



Wenxian People's Hospital

Table of contents

1. Background.....	3
2. Integrated care pathway implementation.....	4
(1) Overview of care pathway implementation	4
(2) Monthly clinical pathway implementation	5
(3) Hospital-acquired infection rate, mortality & patient satisfaction	7
3. Clinical behaviors.....	9
(1) COPD	9
A. Mandatory items	9
B. Optional items	10
(2) TIA.....	11
A. Mandatory items	12
B. Optional items	14
(3) Cerebral hemorrhage	15
A. Mandatory items	15
B. Optional items	16
(4) Cerebral infarction	17
A. Mandatory items	17
B. Optional items	20
4. Healthcare expenditure.....	22
(1) Total hospitalization cost.....	22
A. COPD.....	23
B. TIA	26
C. Cerebral hemorrhage.....	30
D. Cerebral infarction.....	33
(2) Drug cost proportions	36
(3) Examination cost proportions	38
(4) Out of pocket (OOP) proportions.....	40
5. Healthcare efficiency	43
(1) COPD	44
(2) TIA.....	46
(3) Cerebral hemorrhage	48
(4) Cerebral infarction	50



6.	Healthcare quality	53
(1)	Quality of life	53
(2)	Hospital readmission in 30 days.....	53
7.	Rehabilitation	55
(1)	Acute phase rehabilitation	55
(2)	Stable phase rehabilitation	56
8.	Discussion	57
(1)	Effect on hospital management.....	57
(2)	Effect on clinical behavior.....	57
(3)	Effect on medical costs	58
(4)	Other factors on project impact	59

1. Background

Wenxian is located in the city of Jiaozuo, Henan province, located in western China. The total area is 481.3 km², with a total population of 422,000 and per capita GDP of 5,000 CNY. The new rural cooperative medical scheme (NRCMS) management office implemented a mixed payment system including global budget and single disease payment, with a 90% coverage rate. Wenxian People's Hospital, being the main clinical center of the district, is a level 2A hospital with 1,000 beds.

In April 2013, the Wenxian People's Hospital officially joined and launched the China-UK project to implement integrated care pathways for chronic obstructive pulmonary disease (COPD), transient ischemic attack (TIA), cerebral hemorrhage, and cerebral infarction. Prior to joining the project, the hospital has implemented clinical pathway management program for 62 simple diseases, with relevant experiences in the development, application and management of clinical pathways. In September 2013, the hospital employed three main measures to promote and conduct the clinical pathway project. First, the hospital established the clinical pathway office in addition to the original clinical pathway management leadership team. The office took responsibility for detailed establishment, audit, maintenance, development, optimization and supervision of the pathway project. Second, the hospital established the integrated care pathway management implementation program and performance assessment and incentive program, which included the incentive method for doctors based on number of patients completed. Last, the hospital built software for clinical pathway information, based on the original health information system (PACS.LIS.HIS). This would allow effective application, management, and supervision of the pathways, in addition to standardization of informative data collection. In December 2013, the COPD pathway management project was officially implemented in the department of respiratory medicine; and cerebral infarction, cerebral hemorrhage and TIA pathways were implemented in the First and Second Division of the neurology department. The four diseases' pathway projects have currently been implemented under the global budget payment method. In addition, the Wenxian People's Hospital and the Xubao Healthcare Center formed a township-village healthcare network to explore integrated diagnosis and treatment pathway for the pilot diseases.

2. Integrated care pathway implementation

One year and seven months after the care pathway implementation of the four diseases (December 2013 to June 2015), the project achieved high coverage rate, meeting the expected target outcomes. In particular, cerebral infarction had the best implementation results. Infection and mortality rates remained low in departments adopting the clinical pathways both before and after the implementation. The satisfaction rate was also high among pathway patients.

(1) Overview of care pathway implementation of four diseases

From December 2013 to June 2015, a total of 3,163 patients entered the pathway management system for the four diseases of COPD, cerebral hemorrhage, cerebral infarction and TIA (Figure 1). Among them, 2,926 patients completed the pathway. The overall completion rate was 92% and the management rate was 63% (Table 1). The four diseases had different pathway entrance rates (Table 1). The entrance rate of cerebral infarction was highest at 78%, which was followed by cerebral hemorrhage at 64%, COPD at 53%, and TIA at 42%. All four diseases had high pathway completion rates. The completion rate of COPD, cerebral hemorrhage and cerebral infarction were all over 90%, and completion rate of TIA was 87% (Table 1).

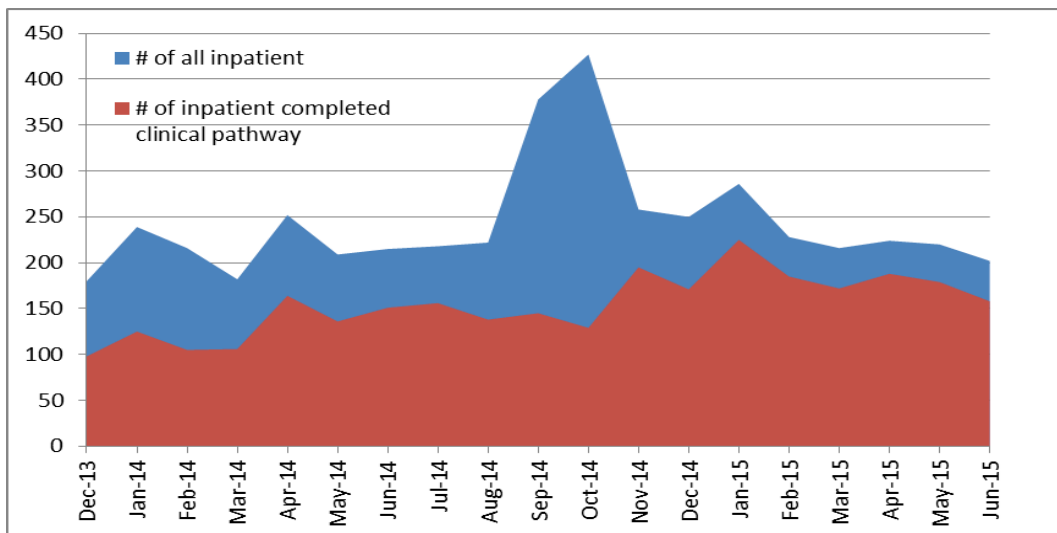


Figure 1 Total number of inpatients and inpatients completing pathway, December 2013 to June 2015

Table 1 Care pathway implementation status by pilot disease

Disease	Total patients	Patients entering pathway	Patient completed pathway	Patients with complications	Entrance rate*	Completion rate*	Management rate*
COPD	657	353	332	21	53.7%	94.1%	50.5%
TIA	722	305	267	38	42.2%	87.5%	37.0%
Cerebral hemorrhage	339	217	201	16	64.0%	92.6%	59.3%
Cerebral infarction	2,904	2,288	2,126	162	78.8%	92.9%	73.2%
Total	4,622	3,163	2,926	237	68.4%	92.5%	63.3%

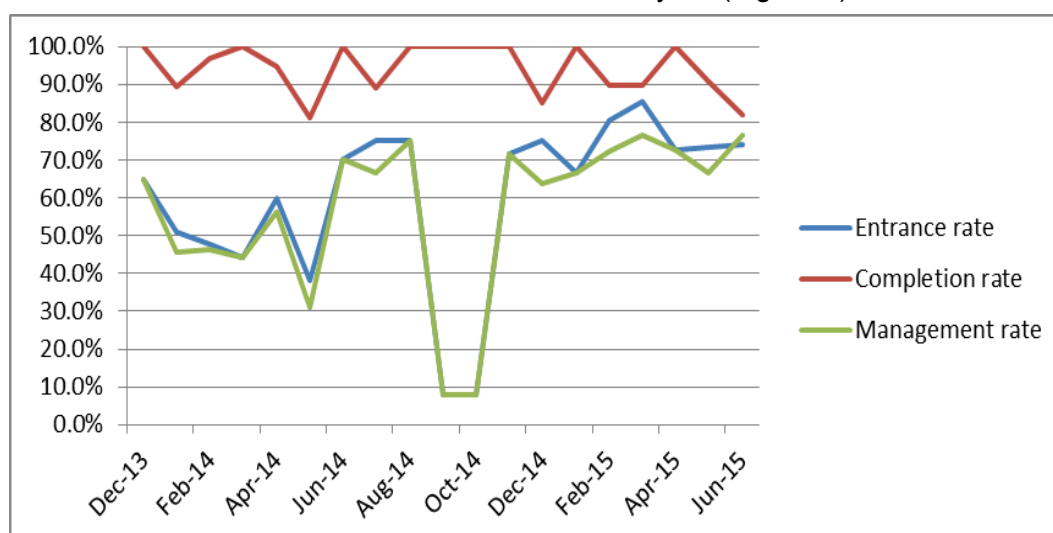
*Entrance rate= # of inpatient entered pathway/ Total # of inpatient

*Completion rate= # of inpatient completed pathway/ # of inpatients that entered pathway

*Management rate= # of inpatient completed pathway/ Total # of inpatient

(2) Monthly clinical pathway implementation of four diseases

As the project progressed, the trends of entrance rate and management rate of all four diseases were consistent. The rates fluctuated the first year, but overall trends showed a gradual increase and became stable by the second year. The completion rate stayed consistently high. The COPD pathway entrance rate increased from around 50% in the first half of 2014, decreased significantly during September and October, and was retained at 75% in 2015 (Figure 2). Management rate was consistent with entrance rate, increasing from around 50% in the first year, decreased for two months and stabilized at 70% in the second year (Figure 2).


Figure 2 COPD pathway implementation rates

The TIA clinical pathway entrance rate increased from 60% in the beginning of

2014, decreased significantly during September and October, and remained steady at 70% in 2015 (Figure 3). Completion rate fluctuated between 70% and 100% (Figure 3). Management rate was consistent with entrance rate, staying around 60% in 2015.

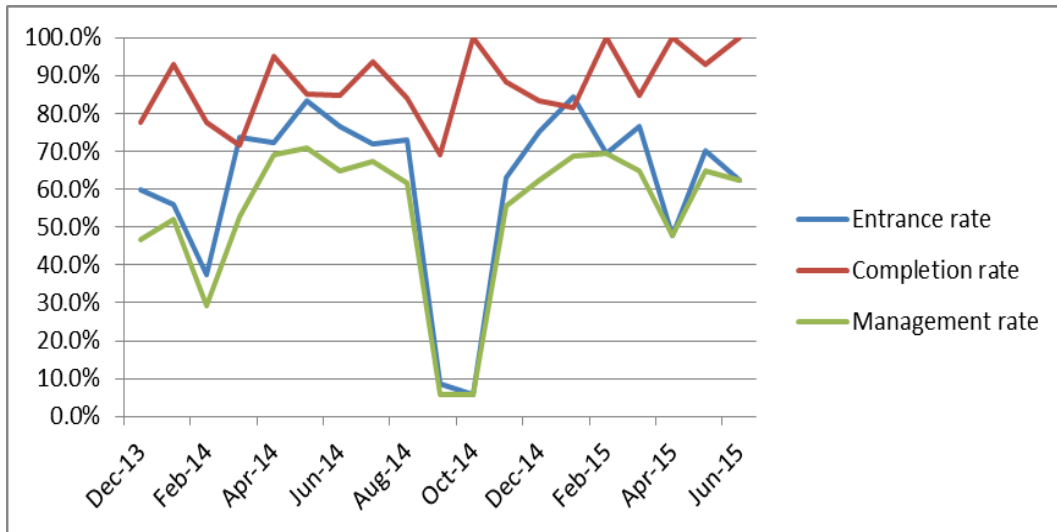


Figure 3 TIA pathway implementation rates

Cerebral hemorrhage pathway entrance rate fluctuated around 60% in the first six months, then decreased significantly during September and October 2014, and gradually increased to 80% in 2015 (Figure 4). Completion rate stayed within 80% and 100% except in July 2014 (Figure 4). Management rate was consistent with the entrance rate, fluctuating around 65% in the first six months and gradually increasing to 80% after three months of decline (Figure 4).

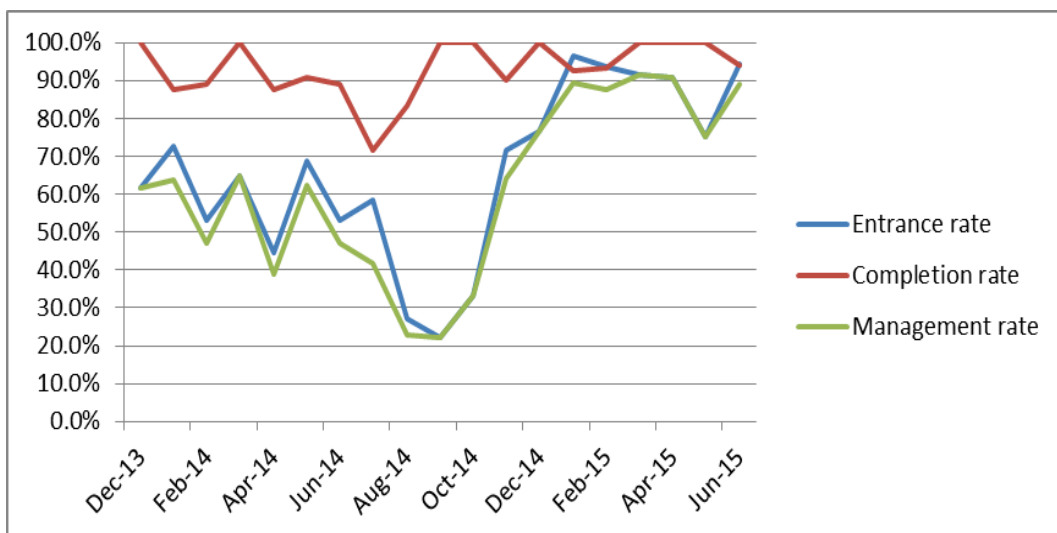


Figure 4 Cerebral hemorrhage pathway implementation rates

Cerebral infarction clinical pathway entrance rate increased from 60% to 90% in

the first six months, then decreased significantly during October 2014, and gradually returned to 90% in 2015 (Figure 5). Completion rate increased from 85% in the first year to 95% in the second year (Figure 5). Management rate was consistent with entrance rate, increasing gradually from 50%, and then staying at around 85% (Figure 5).

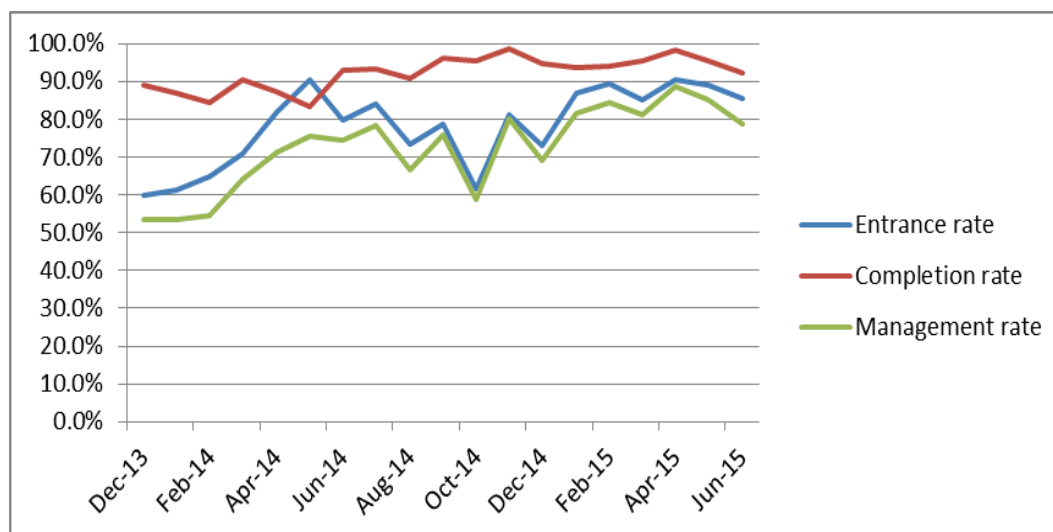


Figure 5 Cerebral infarction pathway implementation rates

(3) Hospital-acquired infection rate, mortality & patient satisfaction

Hospital-acquired infection rate and mortality remained unchanged after the pathway implementation. Patient satisfaction remained high. From 2012 to 2015, the neurology department and the respiratory department had consistently low hospital-acquired infection rate (Table 2), and zero mortality. Since the initiation of the project, the patient satisfaction rates of all four diseases were maintained above 95% (Figure 6).

Table 2 Hospital-acquired infection rate in neurology and respiratory departments (%)

Department	2012	2013	2014	2015*
Neurology	3.2	1.9	2.2	1.0
Respiratory	0	0.3	0	0

*2015 January to June

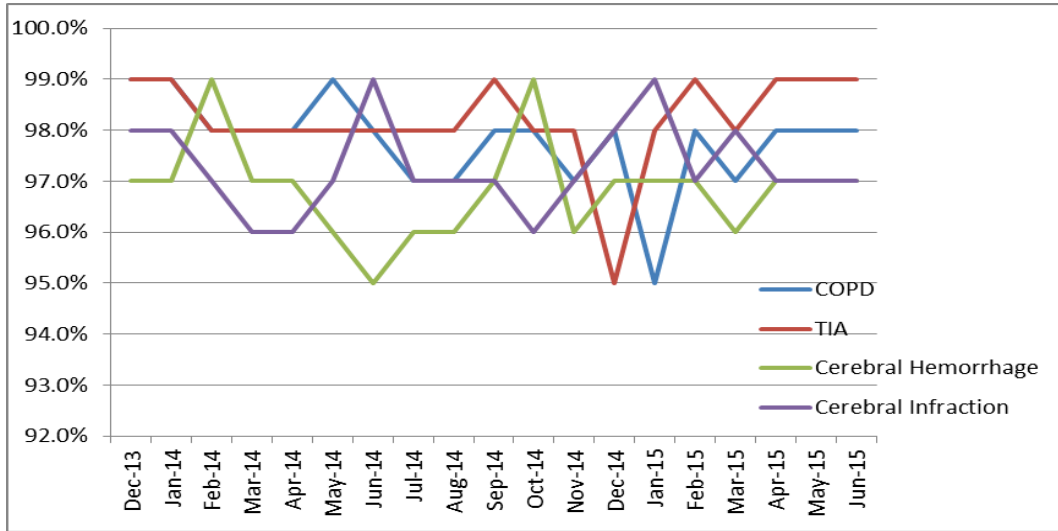


Figure 6 Patient satisfaction of four pathway diseases

3. Clinical behaviors

Clinical pathways have regulated diagnostic and clinical behaviors of the four diseases in varying degrees. Overall, pathway promoted mandatory items, but had a weak influence on optional service items. Detailed behavioral outcomes are shown below:

(1) COPD

The utilization proportions of expectorant and pulmonary function testing, both of which are mandatory items, increased after the implementation of the pathway project. For optional items, or antibiotics in the case of COPD, pathways had little influence.

A. Mandatory items

Before the pilot, the utilization proportion of expectorant in COPD patients was 89.77%. After the pilot, expectorant utilization proportion of both pathway and non-pathway patients increased from 4.89% and 7.79% to 94.67% and 97.56% respectively ($P>0.05$) (Table 3). The improvement was greater among the New Rural Cooperative Medical Scheme (NRCMS) patients, with 7.29% increase in the pathway patients and 9.88% increase in the non-pathway patients ($P<0.05$). There was no difference in the per capita average costs (Table 3, Table 4).

