 2008).

Discussion

This review identified first that infectious illness in the workplace places a substantial cost and productivity burden on employers. The review also identified strategies that have been implemented by organisations to reduce or control infectious illness impacts and evaluations of the effectiveness of these strategies. Introduction of hand hygiene programs, including the use of ABHS, and influenza vaccination are the two most widely reported and evaluated strategies.

Six studies were found on the effect of hand hygiene on infectious illness rates and related absenteeism, excluding one primarily performed on students that additionally recorded teacher absence (Hammond et al., 2000). Among the intervention groups, significantly lower infectious illness incidence rates were found in all six studies while significantly lower absenteeism was found in three; however, the majority of these studies had some methodological inadequacies such as lack of randomisation, allocation concealment and blinding, so positive results should be interpreted cautiously. The strongest studies methodologically (the three cluster RCTs) did not demonstrate a significant reduction in absenteeism; in fact, one demonstrated a significant increase in absenteeism in the intervention group, suggesting that while employers could adopt hand hygiene as a precautionary measure to prevent the spread of infection, it may not impact favourably on absenteeism. Having said this, one of the RCTs was impacted by the global hand hygiene education campaign associated with the H1N1 pandemic that began part way through the study; this could have affected the behaviour of the control group (Savolainen-Kopra et al., 2012).

The results of these studies also suggest that ABHS availability may decrease absenteeism, although doubt remains whether the addition of hand hygiene education and reinforcement further results in further decreases in absenteeism. Reviews conducted in home and community settings (Bloomfield et al., 2007) as well as elementary school settings (Meadows and Le Saux, 2004) have also found that various aspects of hand hygiene can be beneficial in decreasing infectious illness incidence and absenteeism; however, the quality of the available evidence is lacking due to poor methodological design (van de Mortel, 2008). Unfortunately, no cost-benefit analyses for hand hygiene and ABHS were found, so this remains an area that requires further research.

Influenza vaccination had stronger supporting evidence for efficacy than hand hygiene programs. Seventeen studies were conducted in a variety of workplace settings. Overall, infectious illness absenteeism in response to influenza vaccination declined significantly in nine studies and declined in at least one season or condition in another three studies among vaccinated workers. A further four studies found non-significant declines in absenteeism. Eleven of these

studies also conducted cost-benefit analyses, with net savings in the range of US\$6.40–83.34 (and savings of up to US\$238–900 if operating costs are included) per vaccinated employee, although one study reported a net cost of US\$11.17–65.69 per vaccinated employee across two seasons. However, methodological inadequacies are ubiquitous throughout these studies, with the majority failing to use randomisation and blinding. The strongest studies methodologically were more likely to demonstrate a significant reduction in absenteeism following vaccination. For example, 100% of the RCTs demonstrated a significant decline in absenteeism following vaccination versus 60% of prospective interventional studies, 50% of prospective observational studies and 50% of retrospective observational studies.

Overall, the results from these studies suggest that influenza vaccination programs may decrease infectious illness incidence and absenteeism, and may also result in significant cost savings for employers. This is similar to the conclusions made from recent Cochrane systematic reviews conducted in community and aged care settings; however, the potential benefits of vaccination in those reviews were not as optimistic as those of this review (Demicheli et al., 2014; Jefferson et al., 2012). While vaccines were found to be effective in preventing influenza in children over the age of two years, for younger children there was little evidence available (Jefferson et al., 2012). A very modest decrease in absenteeism and influenza symptoms was found in healthy adults including pregnant women (Demicheli et al., 2014). No conclusions could be drawn regarding the effects of vaccines on the elderly due to the generally low quality of available evidence (Jefferson et al., 2010). Neither of these reviews examined potential cost-benefits.

One of the limitations of this review is the difficulty in summarising the results of these very disparate studies. For example, cost savings were variously reported as cost savings per vaccinated employee, cost savings per lost workday, cost savings per dollar spent, cost savings by specific symptoms such as febrile illness, cost savings per vaccinated employee when presenteeism was accounted for and break-even costs for vaccination. Cost savings were also reported in US dollars, Argentinean pesos and Euros, although US dollars were the most common currency reported. Similarly, infectious illness incidence was sometimes reported as total percentage reduction or increase, or specific to particular conditions such as URI, ILI, gastrointestinal illness, febrile illness and serious febrile illness. Absenteeism was variously reported as percentage reduction in absenteeism, reduction in hours of absenteeism per new vaccinees and consecutive vaccinees, reductions in absent days per employee, percentage reduction in total lost workdays, reductions in lost workdays by specific conditions such as URI or febrile illness, days lost per 100,000 worked, reductions by season and reductions in pro rata sick days.

Conclusions

While hand hygiene and influenza vaccination have been identified as appropriate prevention methods, more awareness of effective strategies may reduce the infectious illness cost burden and improve employee health in non-health workplaces. Further research should involve more rigorous research regarding strategy efficacy and cost-benefits in order to ascertain if the generally positive outcomes outlined in this review are supported. More research also should be conducted in regards to workplace infectious illness practices as this review found this information lacking.

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