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Severe acute respiratory infections, the missing link in the surveillance pyramid

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CHAPTER 5

Costs of a clinical pathway with
point-of-care testing during
influenza epidemic in a Dutch hospital

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ABSTRACT

Our study aim is to determine how a new clinical pathway, including PCR-based influenza point-of-care test (POCT), influences the hospitalisation costs of patients suspected of influenza presenting at the emergency department of a Dutch hospital during two consecutive influenza epidemics (2016-2017 and 2017-2018). Compared to mean costs per patient of €3,661 in 2016-2017, the implementation of this new clinical pathway with influenza POCT in 2017 was associated with mean costs per influenza-positive patient of €2,495 in 2017-2018 ($p=0.3$). Our study suggests favourable economic results regarding a new clinical pathway with influenza POCT, reflecting a more efficient care of patients suspected of influenza presenting at the emergency department.

INTRODUCTION

Seasonal influenza epidemics cause substantial morbidity and lead to excess hospitalisations and mortality, especially in the elderly.¹ A sudden increase in the number of patients requiring hospital care for severe acute respiratory infections (SARI), especially pneumonia as complication of influenza virus infection, may pose a significant burden for hospitals in managing bed and staff capacity.² Whether a SARI patient is tested for influenza virus infection is the decision of the individual attending physician in most hospitals and mainly relies on laboratory-based PCR testing with a turnaround time of 24-48 hours.

More frequent testing and timely diagnosis of influenza may better guide isolations and improve patient flow through the hospital and thereby contribute to a more efficient management of patients.^{3,4} In influenza season 2017-2018, the Jeroen Bosch Hospital (JBH) in 's-Hertogenbosch, the Netherlands, implemented a PCR-based point-of-care test (POCT) for influenza virus type A and type B and respiratory syncytial virus (RSV) for all patients presenting with SARI at the Emergency Department (ED).⁵ Furthermore, a temporary ward dedicated specifically to care of influenza-positive patients was established. The POCT (Cobas Liat Assay) has high sensitivity and specificity for influenza A and B virus, and RSV, and can be performed by non-laboratory personnel at the ED.³ The aim of this study is to determine how a new clinical pathway, including POCT, influences the hospitalisation costs of patients suspected of influenza presenting at the ED.

METHODS

STUDY POPULATION AND PERIOD

The study population consisted of patients with an acute respiratory tract infection (RTI) presenting at the ED of a Dutch hospital (JBH) during two consecutive influenza epidemics (2016-2017 and 2017-2018). JBH is a large general hospital in the south-eastern part of the Netherlands with 575 beds and catchment population for RTI of 323,000 persons.

CLINICAL PATHWAYS

In influenza season 2016-2017, influenza diagnostics were requested at the discretion of the treating physician depending on the differential diagnosis, taking into account epidemiology, patient symptoms and costs. Patients suspected of an influenza virus infection by their treating physician had nose-throat swabs collected and subsequently analysed with a laboratory developed real-time polymerase chain reaction (PCR) test

(LDT) for influenza virus type A and B on the BD MAX System. All patients with pending influenza test results were put in droplet isolation on the general ward or intensive care unit (ICU) until test results became available within 24 hours, after which a decision was made on whether isolation had to be continued or not.

In influenza season 2017-2018, from January 8, 2018, a new clinical pathway for patients suspected of an influenza virus infection was implemented in JBH, consisting of three interventions: 1) clinical rule for influenza diagnostics in ED patients; 2) influenza POCT test (Cobas Liat, Roche Molecular Diagnostics); and 3) temporary influenza ward for cohort isolation. The clinical rule for requesting influenza POCT in ED patients was defined as having: 1) a temperature $\geq 38^{\circ}\text{C}$; and 2) symptoms of an acute RTI. As POCT, the influenza A, B and RSV real-time PCR assay on the Cobias Liat System with a turnaround time of 20 minutes was used. The temporary influenza ward consisted of maximum 15 beds for influenza-positive patients, excluding patients admitted to the ICU, haematology, oncology, or paediatric ward. After isolation of maximum 5 days, the influenza-positive patients were allocated to another ward or discharged home.