Table 3 COPD patients' expectorant utilization before and after pilot implementation

Groups	Total patients	Patients that used expectorant	Utilization proportion (%) [*]	Per capita average drug cost (CNY)
Before pilot, all patients	88	79	89.77	267.83
After pilot, pathway	150	142	94.67	285.39
After pilot, non-pathway	123	120	97.56	262.80

Table 4 NRCMS COPD patients' expectorant utilization before and after pilot implementation

Groups	Total patients	Patients that used expectorant	Utilization proportion (%) [*]	Per capita average drug cost (CNY)
Before pilot, all patients	73	65	89.04	251.08
After pilot, pathway	109	105	96.33	280.75

After pilot, non-pathway	96	94	97.92	260.48
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*P<0.05

The proportion of pulmonary function testing was low before the project at only 7.95%. After the pilot implementation, the utilization proportions increased fourfold to 30.67% for pathway patients and threefold to 22.95% for non-pathway patients (P<0.05). Per capita average cost had no significant difference (Table 5).

Table 5 COPD patients' pulmonary function testing before and after pilot implementation

Groups	Total patients	Patents that completed test	Utilization proportion (%)*	Per capita average test cost (CNY)
Before pilot, all patients	88	7	7.95	84.00
After pilot, pathway	150	46	30.67	83.39
After pilot, non-pathway	123	27	21.95	81.41

*P<0.05

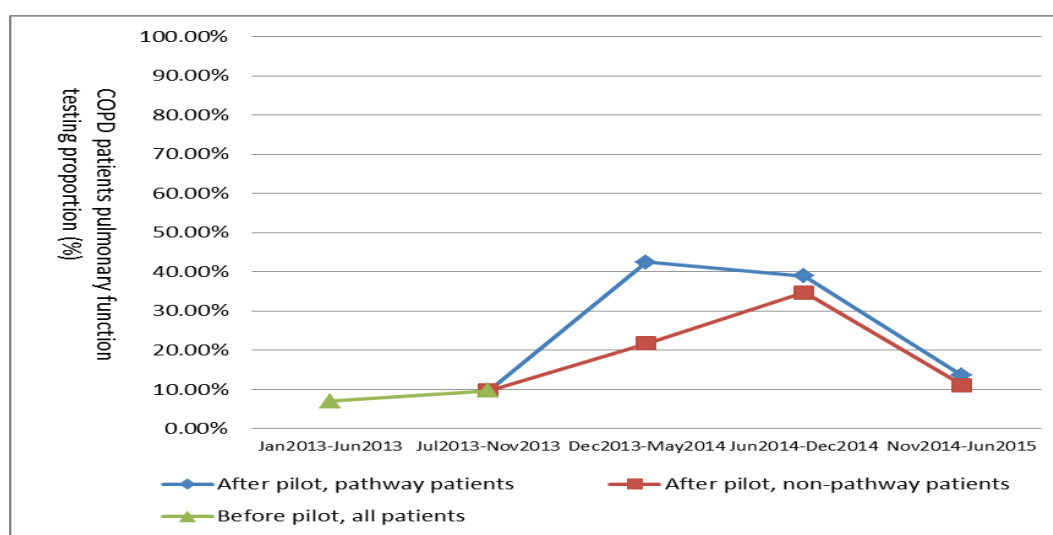


Figure 7 COPD patients' pulmonary function testing proportions before and after pilot implementation

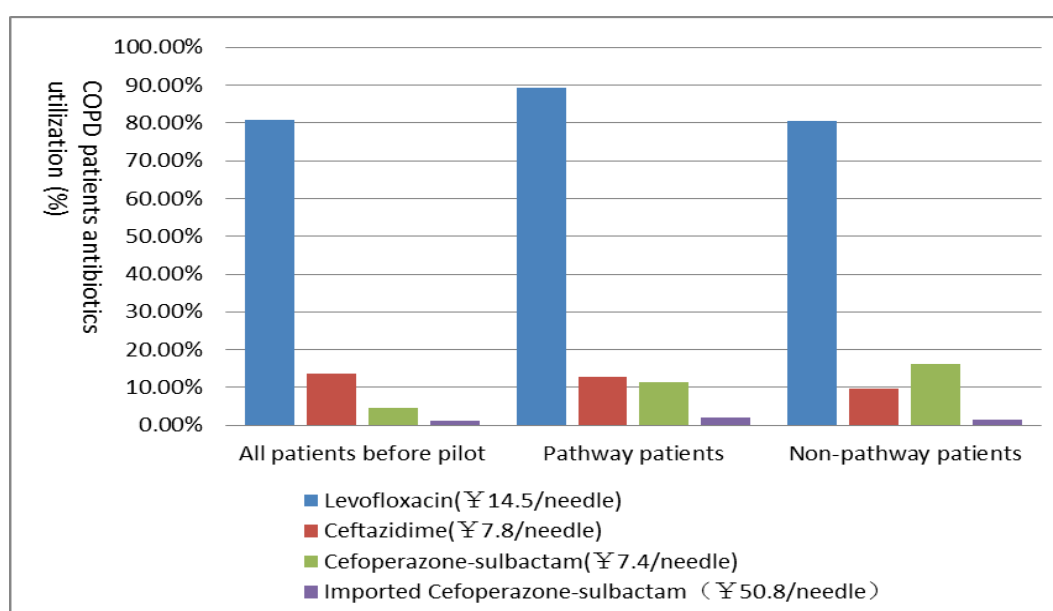
B. Optional items

There was no statistically significant difference in the total antibiotic utilization proportions and the usage duration before and after the pilot implementation. Most patients used single type of antibiotics. The utilization proportions were between 72.36% and 82.95%, with an average duration of 7.92 to 8.41 days; per capita average cost ranged from 261.50 CNY to 297.40 CNY (Table 6).

Table 6 COPD patients' antibiotics utilization before and after pilot

	Total patients	Patients not using antibiotics (%)	Single antibiotic users (%)	Two antibiotics combined users (%)	Three antibiotics combined users (%)*	Per capita utilization days*	Per capita cost (CNY)
Before pilot, all	88	7 (7.95%)	73 (82.95%)	7 (7.95%)	1 (1.14%)	8.32	261.50
After pilot, pathway	150	6 (4.00%)	113 (75.33%)	31 (20.67%)	0 (0.00%)	8.41	274.20
After pilot, non-pathway	123	9 (7.32%)	89 (72.36%)	12 (9.76%)	0 (0.00%)	7.92	297.40

Among the top four used antibiotics, Levofloxacin (14.5 CNY/needle) was used the most (81% to 89%) in all patients before and after the pilot implementation. Each of the other three types of antibiotics accounted for less than 20% (Figure 8).


Figure 8 COPD patients' top four used antibiotics

(2) TIA

Mandatory items for TIA included antiplatelet drugs and statins, whose utilization proportions and subscription amounts significantly increased in pathway patients after the implementation. However, CT and MRI utilization proportions did not change. For optional items, the utilization proportion of cerebral perfusion improvement drug was significantly higher in the pathway patients when compared with both the non-pathway patients and patients before the pilot.

A. Mandatory items

The utilization proportion of antiplatelet drugs was low before the pilot (<20.00%), but increased by 61.43% to reach 81.43% among the pathway patients, and increased by 50.97% to reach 70.97% among the non-pathway patients. The per capita average drug cost increased accordingly ($P>0.05$) (Table 7, Figure 9). Per capital average prescription amounts of aspirin and Clopidogrel remained unchanged after pilot the implementation ($P>0.05$) (Table 8).

Table 7 TIA patients' antiplatelet drug utilization before and after pilot

Groups	Total patients	Patients that used antiplatelet drugs	Utilization proportion (%)*	Per capita average drug cost (CNY)*
Before pilot, all patients	150	30	20.00	32.84
After pilot, pathway patients	140	114	81.43	95.09
After pilot, non-pathway patients	124	88	70.97	79.10

* $P<0.05$

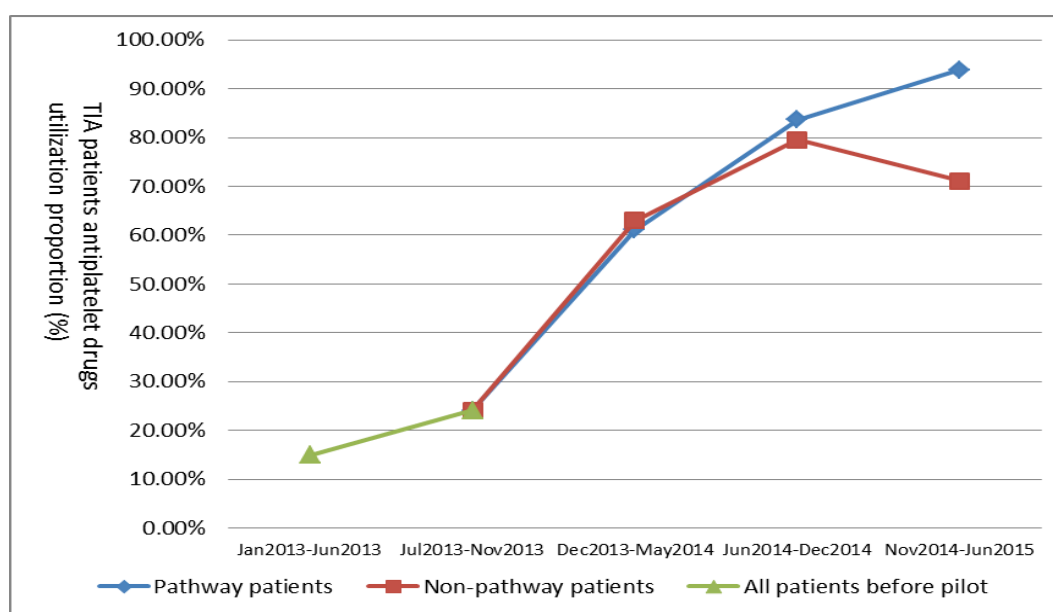


Figure 9 TIA patients' antiplatelet drug utilization proportions before and after pilot implementation (semi-annual average)

Table 8 TIA patients' aspirin and Clopidogrel per capita average prescription amounts (pills)

Groups	Aspirin	Clopidogrel
Before pilot, all patients	33.21	37.50

After pilot, pathway patients	29.90	39.15
After pilot, non-pathway patients	30.65	38.65

The utilization proportion of statins was 58% before pilot, and increased to 70.71% (12.71% change) among the pathway patients and to 76.61% (18.61% change) among the non-pathway patients ($P < 0.05$). Per capita average prescription amount and cost were unchanged after the pilot implementation ($P > 0.05$) (Table 9,

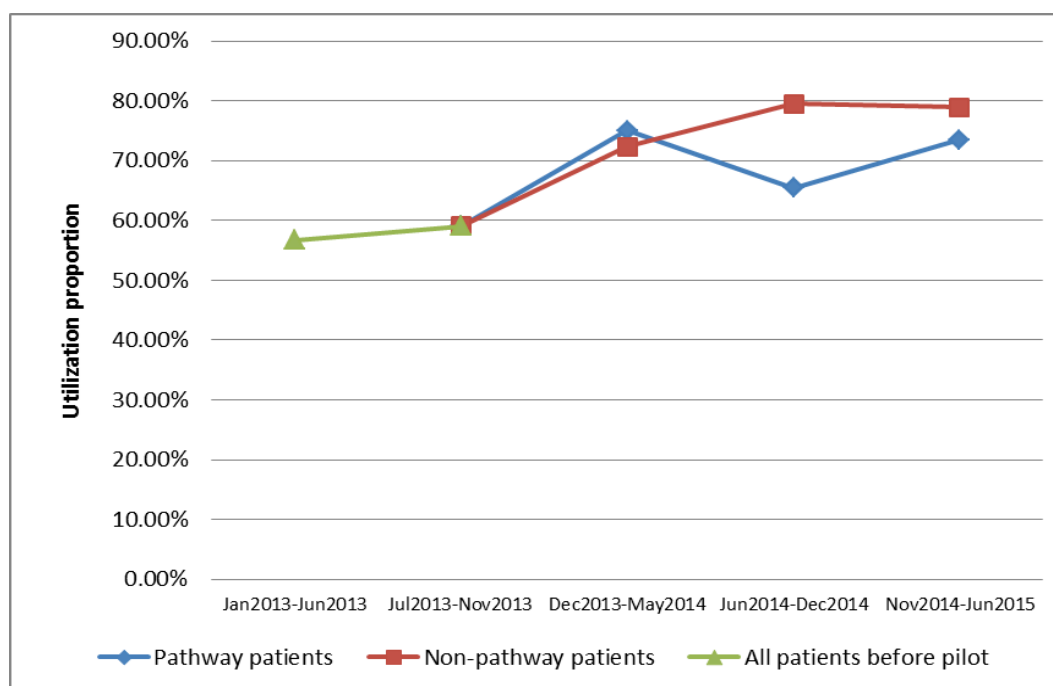


Figure 10).

Table 9 TIA patients' statins utilization before and after pilot implementation

Groups	Total patients	Patients that used statins	Utilization proportion (%) [*]	Per capita average prescription pills	Per capita average drug cost (CNY)
Before pilot, all patients	150	87	58.00	23.06	18.33
After pilot, pathway	140	99	70.71	22.42	17.83
After pilot, non-pathway	124	95	76.61	20.46	16.27

* $P < 0.05$

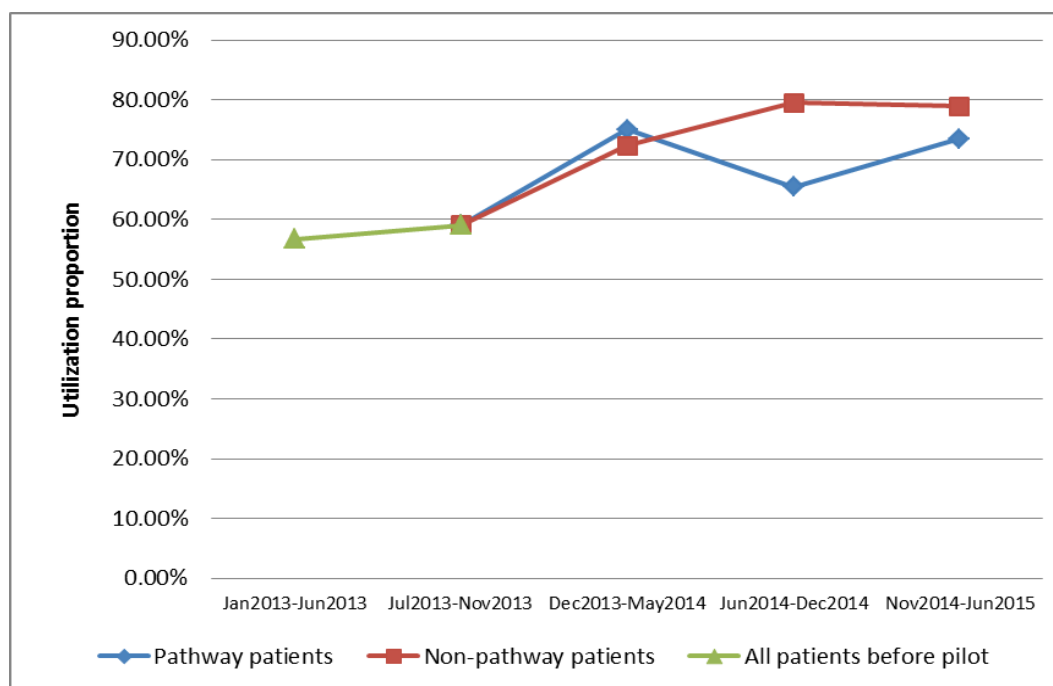


Figure 10 TIA patients' Simvastatin utilization ratio (Semi-annual average)

CT and MRI proportions stayed unchanged after the pilot implementation ($P>0.05$). CT scan proportions were 36.43% to 47.33%, and MRI proportions were 38.67% to 48.57%. Per capita average examination times and costs also remained unchanged (Table 10, Table 11).

Table 10 TIA patients' CT scan before and after pilot implementation

Groups	Total patients	Patients completing CT scan	Utilization proportion (%)	Per capita average usage counts	Per capita average cost (CNY)
Before pilot, all	150	65	47.33	1.10	335.70
After pilot, pathway	148	80	36.43	1.08	315.00
After pilot, non-pathway	150	55	44.35	1.11	346.82

Table 11 TIA patients' MRI examination before and after pilot implementation

Groups	Total patients	Patients that completed MRI	Utilization proportion (%)	Per capita average count	Per capita average cost (CNY)
Before pilot, all patients	150	58	38.67	1.78	521.72
After pilot, pathway	148	68	48.57	1.85	481.47
After pilot, non-pathway	150	48	38.71	1.79	465.42

B. Optional items

The utilization proportion of cerebral perfusion improvement drugs was 90.71% in the pathway patients, which was 1.8 times the proportion of patients before pilot and non-pathway patients. Concordantly, per capita average utilization days and costs increased ($P < 0.05$) (Table 12, Figure 11).

Table 12 TIA patients' cerebral perfusion improvement drugs utilization

Groups	Total patients	Patients using drugs	Utilization proportion (%) [*]	Per capita average utilization days [*]	Per capita average cost (CNY) [*]
Before pilot, all patients	150	83	55.33	7.40	364.82
After pilot, pathway	140	127	90.71	8.46	408.63
After pilot, non-pathway	124	68	54.84	6.82	360.74

^{*} $P < 0.05$

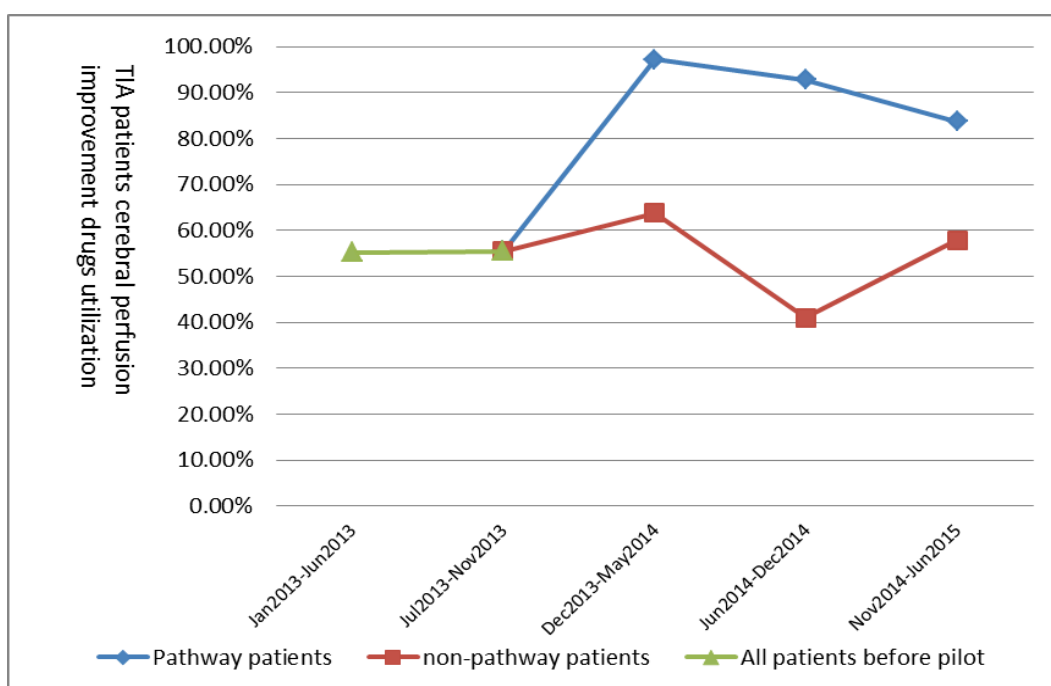


Figure 11 TIA patients' cerebral perfusion improvement drugs utilization proportion before and after pilot implementation (semi-annual average)

(3) Cerebral hemorrhage

The proportion of CT scan within 24 hours of hospital admission, a mandatory item of cerebral hemorrhage, increased in the pathway patients. For optional items, oxygen prescription amount were reduced in the pathway patients, but dehydrating

agents remained unchanged.

