Economic Impact of a Healthy School Environment

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School absenteeism due to infectious diseases carries a price tag that goes beyond lost opportunities for learning. Schools spend precious administrative hours tracking absent students and risk potential loss of public funding when students are not in attendance. The productivity of parents also suffers if they have to stay home from work with sick children.

The 3 million children who attend daycare centers (Smith, 2000) are at increased risk of respiratory, ear, and gastrointestinal infections (Public Health Considerations, 1984; Anderson et al., 1988; Bell et al., 1989; Fleming, Cochi, Hightower, & Broome, 1987; Hardy & Fowler, 1993; Hurwitz, Gunn, Pinsky, & Schonberger, 1991; Louhiala, Jaakkola, & Jaakkola, 1995; Nafstad, Hagen, Oie, Magnus, & Jaakkola, 1999; Reves et al., 1993; Thacker, Addiss, Goodman, Holloway, & Spencer, 1992; Wald, Guerra, & Byers, 1991). Studies show that infection control education programs (ICEPs) can reduce the spread of pathogens as well as clinical cases of infectious diseases (Carabin et al., 1999; Kotch et al., 1994; Krilov et al., 1996; Roberts et al., 2000a; Roberts et al., 2000b; Uhari & Mottonen, 1999). Many of these programs are multidimensional and include training of staff, with an emphasis on handwashing, compliance monitoring, and disinfecting supplies. Whether such ICEPs are cost-effective, that is, do the savings gained by schools and society in general through their implementation outweigh their costs, has remained unclear. A recently published economic analysis of data from an ICEP study sheds some light on the effectiveness of these programs (Ackerman, Duff, Dennehy, Mafilios, & Krilov, 2001). The purpose of the original ICEP study (Krilov et al., 1996)—reported in "The Science Behind Lysol: Relevance for Schools," by Rubino & Gaber, page 15 of this publication (results shown in Table 1)—was to design and implement a comprehensive infection control program and measure its effects on the number and types of infectious illnesses experienced by children attending a specialized preschool program. The economic study (Ackerman et al., 2001) examined, with the aid of computer modeling, the impact of a comprehensive ICEP from a societal perspective, assessing costs to the nation as a whole rather than to individual families, and, as a secondary analysis, the impact of less intensive interventions.

Table 1. Reductions in Infectious Diseases and Medical Resource Use

Illness	Baseline Year	Intervention Year	p Value
Total Illnesses	0.70	0.53	< .05
Respiratory	0.67	0.42	< .07
Gastrointestinal	0.08	0.0	NS
Otitis media	0.08	0.08	NS
Sinusitis	0.0	0.0	NS
Physician visits	0.5	0.33	< .05
Antibiotic courses	0.33	0.28	< .05
Days absent from school	0.75	0.40	< .05

NS = Not statistically significant.

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STUDY OBJECTIVES AND DESIGN

The study was undertaken by researchers at Covance Health Economics and Outcomes Services Inc., Gaithersburg, Maryland; Brown Medical School, Providence, Rhode Island; and Winthrop University Hospital, Mineola, New York. The researchers developed a Markov health-state transition model to simulate the mean annual costs of illness per child in the baseline year (current IC practices) and intervention year (comprehensive ICEP). Health-state transition models are based on the probability of a subject moving between predefined states of health; the Markov form is a recursive decision tree and is useful when a decision involves repetitive events, such as infections (Sonnenberg & Beck, 1993).

This particular model assigned each child in a cohort of 1,000 children to one of five states of health: (1) well, (2) respiratory illness, (3) sinusitis, (4) otitis media, or (5) gastrointestinal illness. It allowed children one of these illnesses per month (1-month time interval being long enough to capture significant events and short enough to be sensitive to cost differences over time) and incurred the corresponding cost of that illness. For the primary analysis (specialized preschool with a comprehensive ICEP), transition probabilities (probabilities of passing from one health state to another), physician office visits for illnesses, antibiotic use, and days absent from school were derived from Krilov et al (1996).

Direct medical costs (including physician office visits, emergency room visits, hospitalization, diagnostic tests, and courses of antibiotics) were derived from 1999 Medicare reimbursement schedules and the *Drug Topics Red Book*. (1999a) The model used the data to estimate mean costs per episode of illness (Table 2).

The model calculated the cost of lost parental work time by two methods. The first used only lost wages based on the national average of $117 per day (1999b). The second assumes that in 20% of cases, a parent would continue to work and hire a caregiver for half the national wage rate ($58.50 per day). In neither case did the study account for incidence of secondary infection among family members of infected children, which would have increased costs associated with lost parental work time.