CLINICAL DATA FOR COST ESTIMATES

Retrospective data were collected using the electronic patient records. The dataset included number of requested influenza tests (LDT/POCT), admissions to hospital (ward/ICU), isolated patients, treatment for patients suspected of influenza (antibiotics/antivirals), and median length of hospital stay (LOS). Costs were calculated from the start of the epidemic using a bottom-up approach following Dutch guidelines for economic evaluations.⁶ Test costs were retrieved from JBH, ED consultations and hospitalisation costs were based on the national cost manual for economic evaluations⁷, isolation costs were taken from literature⁸, and medication costs were taken from the National Health Care Institute website.⁹ Hospitalisation costs were calculated by multiplying recorded units of used healthcare resource with corresponding unit prices (Supplementary file, Table 1). The maximum isolation duration, additional diagnostics, and type and duration of antibiotic and/or antiviral treatment were based on recent literature (footnotes Table 1). All costs were expressed in 2018 euros.

RESULTS

The influenza epidemic of 2016-2017 lasted 15 weeks (week 48 of 2016 until week 10 of 2017), while the duration of the influenza epidemic of 2017-2018 was 18 weeks (week 50 of 2017 until week 15 of 2018). Compared to mean costs per patient of €3,661 in 2016-2017, the implementation of this new clinical pathway with influenza POCT in 2017 was associated with mean costs per influenza-positive patient of €2,495 in 2017-

2018 (Mann-Whitney U test; p=0.3). The mean costs per influenza-negative patient was €5,115 in 2016-2017 and after the implementation of the new clinical pathway this amounted to €2,912 in 2017-2018 (Mann-Whitney U test; p=0.8) (Table 1).

Table 1. Hospitalisation costs of influenza-positive and influenza-negative patients in a Dutch hospital during influenza epidemic 2016-2017 and 2017-2018

Cost type	Influenza test result	Influenza epidemic 2016-2017 (week 48, 2016 – week 10, 2017)			Influenza epidemic 2017-2018 (week 2, 2018 – week 15, 2018)			
		Patients (n)	Hospitalisation costs (€)		Patients (n)	Hospitalisation costs (€)		
			Per week	Per person		Per week	Per person	
Emergency department [†]	positive	189	3,398	270	624	9,348	270	
	negative	402	7,227	270	922	13,812	270	
Admissions								
General ward [‡]	positive	161	31,170	2,904	434	55,084	2,285	
	negative	346	74,417	3,226	719	108,280	2,711	
Intensive care unit [‡]	positive	11	7,692	10,489	21	12,237	10,489	
	negative	27	48,712	27,062	20	15,384	13,846	
Diagnostics								
Influenza test ^{‡‡}	positive	189	1,417	112	624	3,898	112	
	negative	402	3,013	112	922	5,759	112	
Urine antigen test	positive	172	165	14	455	332	13	
	negative	373	358	14	739	538	13	
Other [‡]	positive	189	1,176	93	624	3,236	93	
	negative	402	2,502	93	922	4,781	93	
Isolation ^{§§}								
	positive	172	890	78	455	1,963	78	
	negative	373	386	16	0	0	0	
Treatment								
Antibiotics [¶]	positive	99	195	29	206	330	29	
	negative	229	450	29	364	584	29	
Oseltamivir ^{¶¶}	positive	15	22	22	50	61	22	
	negative	34	10	4	13	2	2	
Total costs		positive	189	46,125	3,661	624	86,488	2,495
		negative	402	137,075	5,115	922	149,141	2,912

[†]Costs for emergency department consultation.

[‡]Weighted mean hospitalisation costs per day on general ward.

^{‡‡}Hospitalization costs per day on intensive care unit including costs for diagnostics and medication.

^{‡‡‡}Costs for influenza LDT (BD MAX System) in 2016-2017 and influenza POCT (Cobas Liat) in 2017-2018.

^{‡‡‡‡}Other diagnostics include chest x-ray, blood examination (Hb, MCV, Ht, leukocytes, platelets, ASAT, ALAT, GGT, AF, LD bilirubin, creatinine, urea, sodium, potassium, chloride, calcium, total protein, glucose, CRP), and urine examination (urine screening test).

^{§§}Isolation costs in the general ward room and associated isolation costs (use of gloves, Free Flight Phase 1 masks, additional workload for medical and cleaning personnel) for one day in influenza-negative patients (only in 2016-2017) and the duration of five days in influenza-positive patients (2016-2017 and 2017-2018).