A. Mandatory items

CT scan utilization almost reached 100% both before and after the pilot implementation; but MRI utilization remained low at 6.98% to 13.42% without statistical significant difference between pre- and post-pilot implementation (Table 13, Table 14).

Table 13 Cerebral hemorrhage patients' CT scan proportions before and after pilot implementation

Groups	Total patients	Patients completing CT scan	Utilization proportion (%)	Per capita average counts	Per capita average cost (CNY)
Before pilot, all patients	62	60	96.77%	3.47	981.75
After pilot, pathway	149	148	99.33%	3.36	989.70
After pilot, non-pathway	43	43	100.00%	4.49	1,395.93

Table 14 Cerebral hemorrhage patients' MRI examination proportion before and after pilot implementation

Groups	Total patients	Patients that completed MRI	Utilization proportion (%)	Per capita average counts	Per capita average cost (CNY)
Before pilot, all patients	62	5	8.06	1.20	344.00
After pilot, pathway	149	20	13.42	1.50	386.50
After pilot, non-pathway	43	3	6.98	1.33	340.00

The proportion of administering imaging examinations (CT or MRI) within 24 hours of hospital admission was 70.97% before the pilot, and reached 78.52% in the pathway patients (7.55% increase) and 90.71% in the non-pathway patients (19.73% increase) after the pilot implementation (P<0.05) (Table 15).

Table 15 Cerebral hemorrhage patients' CT/MRI examination within 24 hours of hospital admission, before and after pilot implementation

Groups	Total patients	CT or MRI utilization proportion (%)*	CT utilization proportion (%)*	MRI utilization proportion (%)
Before pilot, all	124	70.97	69.35	1.96
After pilot, pathway	115	78.52	77.85	4.13



After pilot, non-pathway	102	90.70	88.37	2.78
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*P<0.05

B. Optional items

Oxygen utilization proportions remained high both before and after pilot implementation (89.26% - 93.55%). However, prescription amount and cost were significantly lower among the pathway patients (P<0.05) (Table 16).

Table 16 Cerebral hemorrhage patients' oxygen utilization before and after pilot implementation

Groups	Total patients	Patients that used oxygen	Utilization proportion (%)	Per capita average prescription amount*	Per capita average cost (CNY)*
Before pilot, all patients	62	58	93.55	262.30	525.79
After pilot, pathway	149	133	89.26	215.65	433.54
After pilot, non-pathway	43	40	93.02	310.64	621.54

*P<0.05

The utilization proportion of dehydrating agents and per capita average duration did not change after the pilot implementation (P>0.05) (Table 17).

Table 17 Cerebral hemorrhage patients' dehydrating agent usage before and after pilot implementation

Groups	Total patients	Patients using dehydrating agents	Utilization proportion (%)	Per capita average days	Per capita average cost (CNY)
Before pilot, all patients	62	53	85.48	18.21	621.48
After pilot, pathway	149	119	79.87	15.50	546.08
After pilot, non-pathway	43	36	83.72	16.78	595.82

(4) Cerebral infarction

The mandatory items for cerebral infarction had the following utilization results: The utilization proportion and average usage duration per capita utilization increased in the pathway patients. Utilization proportions of statins and CT scans within 24 hours of hospital admission stayed unchanged. For optional items, oxygen prescription in the pathway patients was similar to patients before the pilot but was

significantly lower than non-pathway patients. The utilization proportion and average amount of nerve nutrition drugs per capita were significantly higher in the pathway patients than patients before the pilot and non-pathway patients.

A. Mandatory items

The utilization proportion of antiplatelet drug was 27.33% before the pilot, which increased threefold to 78.38% in the pathway patients and twofold to 59.33% in the non-pathway patients ($P<0.05$). Average cost per capita also increased 3 times for pathway patients and 2.5 times for non-pathway patients ($P<0.05$) (Table 18). Specifically, per capita prescription amounts of aspirin and Clopidogrel increased significantly (Table 19).

Table 18 Cerebral hemorrhage patients' antiplatelet drugs utilization before and after pilot implementation

Groups	Total patients	Patients using antiplatelet drugs	Utilization proportion (%)*	Per capita average cost (CNY)*
Before pilot, all patients	150	41	27.33	33.42
After pilot, pathway patients	148	116	78.38	107.96
After pilot, non-pathway	150	89	59.33	86.17

* $P<0.05$

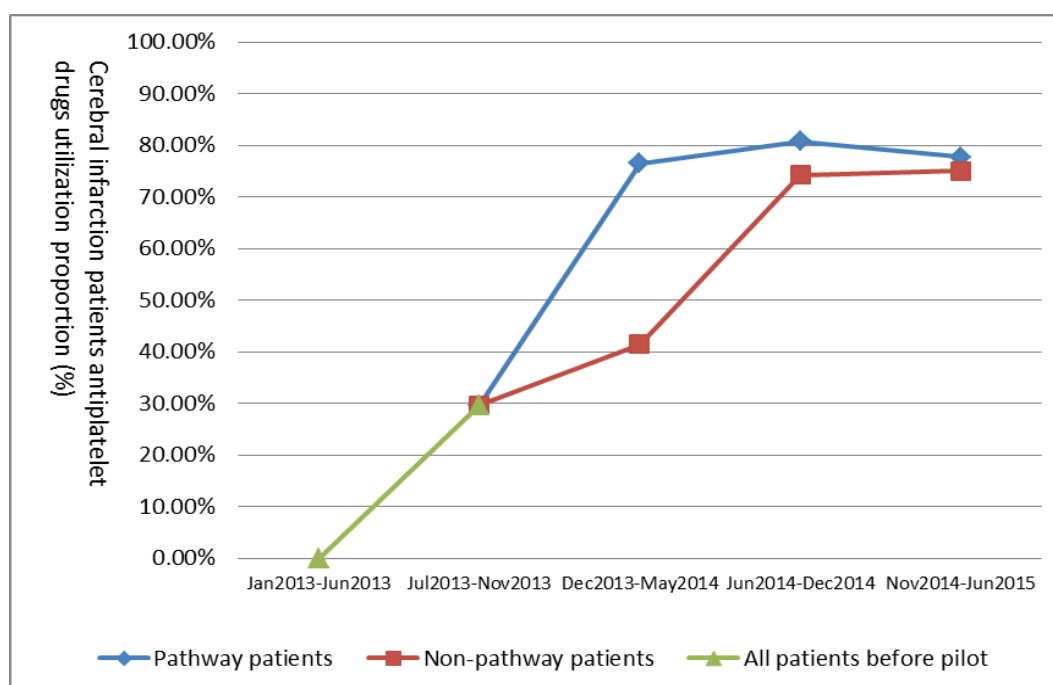


Figure 12 Cerebral infarction patients' antiplatelet drugs utilization proportion before and after pilot implementation (semi-annual average)

Table 19 Cerebral infarction patients' aspirin and Clopidogrel average prescription amount per capita (pills) before and after pilot implementation

Groups	Aspirin*	Clopidogrel*
Before pilot, all patients	1.08	19.00
After pilot, pathway patients	55.00	39.91
After pilot, non-pathway patients	38.30	26.78

*P<0.05

The utilization proportion of statins ranged from 54.67% to 68.24% both before and after the pilot, without statistically significant difference. Average prescription amount and cost were also unchanged (Table 20)

Table 20 Cerebral infarction patients' statins utilization before and after pilot

Groups	Total patients	Patients that used statins	Utilization proportion (%)	Per capita average prescribed pills	Per capita average cost (CNY)
Before pilot, all patients	150	96	64.00	22.69	18.04
After pilot, pathway	148	101	68.24	27.23	21.65
After pilot, non-pathway	150	82	54.67	23.41	18.61

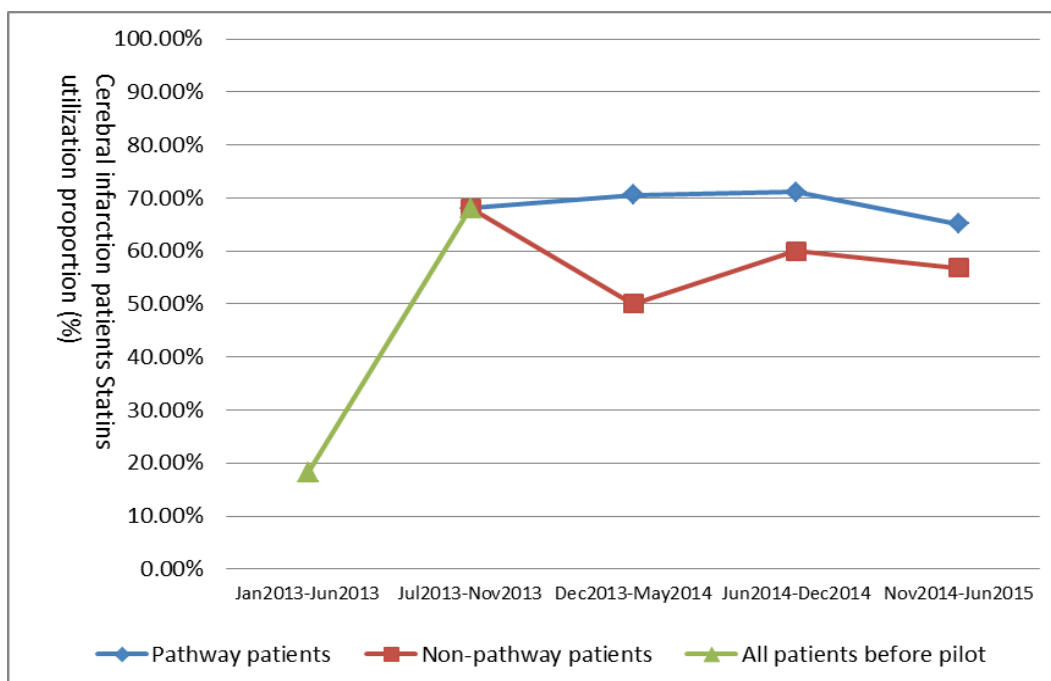


Figure 13 Cerebral infarction patients' statins utilization proportion before and after pilot implementation (semi-annual average)

Imaging examination (CT and MRI) proportion were 70.5 to 81.7% before and after the pilot, with no statistically significant difference. MRI proportion in the pathway patients was 59.13%, which was higher than patients before the pilot and non-pathway patients ($P < 0.05$) (Table 21).

Table 21 Cerebral infarction patients' CT and MRI examination proportions before and after pilot implementation

Groups	Total number of patients	CT or MRI utilization proportion (%)	CT utilization proportion (%)	MRI utilization proportion (%)*
Before pilot, all patients	124	77.42	52.42	41.94
After pilot, pathway	115	81.74	44.35	59.13
After pilot, non-pathway	102	70.59	49.02	37.25

* $P < 0.05$

Proportions of providing imaging examinations (CT and MRI) within 24 hours of hospital admission remained the same, with a range of 60.78% to 67.78%. Proportion of MRI utilization within 24 hours of admission in the pathway patients was 36.26%, which was higher than both patients before the pilot and non-pathway patients



(P<0.05) (Table 22).

Table 22 Cerebral infarction patients' CT and MRI (within 24 hours of hospital admission) proportions before and after pilot implementation

Groups	Total number of patients	CT or MRI utilization proportion (%)	CT utilization proportion (%)	MRI utilization proportion (%)*
Before pilot, all	124	66.94	45.97	22.58
After pilot, pathway	115	66.96	34.78	38.26
After pilot, non-pathway	102	60.78	36.27	24.51

*P>0.05

B. Optional items

Oxygen utilization proportion in the pathway patient was 6.08%, similar to patients before the pilot but significantly lower than the non-pathway patients (25.33%). Per capita utilization amount and cost were also lower in the pathway patient group (Table 23, Figure 14). The utilization proportion and the amount of nerve nutrition drugs were significantly higher in the pathway patients than both patients before the pilot and non-pathway patients (Table 24).

Table 23 Cerebral infarction patients' oxygen utilization before and after pilot

Groups	Total patients	Patients that used oxygen	Utilization proportion (%)*	Per capita average prescribed hours*	Per capita average cost (CNY)*
Before pilot, all patients	150	14	9.33	59.07	118.14
After pilot, pathway	148	9	6.08	105.06	210.44
After pilot, non-pathway	150	38	25.33	117.68	235.53

*P<0.05

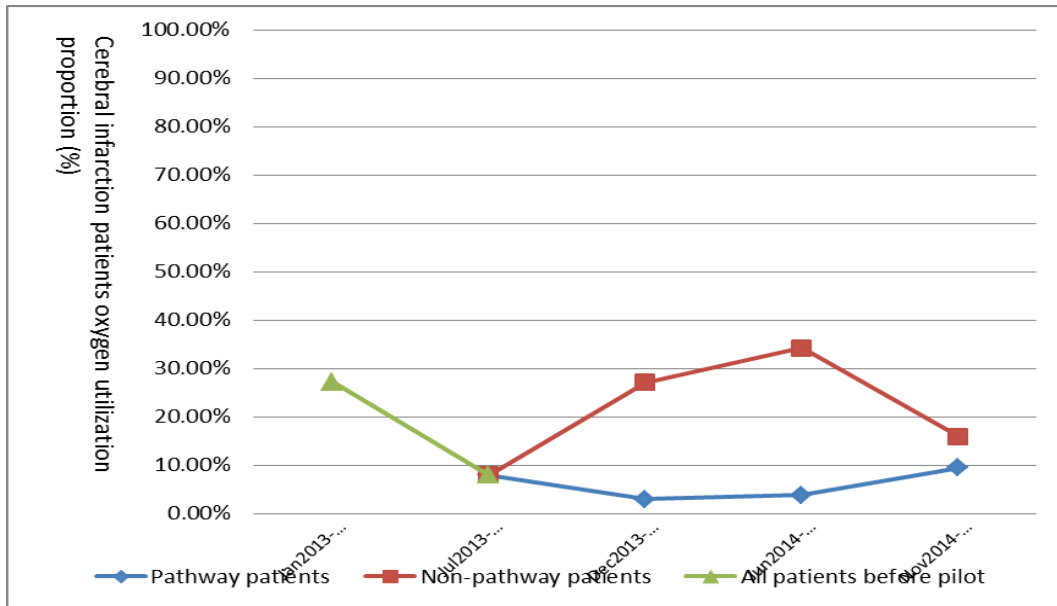


Figure 14 Cerebral infarction patients' oxygen utilization proportion before and after pilot implementation

Table 24 Cerebral infarction patients' nerve nutrition drug utilization before and after pilot implementation

Groups	Total patients	Patients using nerve nutrition drug	Utilization proportion (%)*	Per capita average prescribed hours	Per capita average cost (CNY)
Before pilot, all patients	124	54	43.55	17.35	18.04
After pilot, pathway	115	98	85.22	22.05	21.65
After pilot, non-pathway	102	56	54.90	17.48	18.61

*P<0.05

4. Healthcare expenditure

(1) Total hospitalization cost

The average total hospitalization cost of TIA, cerebral hemorrhage and cerebral infarction patients stayed the same after the pilot implementation. The average total hospitalization cost of COPD patients was 15% higher in patients after the pilot (Figure 15). The variation of total hospitalization cost in TIA and cerebral infarction patients were similar to before the pilot. Variation in COPD costs after the pilot implementation was larger than before-pilot costs. Variation in TIA costs after the pilot implementation was smaller (Figure 15).

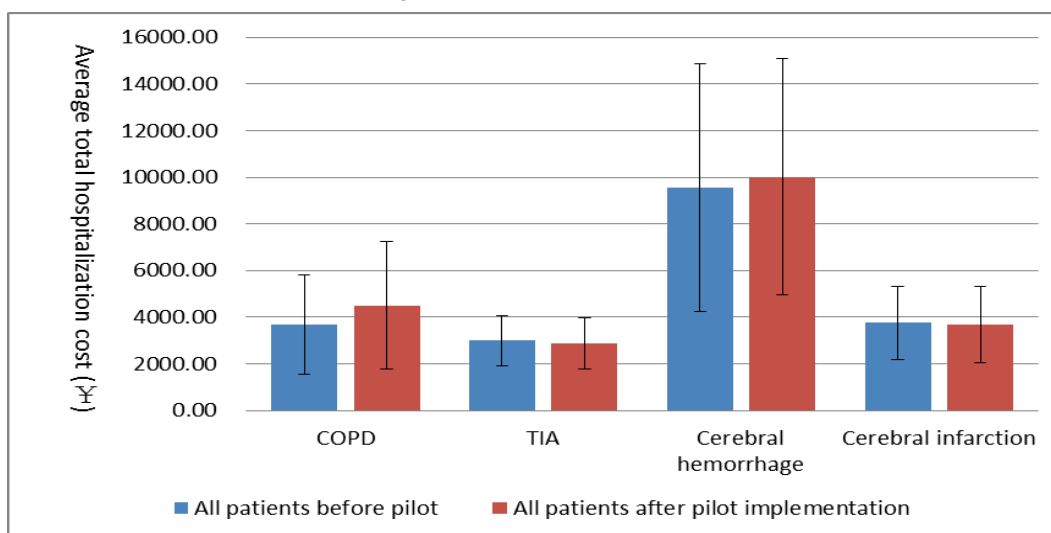


Figure 15 Average total hospitalization costs of four diseases before and after pilot implementation

Comparisons of costs between pre-pilot patients, pathway patients and non-pathway patients revealed the following: the average hospitalization costs of TIA, cerebral hemorrhage and cerebral infarction for pathway patients were similar to costs for all patients before the pilot; whereas the cost of COPD was higher in the pathway patients than patients before the pilot (Figure 16). At the same time, variations of total hospitalization costs of all four diseases' pathway patients were smaller than the cost variations of the pre-pilot patients, especially for cerebral hemorrhage (Figure 16). The costs of COPD, cerebral hemorrhage and cerebral infarction for pathway patients were lower than non-pathway patients, particularly for cerebral hemorrhage (Figure 16). The variations of total hospitalization costs were smaller in pathway patients than non-pathway patients.

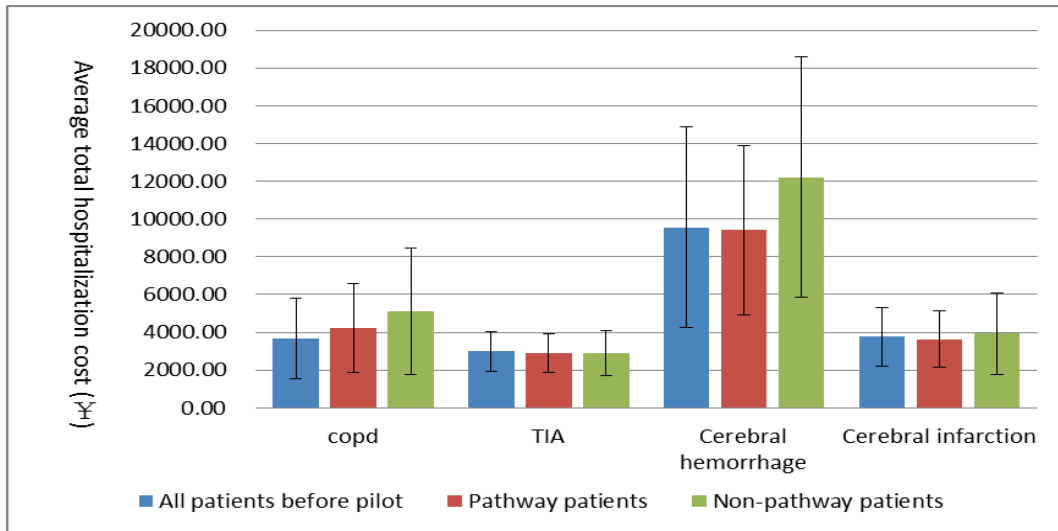


Figure 16 Average hospitalization costs of four diseases by pathway status before and after pilot

A. COPD

The average hospitalization cost of COPD patients after the pilot implementation was 4,507.57 CNY, which increased by 834.71 CNY (15%) from 3,672.86 CNY before the pilot ($P < 0.05$) (Table 25). Drug cost accounted for the highest proportion of the total cost in both before- and after-pilot patients (Figure 17). Five types of costs had significant differences. Laboratory cost increased by 292.68 CNY; drug cost increased by 274.04 CNY; and diagnosis and treatment cost increased by 186.94 CNY ($P < 0.05$) (Table 25).