The model used sensitivity analysis to vary some assumptions within a reasonable range to determine how changes in input assumptions affect results. This allows the model to calculate the economic value of less intensive ICEP intervention in nonspecialized preschool settings.

Table 2. Mean Cost per Episode of Illness in a Specialized Preschool*

Illness	Costs
Respiratory†	$76
Common cold (86%)	$24
Pharyngitis (3%)	$96
Bronchitis (3%)	$110
Croup (2%)	$304
Bronchiolitis (3%)	$677
Pneumonia (3%)	$757
Sinusitis	$325
Otitis media	$325
Gastrointestinal illness	$218

*Mean costs include both direct and indirect costs associated with lost parental time.

†Distribution of respiratory illness.

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Table 3. Annual Savings Attributable to ICEPs

	Specialized Preschool*			Nonspecialized Preschool†		
	Current IC Practices	Comprehensive ICEP	Net Cost (Savings)	Current IC Practices	Less Intensive ICEP	Net Cost (Savings)
Costs of illness‡	$46,930	$23,370	($23,560)	$36,556	$23,332	($13,224)
IC costs for entire day care center	$716	$75,627	$74,911	$716	$3,087	$2,371
Total costs Per 38 children	—	—	$51,351	—	—	($10,853)
Per child	—	—	$1,351	—	—	($286)

*Preschool setting with a Downs syndrome population (primary analysis).
†Preschool setting with a non-Downs syndrome population (secondary analysis).
‡Costs (direct medical costs plus costs associated with lost parental working time) for 38 children (the number that participated in the specialized preschool research study by Krilov et al., 1996).
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ANALYTICAL RESULTS

The primary analysis quantified massive intervention at the specialized daycare center. In the baseline year, the daycare center spent $716 on infection control. The mean cost of illness was $1,235 per child, primarily due to lost productivity (68%) and physician visits (14%). During the intervention year, ICEP expenditures rose to $75,627 (92% for the cleaning service), but the cost of illness per child declined by nearly half, to $615 (71% lost productivity, 20% physician visits). Total cost savings from reduced incidence of infection among the 38 children ($23,560) in the study offset 31% of the incremental cost of the comprehensive ICEP (Table 3).

Sensitivity analyses demonstrated that the incremental cost of illness varied little with baseline infection rates, caregiver (parent vs. babysitter), use of over-the-counter (OTC) products, number of potential monthly infections, distribution of respiratory illness, and the approach used to account for lost productivity.

A secondary analysis assumed implementation of a less intensive ICEP in a nonspecialized preschool. The model substituted staff for an outside cleaning service, and assumed the same baseline cost of infection control ($716), a 10% dimunition in baseline illness, a 25% reduction in cleanser and disinfectant use, a 25% decline in ICEP effectiveness, and a 50% decrease in direct medical costs compared with the intensive ICEP.

These variations translated to a mean cost of illness per child of $962 in the baseline year and an annual cost of $3,087 for the less intensive ICEP, or an incremental cost of $2,371, and a reduction in the cost per illness to $614. When the savings of $348 per child are multiplied by 38 children, it exceeds the ICEP's incremental cost by $10,853 (Table 3). In fact, the less intensive program would only have to reduce respiratory disease by 12.8% to prove cost-neutral from the societal perspective.

Implementation of low-intensity ICEPs also appears beneficial from a household perspective. Using sensitivity analysis, the model limits costs only to direct, out-of-pocket medical expenditures, such as copayments/coinsurance, OTC products, and babysitting. The mean annual cost of illness per child was $176 in the baseline year and $113 after intervention, a $63 difference. If the daycare center passed on the entire incremental cost of less intensive ICEP intervention ($2,371) to each of the 38 children, it would come to $62.39 per child per year. This suggests that ICEPs could prove to be a cost-neutral proposition even without accounting for lost sick days by adults.

CONCLUSION

To the best of our knowledge, this study is the first to evaluate the economic impact of a multidimensional ICEP in a daycare setting. While massive interventions may not make economic sense, the analysis suggests that societal savings from reduction of illness significantly exceed the cost of moderately intensive ICEPs in nonspecialized daycare settings. In fact, the study may actually underestimate savings because it does not consider costs associated with secondary infections in parents, siblings, or daycare center personnel. Even from a household perspective, ICEP interventions may make sound economic sense.

The results underscore the need to improve awareness among daycare center staff about the importance of infection control education, handwashing, disinfection, and cleaning. These hygienic practices will improve both student and staff health. Furthermore, because parents will ultimately have to pay higher fees to support ICEPs, daycare centers must educate parents about the clinical and financial benefits of these practices.

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