[¶]Costs for antibiotic treatment on the general ward were calculated for average empiric antibiotic therapy course in line with Dutch Working Party on Antibiotic Policy (SWAB) guidelines in Jeroen Bosch Hospital.

^{¶¶}Costs for oseltamivir treatment on the general ward were calculated for the duration of five days according to SWAB guidelines.



Sensitivity analysis indicated that ICU admissions affected mean cost estimates of influenza-negative patients in 2016-2017 compared to 2017-2018 to a larger degree than influenza-positive patients (Supplementary file, Table 2). A higher number of ICU admissions (27 versus 20) and notably longer LOS in ICU (12.9 versus 6.6) of influenza-negative patients contributed to this finding.

DISCUSSION

A new clinical pathway in JBH, including a clinical rule for requesting influenza diagnostics, POCT testing, and establishment of a ward for cohort care, resulted in lower mean hospitalisation costs per influenza-positive and influenza-negative patient in 2017-2018 compared to 2016-2017. Because of low numbers, differences were not significant. The new clinical pathway appeared to improve patient flow and influenza awareness in JBH, which is most clearly illustrated by a relative decrease in admissions and a shorter LOS of patients suspected of influenza.⁵ It has to be noted that differences in ICU admissions and LOS in ICU in 2016-2017 contributed substantially to the decrease in mean costs of especially influenza-negative patients. This is primarily caused by the higher number of ICU admissions and longer length of ICU stay in influenza-negative patients in 2016-2017 than 2017-2018.

While most influenza POCT studies focused on test performance, to our knowledge only one study investigated POCT-associated costs. In contrast to our results, this study in an acute paediatric ward found no change in mean hospitalisation costs for patients with proven influenza infection after the introduction of influenza POCT (10). This could be explained by different study populations (children versus adults) and wards (acute ward versus all ward types). Our study has several limitations to take into account. First, our hospitalisation costs are likely to be an underestimation of the true costs, because they are restricted to influenza-related costs. Additional costs because of treatment of complications were not taken into account. Second, because of data limitations, duration of isolation and type of requested diagnostics, were based on literature.

To conclude, this study suggests favourable economic results regarding a new clinical pathway with influenza POCT, reflecting a more efficient care of patients suspected of influenza presenting at the ED. Acknowledging the research gap in influenza POCT-associated costs, further research into the cost-effectiveness of influenza POCT is recommended.

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SUPPLEMENTARY MATERIAL

Table S1. Cost unit prices per cost type expressed in 2018 euros

Cost type	Cost details	Cost unit price (€)	Source	
Medication (per treatment)	antibiotics	amoxicillin	25.60	(9)
		cefuroxime	50.40	
		ciprofloxacin	0.58	
		average 2016-2017	29.40	
		average 2017-2018	28.90	
Emergency department (per admission)	oseltamivir	21.80	(9)	
	consultation	269.65	(11)	
	diagnostics	influenza POCT (Cobas Liat)	112.44	(†)
		influenza LDT (BD MAX System)	112.44	(†)
		chest X-ray	42.53	(13)
blood & urine screening test		51.80		
Hospitalization (per day)	general ward	urine antigen test	25.72	(14)
		weighted arithmetic mean	495.57	(11)
	intensive care unit	2097.85	(11)	
	additional isolation costs	15.53	(15)	

[†]personal communication Jeroen Bosch Hospital.

Table S2. The impact of intensive care unit admissions on hospitalization costs of influenza-positive and influenza-negative patients during influenza epidemic 2016-2017 and 2017-2018

Cost type	Influenza test result	Influenza epidemic 2016-2017 (week 48, 2016 – week 10, 2017)		Influenza epidemic 2017-2018 (week 2, 2018 – week 15, 2018)			
		Patients (n)	Hospitalisation costs (€)		Patients (n)	Hospitalisation costs (€)	
			Per week	Per patient		Per week	Per patient
<i>Hospitalization costs, including ICU admissions</i>							
Total costs	positive	189	46,125	3,661	624	86,488	2,4955
	negative	402	137,075	5,115	922	149,141	2,912
<i>Hospitalization costs, excluding ICU admissions</i>							
Total costs	positive	178	38,432	3,239	603	74,251	2,216
	negative	375	87,481	3,499	902	133,214	2,658