Among the pathway patients for COPD, the average hospitalization cost was 4,235.24 CNY, which was 562.38 CNY higher than patients before the pilot (3,672.86 CNY) ($P < 0.05$); but the pathway patients' average cost was 854.41 CNY lower than non-pathway patients (5,087.56 CNY) (Table 25). Drug cost accounted for the highest proportions in all three groups of patients (Figure 18). Nine types of costs had significant differences. Laboratory cost, drug cost and treatment cost had the largest differences when comparing pathway patients and all patients before the pilot: laboratory cost increased by 240.18 CNY; drug cost increased by 193.59 CNY; and treatment cost increased by 105.07 CNY ($P < 0.05$) (Table 25, Figure 18). In addition, variations of costs in pathway patients were smaller than non-pathway patients (Table 25).

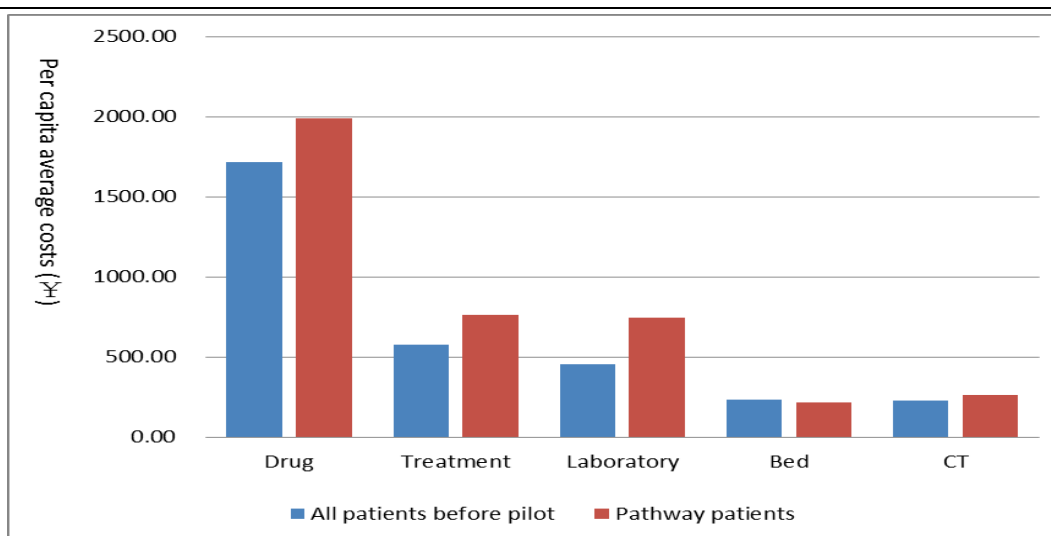


Figure 17 Top five costs of COPD patients before and after pilot implementation

Table 25 COPD inpatients' per capita average costs

Types	Before pilot: All patients (n=95)	After pilot: All patients (n=385)	After pilot: Pathway patients (n=262)	After pilot: Non-pathway (n=123)
Total	3,672.86 ± 2,136.68	4,507.57 ± 2,737.12*	4,235.24 ± 2,354.7*	5,087.65 ± 3,349.69
Bed	232.45 ± 161.82	216.95 ± 197.35	196.96 ± 164.8*	259.54 ± 248.59
Nursing	139.94 ± 99.34	166.67 ± 168.19	150.56 ± 130.01*	201.00 ± 226.13
Drug	1,716.73 ± 1,036.79	1,990.77 ± 1130.14*	1910.32 ± 1,046.53*	2,162.13 ± 1,278.09
Examination	12.6 ± 37.61	24.86 ± 43.26*	24.4 ± 41.94*	25.84 ± 46.12
Treatment	578.01 ± 616.86	764.95 ± 950.6	683.08 ± 843.04*	939.33 ± 1130.8
Surgery	0.00 ± 0.00	12.73 ± 97.39	10.69 ± 84.23	17.07 ± 121.03
Diagnosis	12.6 ± 37.61	145.56 ± 59.35	24.4 ± 41.94	25.84 ± 46.12
Laboratory	452.54 ± 338.21	745.22 ± 428.17*	692.72 ± 362.58*	857.05 ± 526.57
B-Ultrasound	4.68 ± 17.92	1.79 ± 11.58	1.45 ± 9.07	2.52 ± 15.67
Color Doppler ultrasound	36.95 ± 74.18	36.21 ± 85.45	38.21 ± 89.68	31.95 ± 75.84
CT	229.89 ± 187.07	262.12 ± 186.53	257.56 ± 179.54	271.83 ± 201.03
Cardiograph	17.17 ± 12.7	20.6 ± 12.99*	19.85 ± 11.03*	22.19 ± 16.34
MRI	17.58 ± 78.11	3.3 ± 34.37*	1.91 ± 21.8*	6.26 ± 51.86
Material	61.07 ± 110.32	80.63 ± 165.83	63.79 ± 111.36*	116.5 ± 241.09
Rehabilitation	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Others	25.62 ± 16.32	35.22 ± 29.45	38.16 ± 31.56	28.95 ± 23.24

*P<0.05

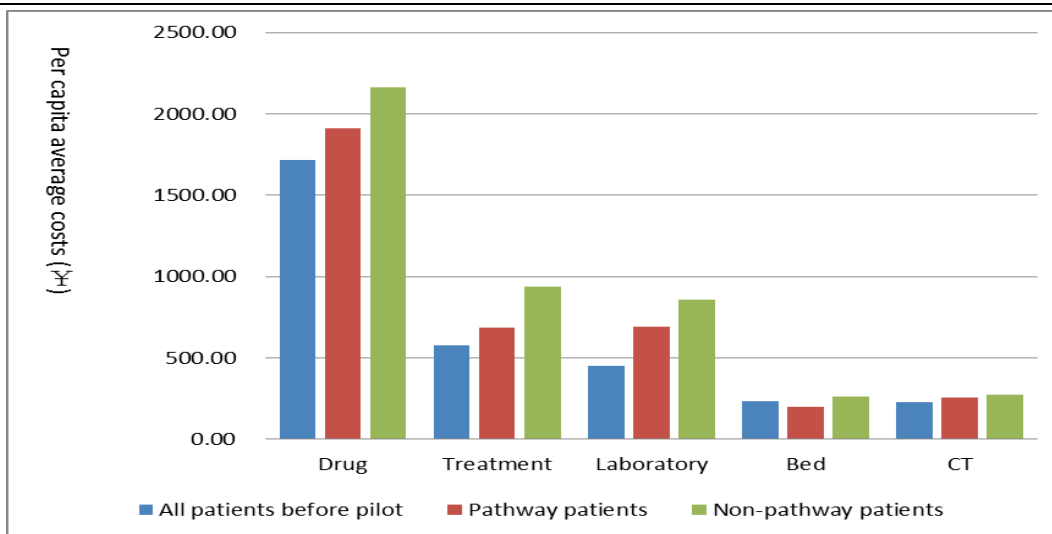


Figure 18 Top five costs of COPD patients by pathway status before and after pilot

Monthly trends showed that the average cost of COPD patients before the pilot fluctuated between 2,500 and 5,000 CNY, with a gradual decreasing trend. The trend changed after the pilot implementation: the costs fluctuated between 3,500 and 5,000 CNY with a slight increasing trend (Figure 19). Among the pathway patients, the total hospitalization costs fluctuated between 2,200 and 6,200 CNY with a slight decreasing trend (Figure 20). However, the changes in trends were not statistically significant (Table 26,

Table 27).

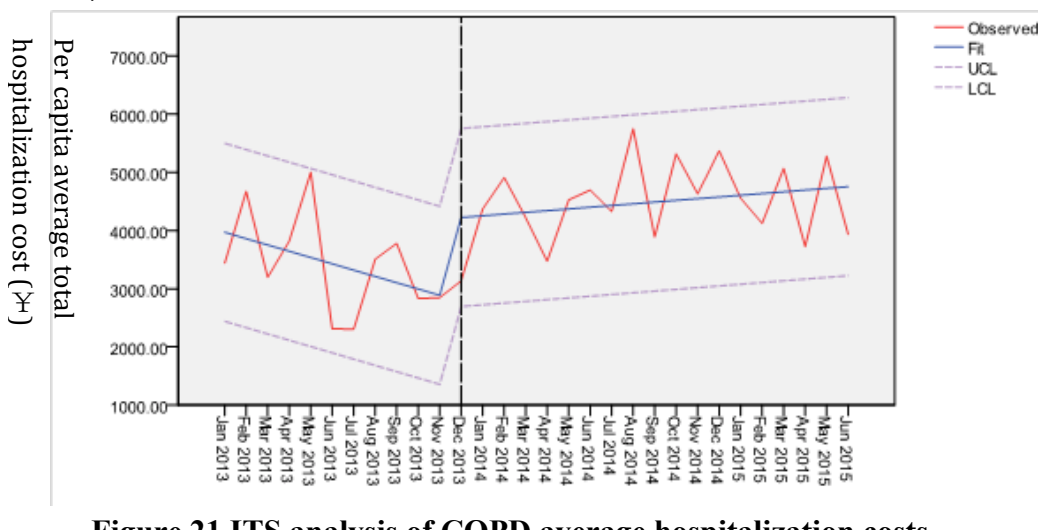


Figure 21 ITS analysis of COPD average hospitalization costs, before vs. after pilot

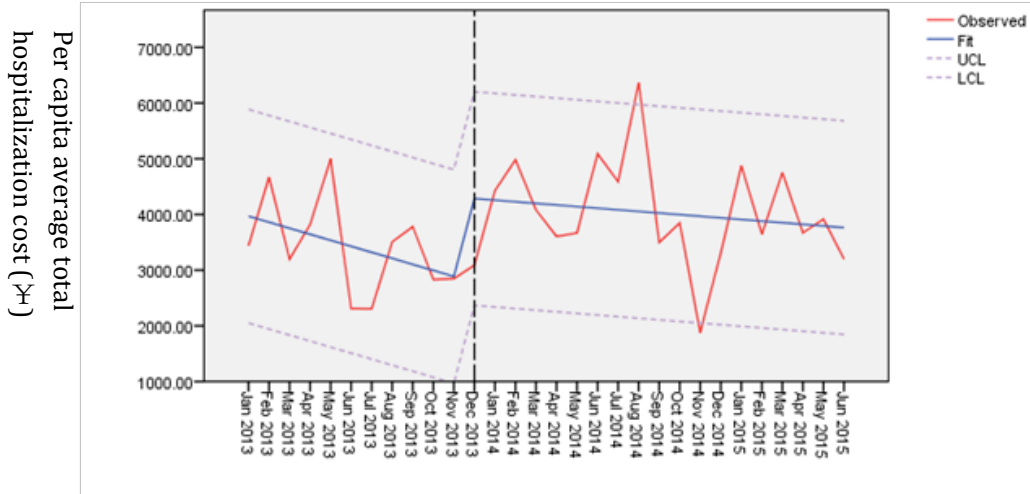


Figure 22 ITS analysis of COPD average hospitalization costs, before-pilot patients vs. after-pilot pathway patients

Table 26 ITS analysis of average hospitalization costs in COPD patients, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	4076.27	481.01	-	8.47	0.00
△Constant	-206.11	829.80	-0.11	-0.25	0.81
Slope before pilot	-108.11	70.92	-1.05	-1.52	0.14
△Slope	137.53	77.46	1.69	1.78	0.09

Table 27 ITS analysis of average hospitalization costs in COPD patients, before-pilot patients and after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	4076.27	603.40	-	6.76	0.00
△Constant	557.06	1040.93	0.28	0.54	0.60
Slope before pilot	-108.11	88.97	-0.99	-1.22	0.24
△Slope	79.16	97.17	0.92	0.81	0.42

B. TIA

The average total hospitalization costs for TIA were 2,989.36 CNY before the pilot and 2,886.56 CNY after the pilot implementation, with no statistically significant difference (Table 28). Drug costs accounted for the highest proportion of the total cost (Figure 23). Six types of costs, including bed cost, nursing cost and treatment cost etc., had statistically significant differences, but the differences were all within 100 CNY (Table 28).

There were no statistically significant differences in costs among patients before the pilot, pathway patients and non-pathway patients after the pilot (Table 28). Drug costs accounted for the highest proportion of the total costs in all three groups (Figure 24). Six types of costs, including bed cost, nursing cost and treatment cost etc., had statistically significant differences among the three groups, but all within 100 CNY (Table 28).

Table 28 TIA inpatients' per capita average costs

Types	Before pilot: All patients (n=165)	After pilot: All patients (n=360)	After pilot: Pathway patients (n=231)	After pilot: Non-pathway (n=129)
Total	2,989.36 ± 1,054.83	2,886.56 ± 1,094.66	2,889.1 ± 1,036.57	2,882.01 ± 1,195.84
Bed	183.06 ± 99.52	197.14 ± 95.49	206.11 ± 93.19*	181.08 ± 97.8
Nursing	121.62 ± 47.94	112.65 ± 47.46*	116.19 ± 44.86*	106.31 ± 51.36
Drug	1,448.23 ± 658.28	1,354.27 ± 660.66	1,367.33 ± 629.13	1,330.89 ± 715.61
Exam	15.86 ± 63.55	6.68 ± 31.86*	5.39 ± 27.95	9.00 ± 37.88
Treatment	163.71 ± 122.79	137.27 ± 141.96*	128.61 ± 97.47*	152.77 ± 197.67
Surgery	0.64 ± 8.17	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Diagnosis	148 ± 58.55	133.42 ± 57.56*	138.25 ± 56.43*	124.77 ± 58.76
Lab	339.5 ± 126.65	394.21 ± 167.65*	370.9 ± 153.2*	435.97 ± 184.17
B-Ultrasound	0.88 ± 6.00	0.28 ± 3.72	0.22 ± 3.29	0.39 ± 4.40
Color Doppler ultrasound	129.03 ± 111.31	142.53 ± 120.28	135.41 ± 110.28	155.27 ± 135.91
CT	167.15 ± 208.01	140.97 ± 199.55	135.91 ± 188.73	150.04 ± 218.06
Cardiograph	20.36 ± 19.48	22.52 ± 25.92	21.06 ± 21.27	25.14 ± 32.55
MRI	206.39 ± 280.10	218.29 ± 248.98	238.39 ± 249.66	182.31 ± 244.60
Material	12.73 ± 41.4	7.84 ± 23.40	6.33 ± 19.80	10.54 ± 28.64
Rehab	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Others	32.21 ± 26.44	18.48 ± 9.08*	19.01 ± 8.12*	17.54 ± 10.55

*p<0.05

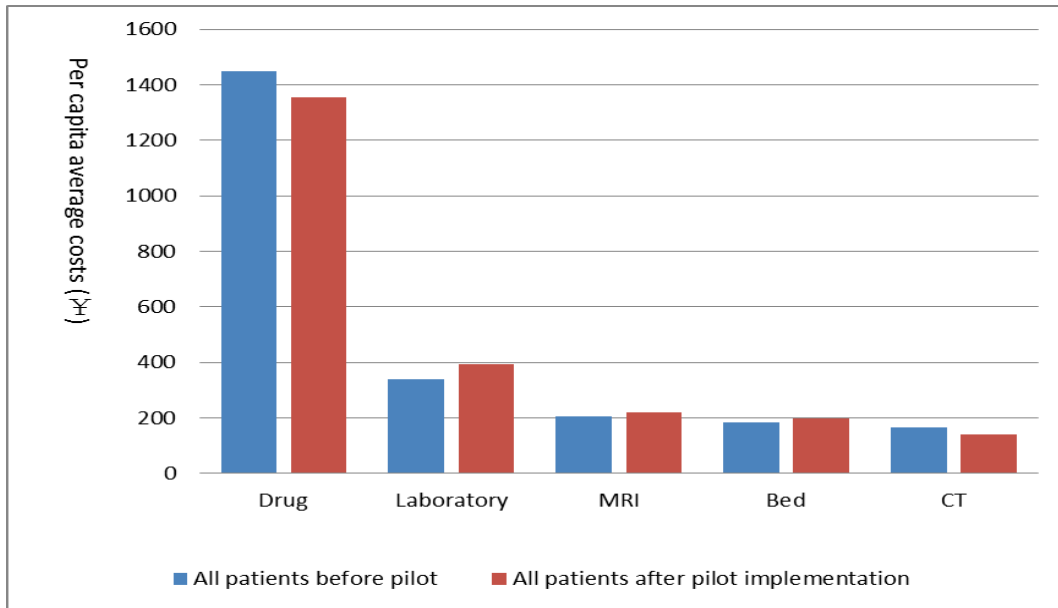


Figure 23 Top five costs of TIA patients before and after pilot implementation

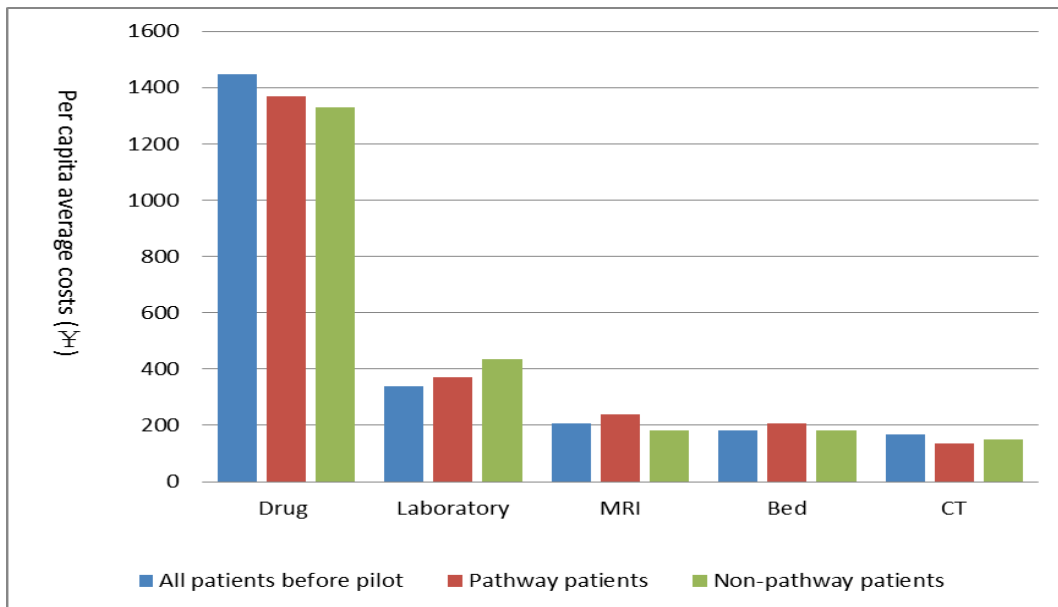


Figure 24 Top five costs of TIA patients by pathway status before and after pilot

There was no significant change in trend after the pilot implementation for TIA costs. Total hospitalization costs fluctuated between 2,600 and 3,400 CNY before the pilot, and remained similar at a range of 2,500 to 3,500 CNY after the pilot implementation (Figure 23, Figure 24). ITS analysis showed no statistically significant change (Table 29, Table 30).

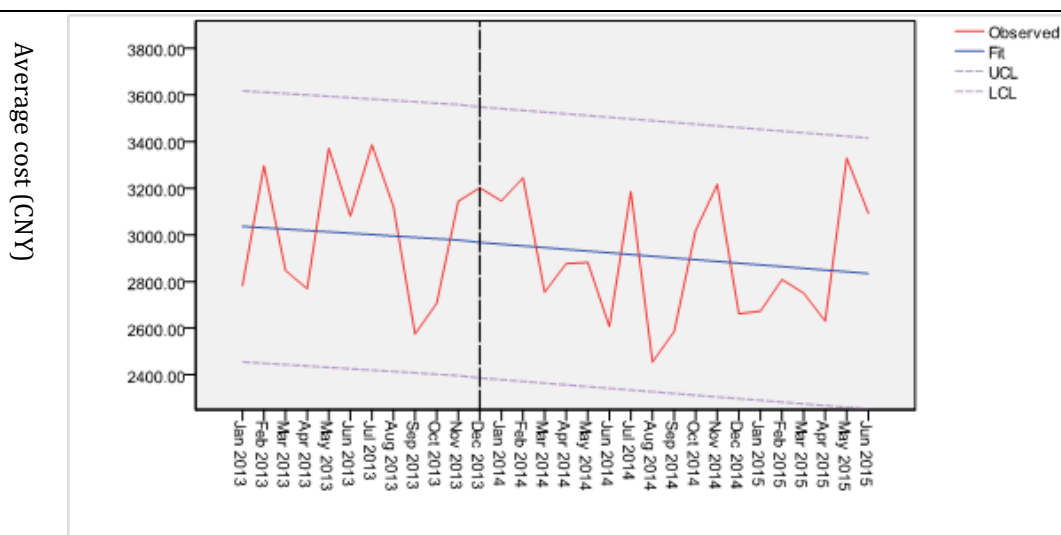


Figure 25 ITS analysis of TIA average hospitalization costs, before vs. after pilot

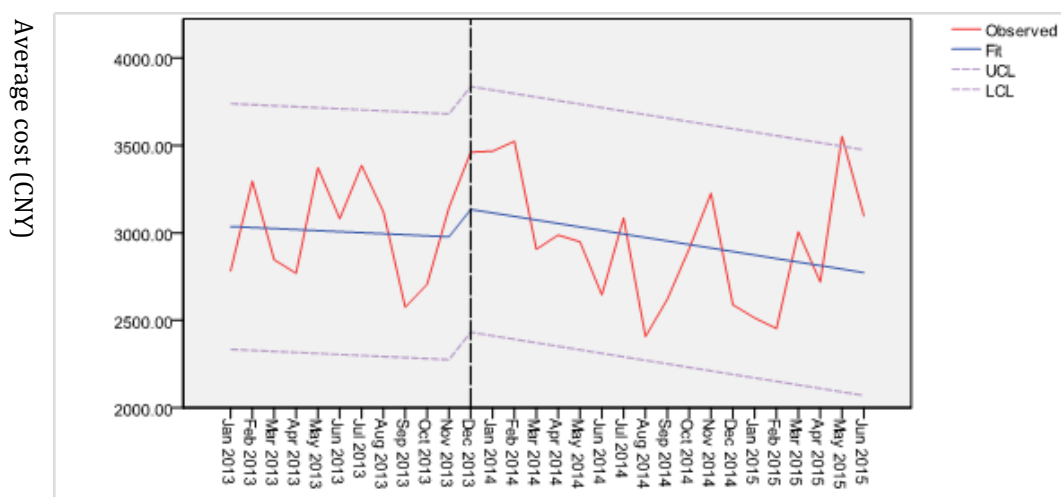


Figure 26 ITS analysis of TIA average hospitalization costs, before-pilot patients vs. after-pilot pathway patients

Table 29 ITS analysis of TIA average hospitalization cost, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	3042.47	182.73	-	16.65	0.00
△Constant	13.68	315.23	0.02	0.04	0.97
Slope before pilot	-5.89	26.94	-0.19	-0.22	0.83
△Slope	-1.49	29.43	-0.06	-0.05	0.96

Table 30 ITS analysis of TIA average hospitalization costs, before-pilot patients vs. after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	3042.47	220.87	-	13.77	0.00
△Constant	332.58	381.03	0.48	0.87	0.39
Slope before pilot	-5.89	32.57	-0.15	-0.18	0.86
△Slope	-14.18	35.57	-0.47	-0.40	0.69

C. Cerebral hemorrhage

The average total hospitalization costs were 9,558.12 CNY before the pilot and 10,014.93 CNY after the pilot implementation, with no statistical significant difference (Table 31). Drug costs accounted for the highest proportion from the total costs (Figure 25). Nursing cost, ultrasound cost and “others” cost had statistically significant difference when comparing before and after pilot costs: the average nursing cost was 128.66 CNY higher in the post-implementation patients, and the other two costs had differences of below 30 (Table 31).

For the pathway patients, the average cost was 9,417.04 CNY, which was slightly lower than patients before the pilot (9558.12 CNY), and significantly higher than non-pathway patients (12,224.55 CNY) ($P < 0.05$) (Table 31). Drug costs accounted for the highest proportion of the total cost (Figure 26). Seven types of costs had statistically significant differences. Drug cost and materials cost had the greatest differences. The average drug cost and material cost was 824.98 CNY and t 380.64 CNY higher in non-pathway patients than in pathway patients ($P < 0.05$) (Table 31). Variations of costs were smaller in pathway patients than non-pathway patients (Table 31).

Table 31 Cerebral hemorrhage inpatients' per capita average costs

Types	Before pilot: All patients (n=62)	After pilot: All patients (n=216)	After pilot: Pathway patients (n=170)	After pilot: Non-pathway patients (n=46)
Total	9,558.12 ± 5,324.9	10,014.93 ± 5,053.39	9,417.04 ± 4,479.33*	12,224.55 ± 6,349.38
Bed	605.95 ± 295.18	618.17 ± 366.28	561.13 ± 303.25*	828.98 ± 487.77
Nursing	438.34 ± 259.59	567.01 ± 417.51*	517.74 ± 358.6*	749.09 ± 553.92
Drug	3,817.65 ± 2,250.62	3,756.42 ± 1,929.19	3,580.73 ± 1,753.38*	4,405.71 ± 2,385.02
Exam	2.00 ± 11.04	2.44 ± 22.67	3.10 ± 25.53	0.00 ± 0.00
Treatment	2,514.5 ± 2,089.96	2,574.85 ± 1,800.66	2,443.60 ± 1,731.23	3,059.91 ± 1,982.35
Surgery	28.63 ± 192.59	79.54 ± 409.09	70.24 ± 401.49	113.91 ± 438.93
Diagnosis	350.56 ± 132.73	312.01 ± 140.99	307.24 ± 135.81	329.67 ± 159.04



Lab	485.1 ± 247.38	564.61 ± 329.54	518.78 ± 290.82*	733.98 ± 404.93
B-Ultrasound Color Doppler ultrasound	2.10 ± 11.72	0.28 ± 3.04*	0.35 ± 3.42	0.00 ± 0.00
CT	981.69 ± 445.99	1,074.14 ± 498.03	1,028.79 ± 452.09*	1,241.74 ± 617.24
Cardiograph	23.03 ± 13.01	24.49 ± 23.60	23.92 ± 23.59	26.59 ± 23.77
MRI	27.74 ± 97.74	46.48 ± 136.10	53.06 ± 145.45	22.17 ± 91.02
Materials	168.16 ± 166.97	277.33 ± 552.73	196.27 ± 260.48*	576.91 ± 1,043.2
Rehab	12.84 ± 63.79	49.84 ± 208.72	44.49 ± 192.49	69.61 ± 261.71
Others	66.76 ± 41.82	45.10 ± 20.86*	44.54 ± 20.33*	47.16 ± 22.83

*P<0.05

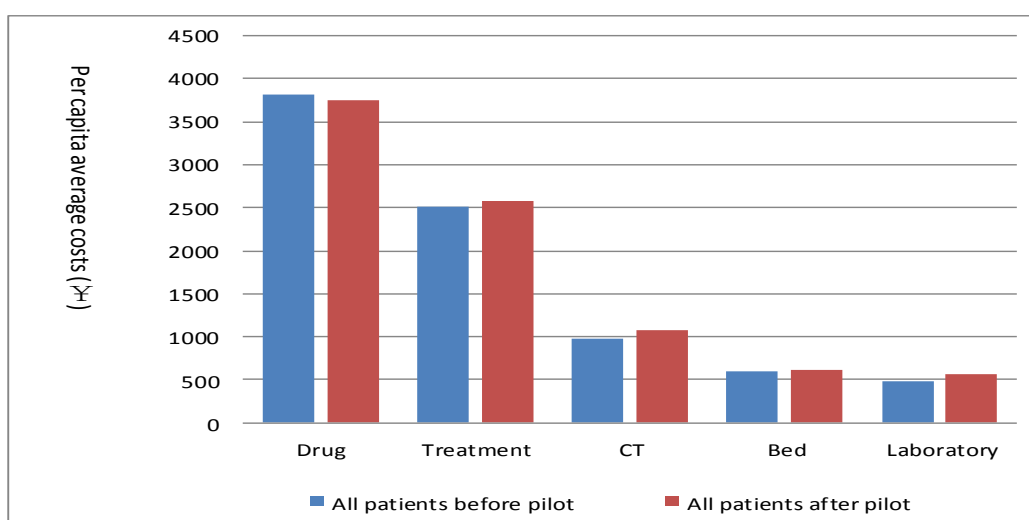


Figure 28 Top five costs of cerebral hemorrhage patients before and after pilot

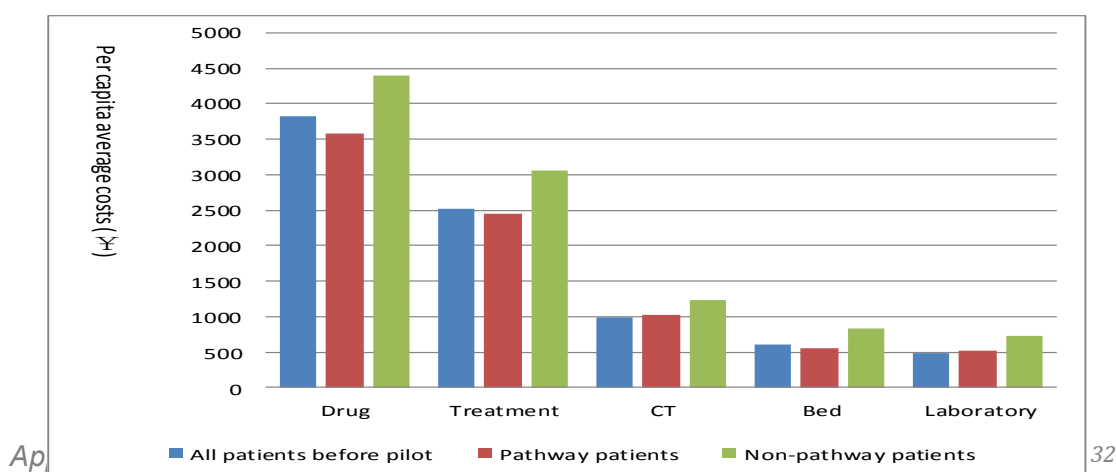


Figure 27 Top five costs of cerebral hemorrhage patients by pathway status before and after pilot

Monthly trends showed that the average cerebral hemorrhage costs before the pilot fluctuated between 7,000 and 12,000 CNY with a decreasing trend. After the pilot implementation, the costs fluctuated between 6,000 and 12,000 CNY with a gradual increasing trend (Figure 28). The costs among pathway patients fluctuated between 6,000 and 10,000 CNY with an increasing trend (Figure 27). ITS analysis showed no statistically significant changes in the trends (Table 32, Table 33)

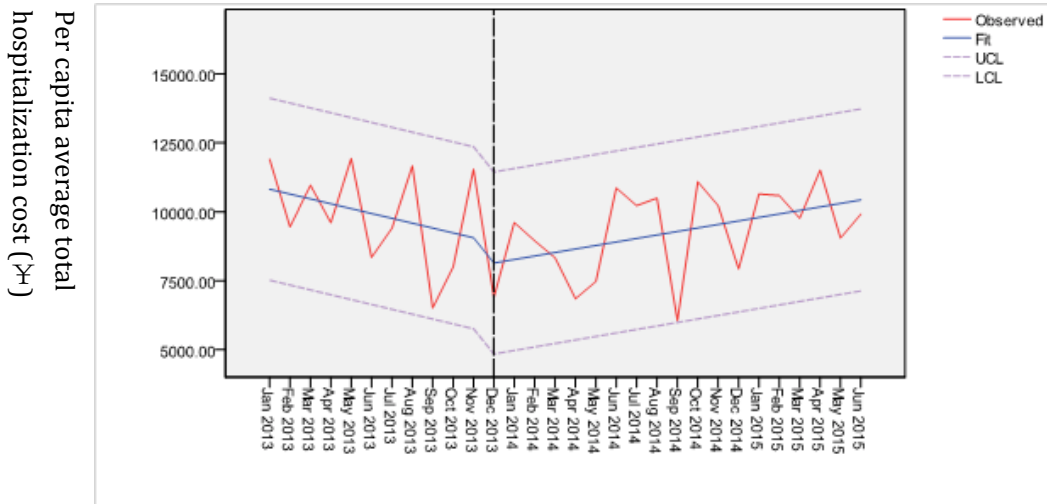


Figure 29 ITS analysis of cerebral hemorrhage average hospitalization costs, before vs. after pilot

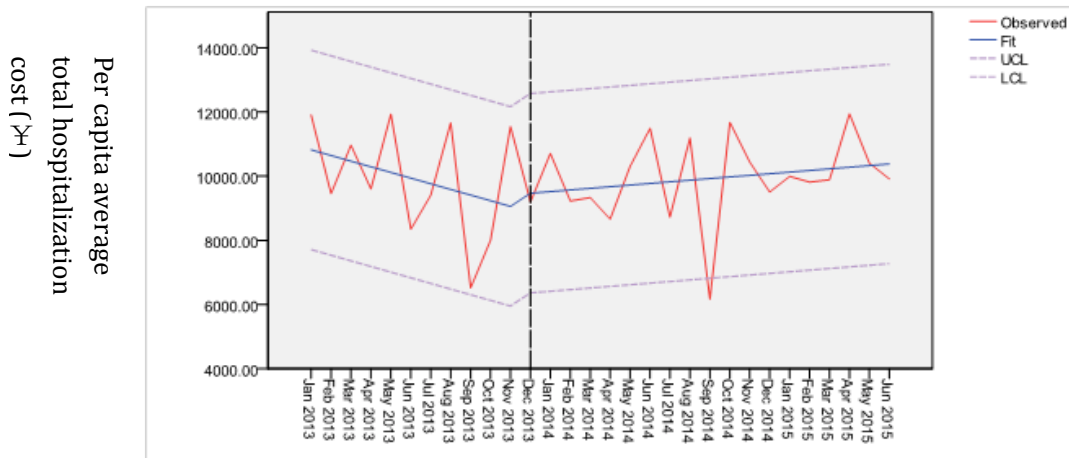


Figure 30 ITS analysis of cerebral hemorrhage average hospitalization costs, before-pilot patients vs. after-pilot pathway patients

Table 32 ITS analysis of cerebral hemorrhage average hospitalization costs, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	10995.70	977.17	-	11.25	0.00
△Constant	-2132.99	1685.72	-0.70	-1.27	0.22
Slope before pilot	-176.01	144.08	-1.04	-1.22	0.23
△Slope	226.60	157.36	1.71	1.44	0.16

Table 33 ITS analysis of cerebral hemorrhage average hospitalization costs, before-pilot patients vs. after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	10995.70	1037.72	-	10.60	0.00
△Constant	-4374.02	1790.17	-1.27	-2.44	0.02
Slope before pilot	-176.01	153.00	-0.92	-1.15	0.26
△Slope	302.96	167.12	2.01	1.81	0.08

D. Cerebral infarction

The average hospitalization costs of cerebral infarction patients were 3,762.63 CNY before the pilot and 3,690.20 CNY after the pilot implementation, which were not statistically different (Table 34). Drug cost accounted for the highest proportion of the total cost (Figure 31). Five types of costs had statistically significant differences. Drug cost in the pathway patients had the largest difference, which decreased by 128.45 CNY compared to patients before the pilot. Differences of other costs were relatively small (less than 50 CNY) (Table 34). Among the pathway patients, the average cost was 3,636.12 CNY, which was lower than patients before the pilot (3,762.63 CNY) by 126.51 CNY ($P < 0.05$). The average cost in pathway patients was also lower than the cost of non-pathway patients (3,926.56 CNY) by 290.44 CNY ($P < 0.05$) (Table 34). Drug cost accounted for the highest proportion of the total cost (Figure 32). Eleven types of costs had statistically significant differences. Treatment cost and laboratory cost had the greatest differences. Average treatment cost and laboratory cost in the pathway patients were 100.31 CNY and 81.58 CNY lower respectively when compared to costs before the pilot ($P < 0.05$) (Table 34). Variations of costs were smaller in the pathway patients than non-pathway patients (Table 34).

Table 34 Cerebral infarction inpatients' per capita average costs

Cost types	Before pilot: All patients	After pilot: All patients	After pilot: Pathway patients	After pilot: Non-pathway
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	patients			
Total	3,762.63 ± 1,567.19	3,690.2 ± 1,637.42	3,636.12 ± 1,494.83*	3,926.56 ± 2,138.74
Bed	262.91 ± 122.13	266.5 ± 116.32	269.33 ± 111.62*	254.12 ± 134.41
Nursing	154.74 ± 56.66	155.15 ± 89.90	152.18 ± 72.49*	168.11 ± 142.38
Drug	1,880.78 ± 858.56	1,752.34 ± 828.84*	1,720.06 ± 756.83*	1,893.41 ± 1,078.88
Exam	9.05 ± 33.70	6.41 ± 31.61	5.66 ± 25.17	9.69 ± 50.87
Treatment	308.12 ± 434.15	311.82 ± 449.52	289.71 ± 395.10*	408.43 ± 626.32
Surgery	0.56 ± 8.61	1.29 ± 27.02	0.98 ± 22.80	2.67 ± 40.60
Diagnosis	187.72 ± 66.96	173.51 ± 67.71*	175.7 ± 65.64*	163.93 ± 75.42
Lab	352.37 ± 124.98	404.85 ± 176.80*	398.21 ± 156.47*	433.91 ± 244.87
B-Ultrasound	0.59 ± 4.13	0.43 ± 4.27	0.39 ± 3.95	0.62 ± 5.44
Color Doppler ultrasound	116.94 ± 118.83	126.97 ± 130.03	128.56 ± 127.14	120.02 ± 141.93
CT	171.13 ± 214.04	154.69 ± 206.68	147.24 ± 199.31*	187.29 ± 233.70
Cardiograph	20.18 ± 13.95	20.48 ± 17.05	21.01 ± 16.70*	18.16 ± 18.33
MRI	243.66 ± 283.76	261.85 ± 257.74	273.61 ± 258.32*	210.43 ± 249.07
Material	15.01 ± 43.58	14.37 ± 47.81	11.58 ± 38.40*	26.60 ± 75.22
Rehab	8.11 ± 50.89	14.78 ± 73.92*	16.92 ± 79.87*	5.42 ± 36.96
Others	30.76 ± 19.64	24.75 ± 10.97*	24.98 ± 10.32*	23.74 ± 13.41

*p<0.05

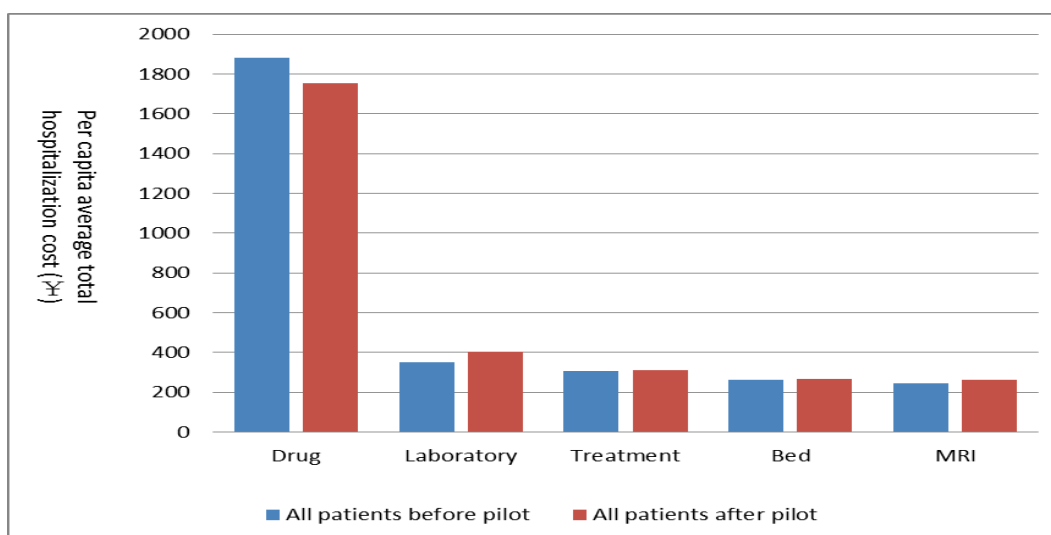


Figure 31 Top five costs of cerebral infarction patients before and after pilot

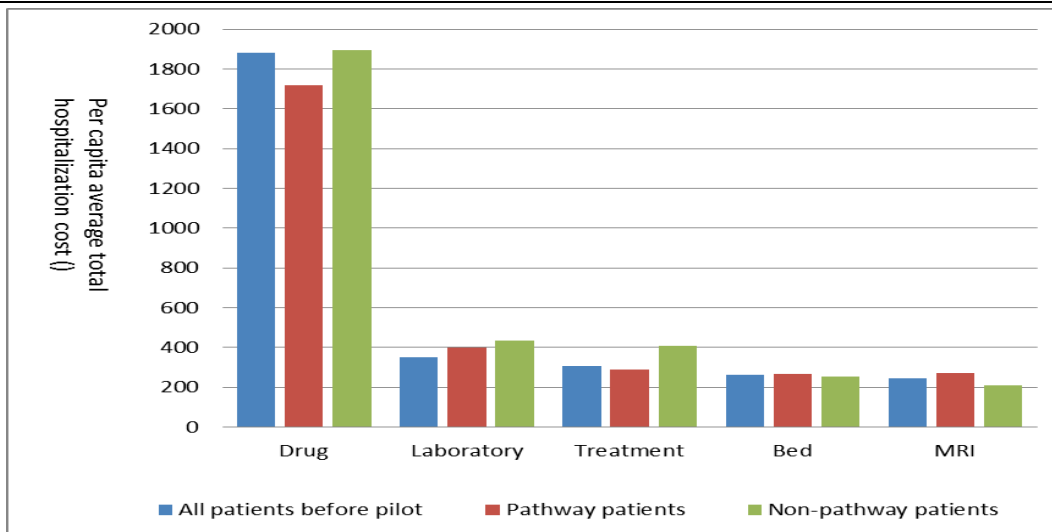


Figure 32 Top five costs of cerebral infarction patients, by pathway status before and after pilot

Monthly trends showed that the average cerebral infarction costs before the pilot fluctuated between 2,800 and 4,200 CNY. After the pilot implementation, the costs in patients, which included both pathway and non-pathway patients, became stable with a range of 3,200 and 4,300 CNY (Figure 31). The costs for pathway patients fluctuated between 3,200 and 4,500 CNY (Figure 32). Both trends after the pilot showed decreasing trends; but ITS analysis revealed no statistically significant change from before (Table 35, Table 36)

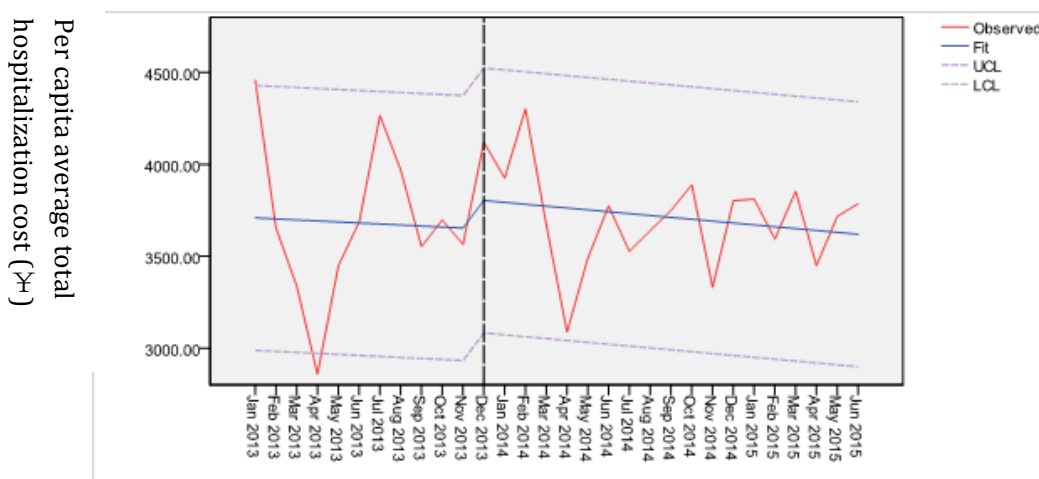


Figure 33 ITS analysis of cerebral infarction average hospitalization costs, before vs. after pilot

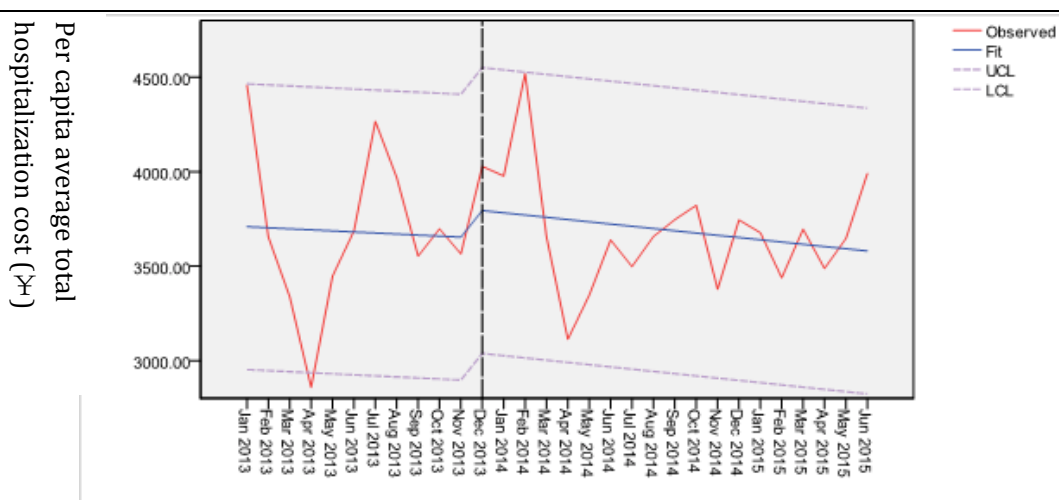


Figure 34 ITS analysis of cerebral infarction average hospitalization costs, before-pilot patients vs. after-pilot pathway patients

Table 35 ITS analysis of cerebral infarction average hospitalization costs, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	3714.71	226.73	-	16.38	0.00
△Constant	211.25	391.14	0.31	0.54	0.59
Slope before pilot	-5.52	33.43	-0.14	-0.17	0.87
△Slope	-4.67	36.51	-0.16	-0.13	0.90

Table 36 ITS analysis of cerebral infarction average hospitalization costs, before-pilot patients vs. after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	3714.71	237.96	-	15.61	0.00
△Constant	222.90	410.50	0.31	0.54	0.59
Slope before pilot	-5.52	35.08	-0.14	-0.16	0.88
△Slope	-6.38	38.32	-0.20	-0.17	0.87

(2) Drug cost proportions

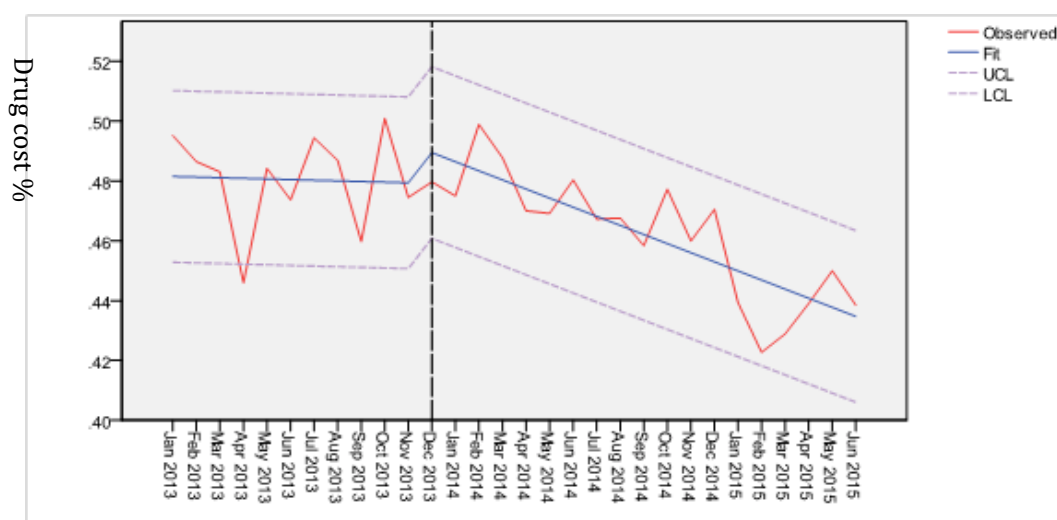
The average drug cost proportion from the total hospitalization cost in all four diseases was 46.10%, which was 2.21% lower than the proportion before the pilot (48.22%) ($P < 0.05$). Drug cost proportion in the pathway patients was 45.40% and non-pathway patients had a proportion of 46.30%, both yielding a 2.82% and 1.92% decrease respectively compared to proportion before the pilot ($P < 0.05$) (Table 37).

Table 37 Drug cost proportion of inpatients before and after pilot

Groups	Total number of patients	Drug cost (%)*
Before pilot: All patients	1,010	48.22 ± 9.72
After pilot: All patients	3,292	46.10 ± 9.78
After pilot: Pathway patients	2,560	45.40 ± 11.93
After pilot: Non-pathway patients	732	46.30 ± 9.07

*P<0.05

Long-term trends showed that the drug cost proportions of the four diseases before the pilot fluctuated between 45% and 50%. After the pilot implementation, drug cost proportions had a small increase (4%) before decreasing. Drug cost proportions after the pilot implementation (including both pathway and non-pathway patients) was between 43% and 49% with a decreasing trend (Figure 33). Drug cost proportions within the pathway patients ranged between 45% and 59% with a decreasing trend (Figure 34). ITS analysis showed that the change in proportions was significant statistically before the pilot, but the change in trend was not significant (Table 38, Table 39).


Figure 35 ITS analysis of average drug cost proportions, before vs. after pilot

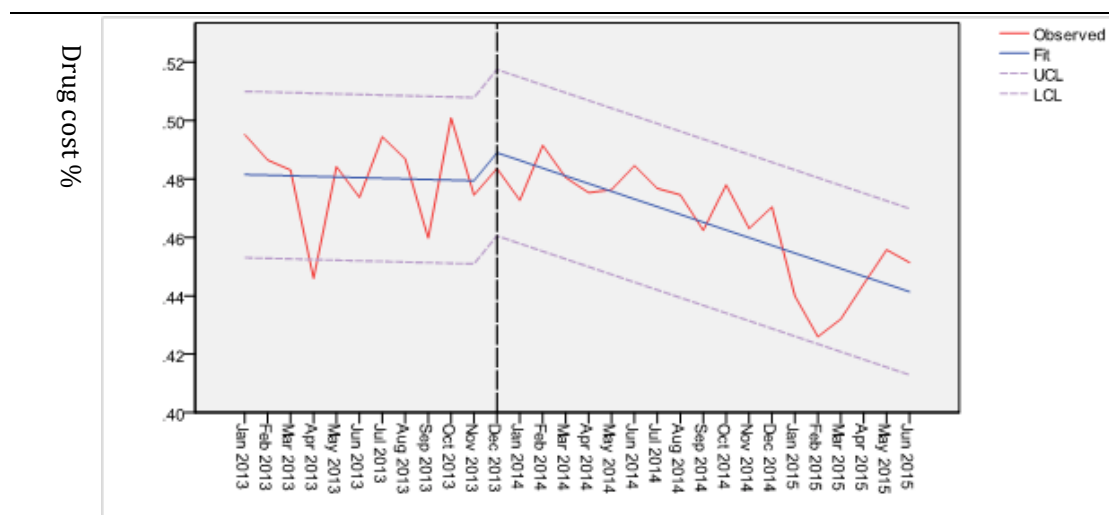


Figure 36 ITS analysis of average drug cost proportions, before-pilot patients vs. after-pilot pathway patients

Table 38 ITS analysis of average drug cost proportions, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	0.48	0.01		53.38	0.00
△Constant	0.04	0.02	1.04	2.84	0.01
Slope before pilot	-0.0002	0.00	-0.09	-0.16	0.87
△Slope	-0.0028	0.00	-1.52	-1.95	0.06

Table 39 ITS analysis of average drug cost proportions, before-pilot patients vs. after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	0.48	0.01	-	53.80	0.00
△Constant	0.04	0.02	1.00	2.52	0.02
Slope before pilot	-0.0002	0.00	-0.10	-0.16	0.87
△Slope	-0.0024	0.00	-1.43	-1.69	0.10

(3) Examination cost proportions

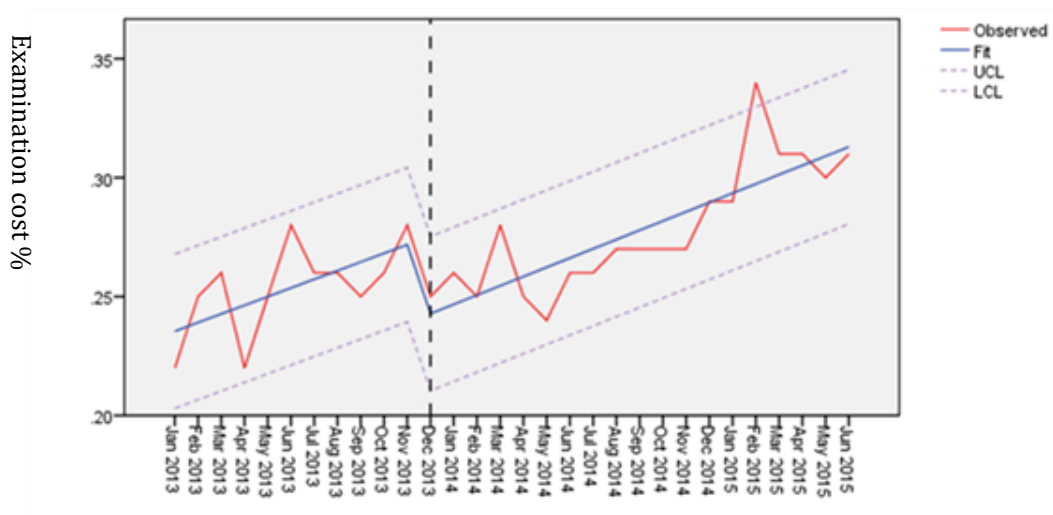
The average examination cost accounted for 27.86% in all patients after the pilot implementation, which was 2.14% higher than patients before pilot (25.72%). The examination cost accounted for 27.64% in pathway patients and 28.62% in non-pathway patients, which were 1.92% and 2.90% higher respectively than patients before the pilot ($P < 0.05$) (Table 40).

Table 40 Examination cost proportions of inpatients before and after pilot

Groups	Total number of patients	Examination cost (%)*
Before pilot: All patients	1,010	25.72 ± 11.48
After pilot: All patients	3,292	27.86 ± 12.09
After pilot: Pathway patients	2,560	27.64 ± 11.31
After pilot: Non-pathway patients	732	28.62 ± 14.49

*P<0.05

Long-term trends showed that the examination cost proportions increased 0.4% monthly before the pilot. After the pilot implementation, proportions experienced a slight drop, and then returned to an increasing trend similar to the pre-pilot period (Figure 35, Figure 36). ITS analysis showed that there is a statistically significant trend before the pilot but the changes in trend were not significant (Table 41, Table 42).


Figure 37 ITS analysis of average exam cost proportions, before vs. after pilot

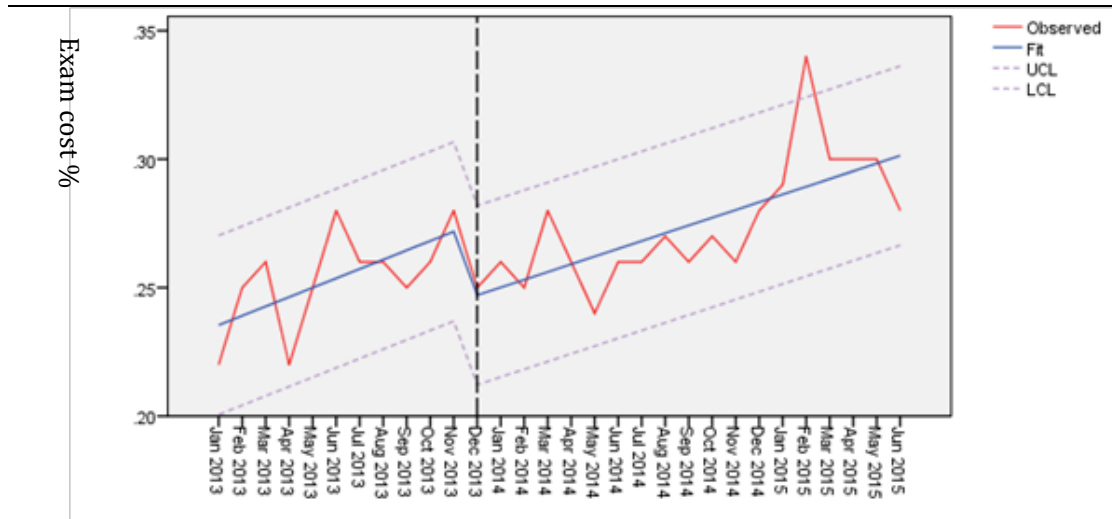


Figure 38 ITS analysis of average examination cost proportions, before-pilot patients vs. after-pilot pathway patients

Table 41 ITS analysis of average exam cost proportions, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	0.23	0.01	-	22.73	0.00
ΔConstant	-0.04	0.02	-0.66	-2.03	0.05
Slope before pilot	0.004	0.00	1.20	2.42	0.02
ΔSlope	0.000	0.00	0.11	0.16	0.88

Table 42 ITS analysis of average examination cost proportions, before-pilot patients vs. after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	0.23	0.01	-	21.14	0.00
ΔConstant	-0.02	0.02	-0.42	-1.11	0.28
Slope before pilot	0.004	0.00	1.32	2.25	0.03
ΔSlope	-0.001	0.00	-0.29	-0.35	0.73

(4) Out of pocket (OOP) proportions

The average OOP proportion of all four diseases was 46.72% after the pilot implementation, which was 0.17% lower than pre-pilot proportion at 46.89%. The OOP proportion in the pathway patients was 46.53%, which was 0.94% lower than the non-pathway patients' proportion at 47.47% (P<0.05) (Table 43).

Table 44 OOP proportions before and after pilot implementation

Groups	Total number of patients	OOP (%)*
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Before pilot: All patients	788	46.89 ± 7.46
After pilot: All patients	3,056	46.72 ± 7.94
After pilot: Pathway patients	2,394	46.53 ± 7.54
After pilot: Non-pathway patients	662	47.47 ± 9.21

*P<0.05

Long-term trends showed that the OOP proportions of patients in the first half of 2013 decreased to 50% after a large fluctuation. The trend of OOP proportions in the pathway patients and the non-pathway patients followed a similar trend, reaching 45% in June 2015 (Figure 39, Figure 40). ITS analysis showed no statistical significance in the change (Table 45, Table 46).

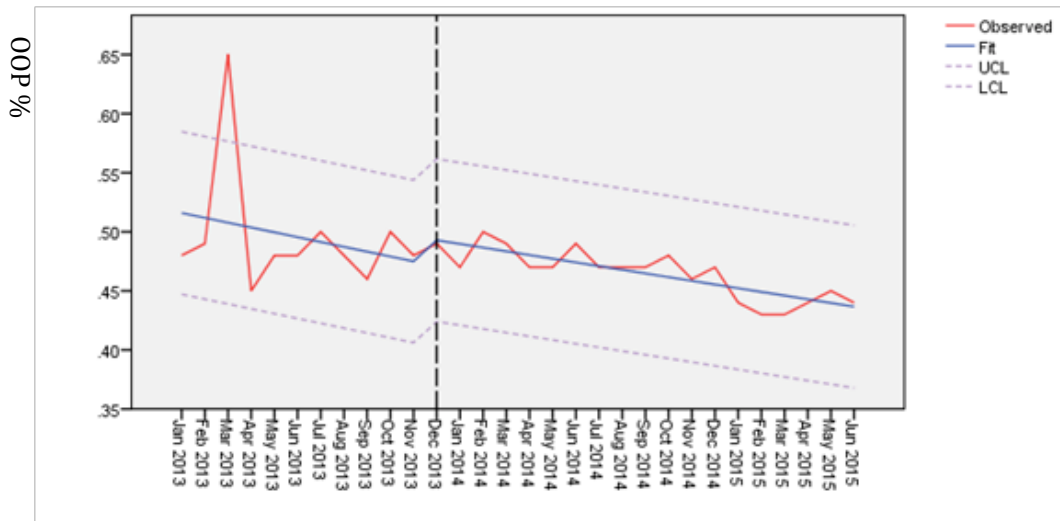


Figure 41 ITS analysis of average OOP proportions, before vs. after pilot

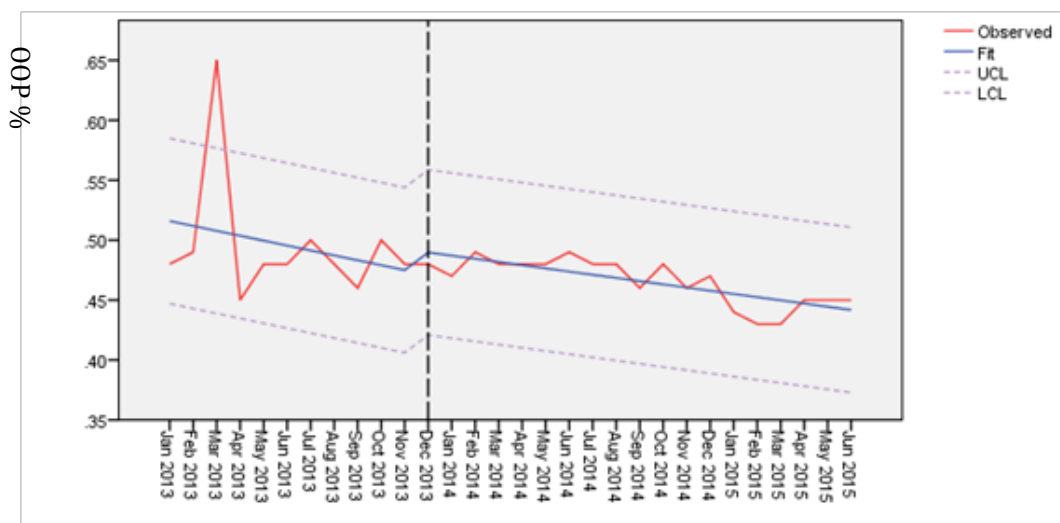


Figure 42 ITS analysis of average OOP proportions, before-pilot patients vs. after-pilot pathway patients

**Table 47 ITS analysis of average OOP proportions, before vs. after pilot**

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	0.52	0.02		24.02	0.00
△Constant	0.01	0.04	0.13	0.28	0.78
Slope before pilot	0.00	0.00	-0.93	-1.28	0.21
△Slope	0.00	0.00	0.28	0.28	0.78

**Table 48 ITS analysis of average OOP proportions,
before-pilot patients vs. after-pilot pathway patients**

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	0.52	0.02		23.98	0.00
△Constant	0.00	0.04	0.02	0.05	0.96
Slope before pilot	0.00	0.00	-0.95	-1.28	0.21
△Slope	0.00	0.00	0.42	0.41	0.69

5. Healthcare efficiency

Among the four diseases, TIA and cerebral infarction patients after the pilot had shorter average hospitalization days than patients before the pilot. Average hospitalization days of COPD and cerebral hemorrhage patients did not change (Figure 43, Figure 44).

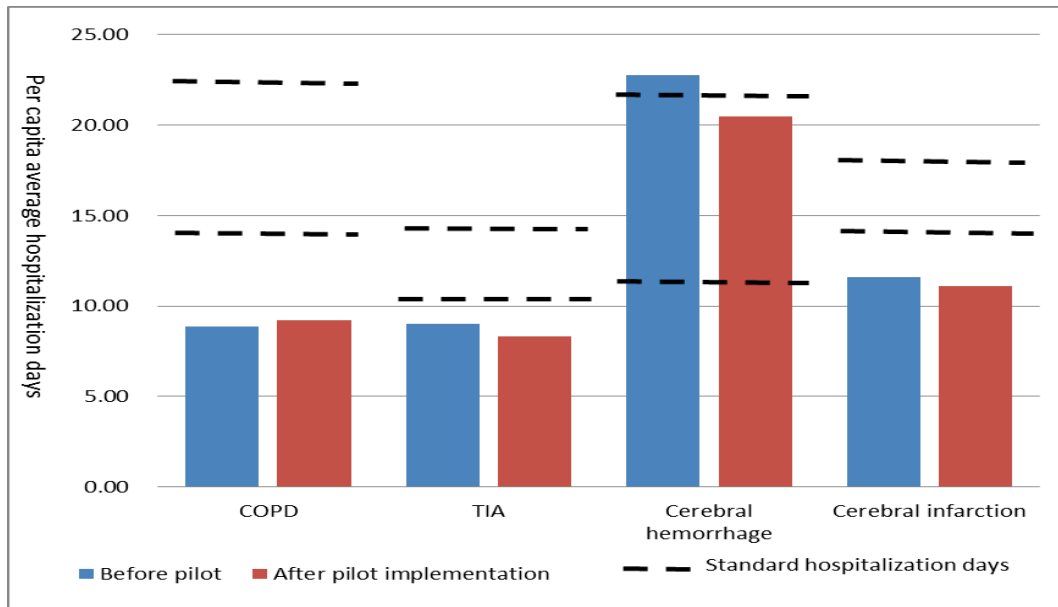


Figure 43 Average hospitalization days of four diseases, before and after pilot

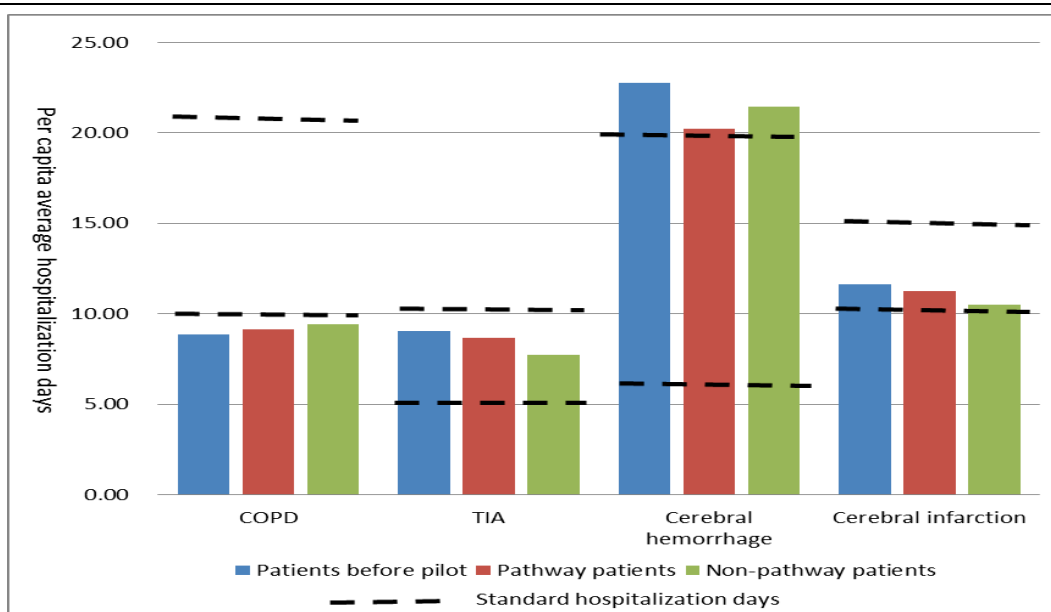


Figure 44 Average hospitalization days by pathway status before and after pilot

(1) COPD

Average hospitalization days were 8.85 days before the pilot and 9.23 days after the pilot implementation, but they were not statistically different (Table 49).

Table 49 Average hospitalization days of COPD patients before and after pilot

Groups	Total number of patients	Average hospitalization days
Before pilot: All patients	95	8.85 ± 3.74
After pilot: All patients	385	9.23 ± 3.92
After pilot: Pathway patients	262	9.14 ± 3.89
After pilot: Non-pathway patients	123	9.41 ± 3.98

Long-term trend showed that the average hospitalization days decreased by 0.23 days monthly before the pilot. After pilot implementation, average hospitalization days returned to around 10 days and were maintained at that level (Figure 41, Figure 42). ITS analysis showed that the downward trend before the pilot and the upward trend after the pilot implementation were statistically significant (Table 50, Table 51).

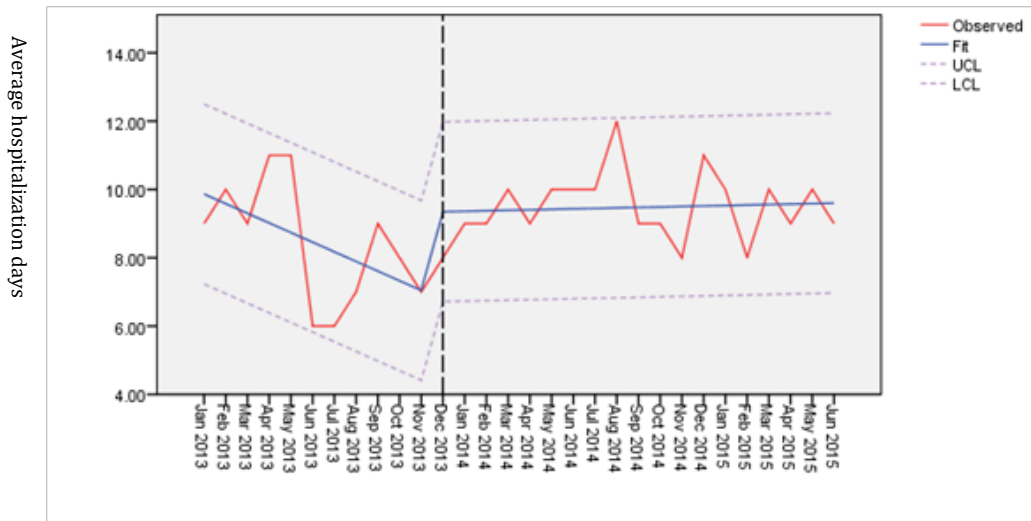


Figure 46 ITS analysis of average COPD hospitalization days, before-pilot patients vs. after-pilot pathway patients

Table 50 ITS analysis of average COPD hospitalization days,

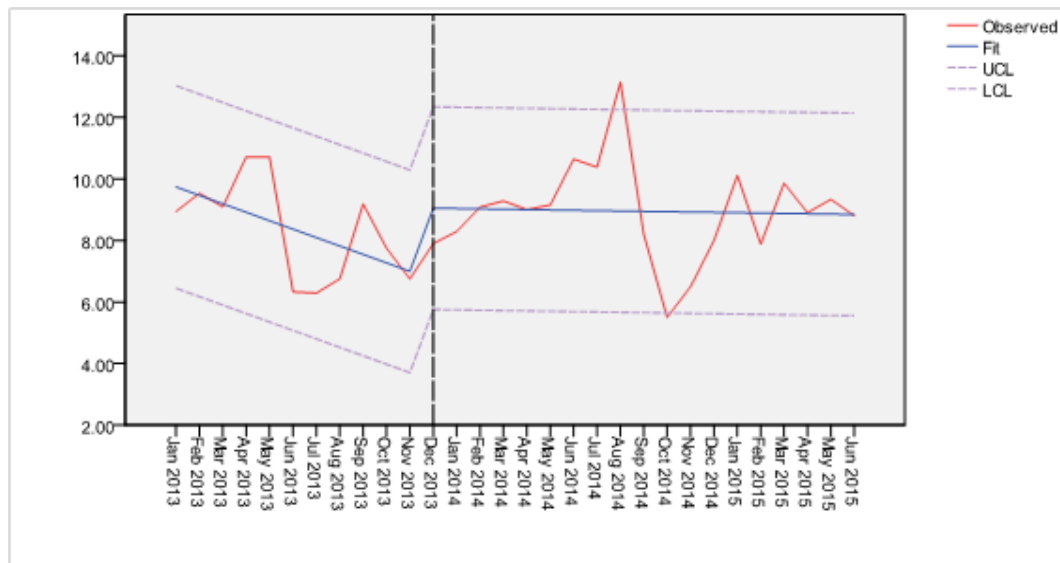


Figure 45 ITS analysis of average COPD hospitalization days, before vs. after pilot

before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	10.15	0.83		12.25	0.00
△Constant	-0.97	1.43	-0.33	-0.68	0.50
Slope before pilot	-0.28	0.12	-1.74	-2.31	0.03
△Slope	0.30	0.13	2.33	2.22	0.04

**Table 51 ITS analysis of average COPD hospitalization days, before-pilot patients vs. after-pilot pathway patients**

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	10.01	1.04		9.67	0.00
△Constant	-0.83	1.79	-0.25	-0.46	0.65
Slope before pilot	-0.27	0.15	-1.48	-1.80	0.08
△Slope	0.26	0.17	1.80	1.58	0.13

(2) TIA

The average hospitalization days of TIA patients after the pilot implementation was 8.31 days, which was 0.71 days shorter than the average before the pilot (9.02 days) ($P < 0.05$). The average in non-pathway patients was shorter (Table 52).

Table 52 Average hospitalization days of TIA patients before and after pilot

Groups	Total number of patients	Average hospitalization days
Before pilot: All patients	165	9.02 ± 3.86
After pilot: All patients	360	8.31 ± 3.78*
After pilot: Pathway patients	231	8.65 ± 3.69*
After pilot: Non-pathway patients	129	7.71 ± 3.88

* < 0.05

Long-term trend showed that average hospitalization days fluctuated between 7.5 to 11.5 days and decreased gradually before the pilot. After the pilot implementation, the range narrowed to 7.5 to 10 days and decreased gradually (Figure 43, Figure 44). ITS analysis showed no statistically significant change in trend (Table 53, Table 54).

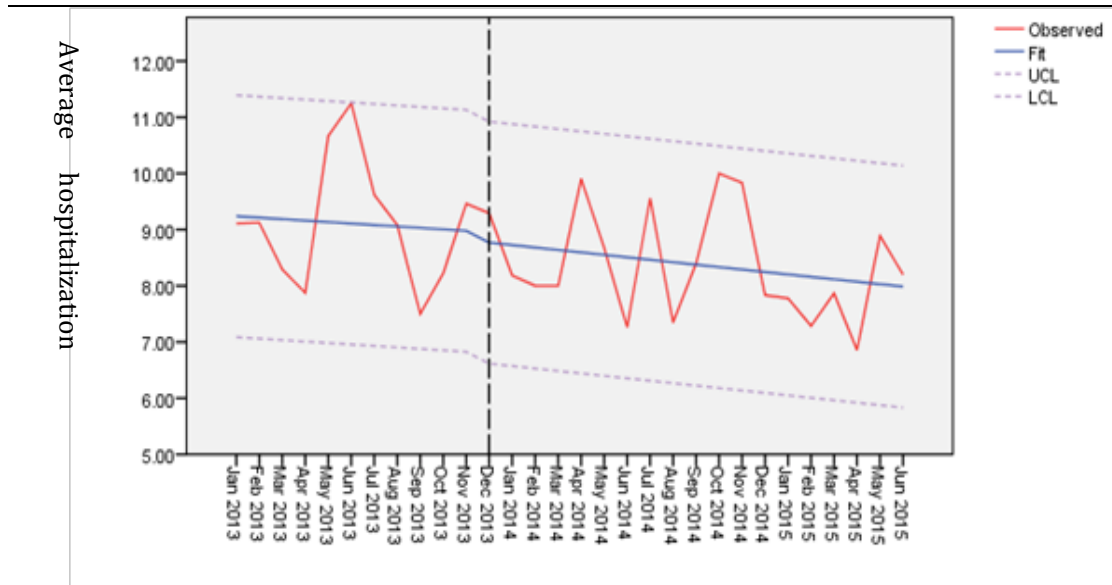


Figure 47 ITS analysis of average TIA hospitalization days, before vs. after pilot

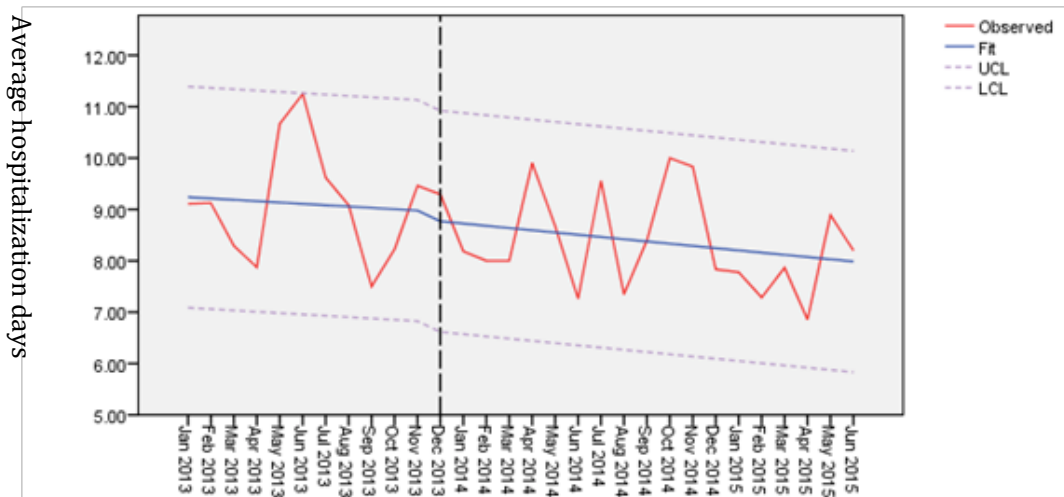


Figure 48 ITS analysis of average TIA hospitalization days, before-pilot patients vs. after-pilot pathway patients

Table 53 ITS analysis of average TIA hospitalization days, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Before pilot: All patients	9.27	0.68		13.68	0.00
After pilot: All patients	0.02	1.17	0.01	0.02	0.98
After pilot: Pathway patients	-0.03	0.10	-0.21	-0.26	0.80
After pilot: Non-pathway patients	-0.02	0.11	-0.18	-0.16	0.87

Table 54 ITS analysis of average TIA hospitalization days,

before-pilot patients vs. after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Before pilot: All patients	9.27	0.78		11.80	0.00
After pilot: All patients	1.03	1.35	0.42	0.76	0.46
After pilot: Pathway patients	-0.03	0.12	-0.19	-0.23	0.82
After pilot: Non-pathway patients	-0.04	0.13	-0.42	-0.35	0.73

(3) Cerebral hemorrhage

Average hospitalization days were 22.7 days before the pilot and 20.5 days after the pilot, and the difference was not statistically significant (Table 55).

Table 55 Average hospitalization days of cerebral hemorrhage patients before and after pilot implementation

Groups	Total number of patients	Average hospitalization days
Before pilot: All patients	62	22.76 ± 8.93
After pilot: All patients	126	20.50 ± 9.20
After pilot: Pathway patients	170	20.25 ± 8.87
After pilot: Non-pathway patients	46	21.43 ± 10.38

Long-term trend showed that the average hospitalization days fluctuated between 20 to 30 days and had a decreasing trend before the pilot. Average of all patients after the pilot implementation decreased by 6.7 days at first, and then fluctuated between 10 to 22 days with a gradual increasing trend (Figure 46). For pathway patients, the average decreased by 9.19 days at first, then, fluctuated between 12 to 22 days with a gradual increasing trend (Figure 48). ITS analysis showed that the decreasing trend in the pathway patients was statistically significant (Table 56, Table 57).

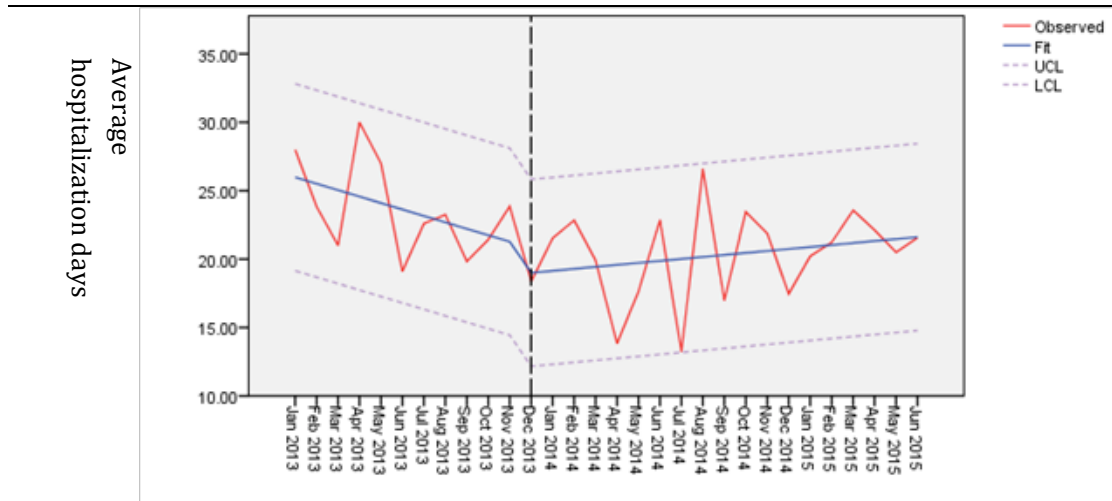


Figure 49 ITS analysis of average cerebral hemorrhage hospitalization days, before-pilot patients vs. after-pilot pathway patients

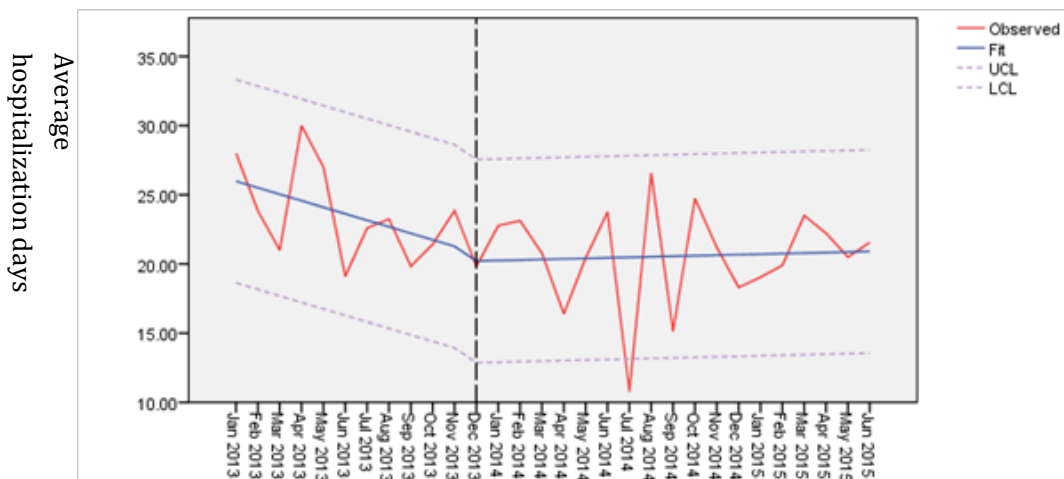


Figure 50 ITS analysis of average cerebral hemorrhage hospitalization days, before vs. after pilot

Table 58 ITS analysis of average cerebral hemorrhage hospitalization days, before vs. after pilot

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	26.45	2.31		11.45	0.00
△Constant	-6.70	3.99	-0.86	-1.68	0.10
Slope before pilot	-0.47	0.34	-1.08	-1.38	0.18
△Slope	0.51	0.37	1.49	1.37	0.18

Table 59 ITS analysis of average cerebral hemorrhage hospitalization days, before-pilot patients vs. after-pilot pathway patients

Estimate	B	SE	Standardized B	t-value	P-value
Constant before pilot	26.45	2.15		12.31	0.00
△Constant	-9.19	3.71	-1.21	-2.48	0.02
Slope before pilot	-0.47	0.32	-1.11	-1.48	0.15
△Slope	0.62	0.35	1.86	1.78	0.09

(4) Cerebral infarction

Average hospitalization days of cerebral infarction patients after the pilot implementation was 11.12 days, 0.49 days shorter than the average before the pilot (11.61 days) ($P < 0.05$). The average in the non-pathway patients decreased as well (Table 60).

Table 60 Average hospitalization days of cerebral infarction patients before and after pilot

Groups	Total number of patients	Average hospitalization days
Before pilot: All patients	688	11.61 ± 4.45
After pilot: All patients	2331	11.12 ± 4.45*
After pilot: Pathway patients	1897	11.26 ± 4.31*
After pilot: Non-pathway patients	434	10.49 ± 4.96

* $P < 0.05$

Long-term trend showed that average hospitalization days fluctuated between 9.5 to 14 days and had a decreasing trend before the pilot. Average of patients after the pilot implementation had also had a decreasing trend but at a slower rate, and fluctuated between 10 to 11 days (Figure 48). For pathway patients, the average fluctuated between 10.5 to 13 days with a fluctuating decreasing trend (Figure 47). ITS analysis showed no statistically significant changes before and after the pilot (Table 61, Table 62).

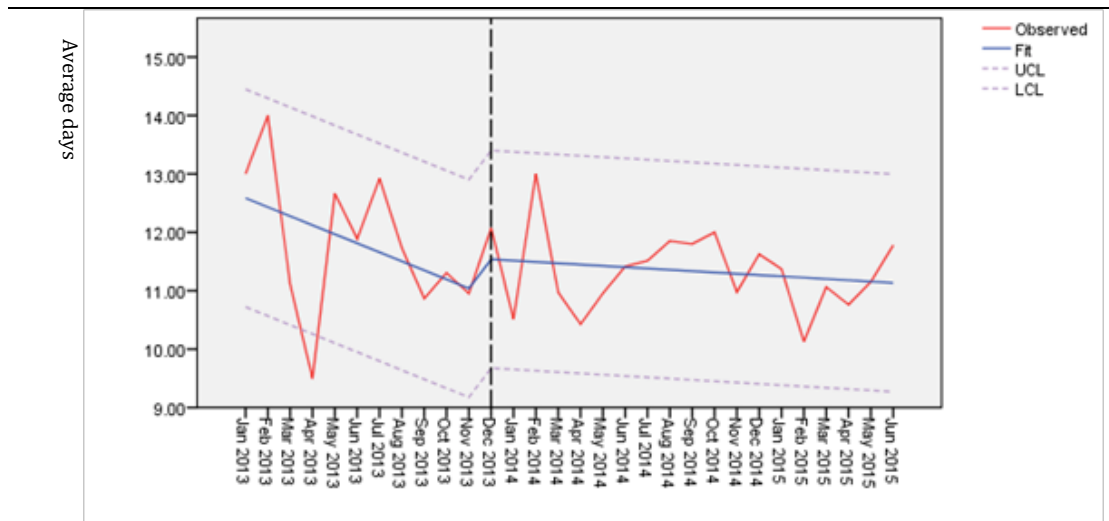


Figure 51 ITS analysis of average cerebral infarction hospitalization days, before-pilot patients vs. after-pilot pathway patients

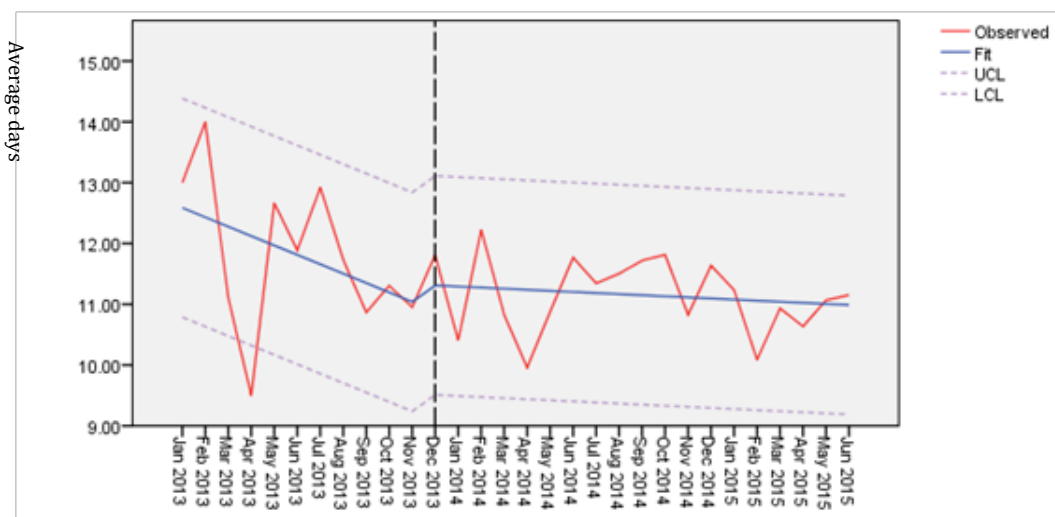


Figure 52 ITS analysis of average cerebral infarction hospitalization days, before vs. after pilot

Table 61 ITS analysis of average cerebral infarction hospitalization days, before vs. after pilot

Estimate	b	SE	t-value	P-value	Estimate
Constant before pilot	12.74	0.57	22.50	0.00	
Δ Constant	-1.22	0.98	-0.63	-1.25	0.22
Slope before pilot	-0.15	0.08	-1.44	-1.85	0.08
Δ Slope	0.14	0.09	1.62	1.50	0.15



**Table 62 ITS analysis of average cerebral infarction hospitalization days,
before-pilot patients vs. after-pilot pathway patients**

Estimate	b	SE	t-value	P-value	Estimate
Constant before pilot	12.74	0.59		21.74	0.00
Δ Constant	-0.93	1.01	-0.48	-0.92	0.36
Slope before pilot	-0.15	0.09	-1.44	-1.79	0.09
Δ Slope	0.13	0.09	1.57	1.40	0.17

6. Healthcare quality

All patients after pilot implementation had higher quality of life scores at hospital discharge when compared with quality of life at admission. Hospital readmission rate in 30 days were similar before and after pilot implementation. Details are shown below:

(1) Quality of life

Quality of life scores were at hospital discharge than admission for all four diseases after pilot implementation. EQ-5D scores of COPD, TIA, cerebral hemorrhage and cerebral infarction increased by 0.25, 0.11, 0.33 and 0.12 points respectively. VAS scores of COPD, TIA, cerebral hemorrhage and cerebral infarction increased by 20.33, 23.45, 24.85 and 16.81 points respectively (Table 63).

Table 63 EQ-5D and VAS scores at admission and discharge after pilot

Disease	Patients	EQ-5D score *			VAS score *		
		Admission	Discharge	SE	Admission	Discharge	SE
COPD	122	0.55±0.13	0.81±0.1	0.25±0.15	68.45±6.86	88.78±7.38	20.33±8.84
TIA	167	0.72±0.13	0.81±0.05	0.11±0.11	58.5±18.8	82.33±11.41	23.45±16.61
Cerebral hemorrhage	70	0.35±0.28	0.68±0.24	0.33±0.27	48.55±18.51	74.26±17.34	24.84±17.41
Cerebral infarction	1, 551	0.66±0.17	0.77±0.15	0.12±0.15	62.36±15.58	79.37±14.24	16.81±14.32

*P<0.05

(2) Hospital readmission in 30 days

The average hospital readmission in 30 days of all four diseases stayed at low level, with no statistical difference between before and after pilot implementation. Readmission rate of TIA, cerebral hemorrhage and cerebral infarction patients were all below 3% before and after pilot implementation. COPD patients' readmission rates in 30 days were between 4.21-5.19% (Table 64).

Table 64 Hospital readmission in 30 days by disease, before and after pilot

Groups	COPD		TIA		Cerebral hemorrhage		Cerebral infarction	
	Patients	Rate (%)	Patients	Rate (%)	Patients	Rate (%)	Patients	Rate (%)



Before pilot, all	95	4.21	165	0.00	62	0.00	688	1.16
After pilot, all	385	5.19	360	0.00	216	0.46	2,331	1.46
After pilot, pathway	262	3.82	231	0.00	170	0.59	1,897	1.32
After pilot, non-pathway	123	8.13	129	0.00	46	0.00	434	2.07

7. Rehabilitation

(1) Acute phase rehabilitation

Cerebral hemorrhage and cerebral infarction patients did not complete the National Institutes of Health Stroke Scale (NIHSS) scores before the pilot. After the pilot implementation, the total number of cerebral hemorrhage and cerebral infarction patients was 3,508 and among them, 445 patients (12.54%) had NIHSS scores. After the pilot implementation, patients completed the swallowing dysfunction test within one to two days of hospitalization.

The proportion of cerebral hemorrhage and cerebral infarction patients that received rehabilitation treatment during hospitalization after the pilot implementation increased. Cerebral hemorrhage patients' rehabilitation proportion was 11.10%, 2.3 times higher than the 4.84% before the pilot (Table 65). Cerebral infarction patients' rehabilitation ratio was 6.61% after the implementation, which was 1.5 times higher than the 4.36% before the pilot; the rehabilitation rate was higher in pathway patients than non-pathway patients (Table 66). (The above ratios were determined by the neurology patients' medical record data, and were unrelated to the hospital billing system. The cost of diagnosis and treatment in rehabilitation department were not included, thus the number could be underestimated).

Table 65 Rehabilitation ratio of cerebral hemorrhage patients during hospitalization before and after pilot implementation

Groups	Total number of patients	Rehabilitation ratio during hospitalization (%)*
Before pilot, all	62	4.84 ± 4.68
After pilot, all	216	11.10 ± 9.92
After pilot, pathway	170	9.41 ± 8.58
After pilot, non-pathway	46	17.39 ± 14.64

*P<0.05



Table 66 Rehabilitation ratio of cerebral infarction patients during hospitalization before and after pilot implementation

Groups	Total number of patients	Rehabilitation ratio during hospitalization (%)*
Before pilot, all	1,010	4.36 ± 4.18
After pilot, all	3,292	6.61 ± 6.17
After pilot. pathway	2,560	7.22 ± 6.70
After pilot, non-pathway	732	3.92 ± 3.77

*P<0.05

(2) Stable phase rehabilitation

Cerebral hemorrhage and cerebral infarction patient with more severe disease status but at stable phases were referred to the rehabilitation department in the hospital for further rehabilitation. Moreover, Wenxian People's hospital established a hospital association with Xubao Health Center, and referred 30 stable patients to the lower-level facility.

8. Discussion

The China-UK project aimed to use pathways to standardize clinical behaviors, ensure medical quality, control unreasonable medical expense, and stabilize patients' OOP expenses. The project made significant impact in the pilot hospitals during the 19 months since the implementation, reaching expected targets.

(1) Effect on hospital management

The overall implementation of integrated pathway reached high coverage rates and target goals. Most patients received treatment under the pathway management. A total of 2,926 patients completed the pathway, accounting for 63% of the total inpatients of the four pilot diseases, which was higher than the original target of 60%. Good implementation of pathway was through continuous innovation and improvement of hospital management philosophy and mechanism, as reasoned below.

First, healthcare managers actively supported the care pathway management based on their need to reasonably control medical costs, using evidence-based method of cost control. Wenxian implemented global budget, and the hospital managers faced double challenges of inconsistent quality due to cost control and clinical behavioral changes. Care pathway management would allow standardization of clinical behavior without compromising medical quality, achieving the goal of controlling unreasonable medical expenses. Thus, the hospital recognized the benefits and provided support for the project.

Second, doctors' compliance to the pathway was the result of hospital management mechanism, which included adequate pathway development, information technology, continuous pathway management, and effective incentive system. Initially, the central and local experts participated in the establishment of integrated pathway, ensuring professionalism and applicability. Information system also enhanced implementation and management simplicity. In addition, the hospital set up care pathway office to continuously optimize pathway promotion, training and management, and ensure quality. Moreover, adequate and effective incentive system ensured doctors' participation.

(2) Effect on clinical behavior

Integrated pathway's effect on clinical behavior was mainly reflected in the use of



insufficient and excessive clinical actions. Analysis results of clinical behaviors are shown below:

Clinical pathway could effectively correct some inadequate actions to ensure safety and quality of care. Before the pilot, many doctors lacked the knowledge of evidence-based treatment and drugs/tests as suggested by approved guidelines. Examples include pulmonary function test for COPD patients and acute phase rehabilitation for stroke patients. Also, some action items were at a low price, lacking incentives for physicians to use. Antiplatelet drugs for cerebral infarction patients, for example, were cheap resulting in insufficient utilization.

After the pilot implementation, the hospital conducted training to raise awareness among physicians, specified mandatory drugs and tests in the pathways, and monitored behaviors, eventually leading to a change in clinical behaviors. For example, antiplatelet drug usage increased two to three times in cerebral infarction patients and pulmonary function test increased three to four times in COPD patients, for both pathway and non-pathway patients. Moreover, physicians in the neurology department had better awareness of early rehabilitation for stroke patients, improving acute phase rehabilitation.

Clinical pathway also controlled unnecessary clinical behaviors. There was unjustified usage of drugs and tests for the four pilot diseases. Due to physicians' prescription habits, patients' treatment preferences, and financial incentives, usage of unnecessary drugs and tests was hard to control in the short-term. Result showed that clinical pathway had little effect on excessive clinical behaviors. In addition, the pilot hospital did not implement pathway under the single disease fixed payment method, limiting the control effect of clinical pathway.

(3) Effect on medical costs

Clinical pathway corrected insufficient and excessive clinical behaviors through standardizing actions, thus the impact on medical cost was complicated. Overall, pathway controlled unreasonable medical cost and reduced variance, at the same time reducing drug cost proportion and OOP proportions. There were different effects by the four diseases on medical costs.

Through the standardization brought on by clinical pathways, the hospitalization costs of TIA, cerebral hemorrhage and cerebral infarction patients did not increase, but had smaller variance. The average total hospitalization cost has been annually increasing before the pilot, but the trend stopped after the implementation. The hospitalization cost particularly for cerebral infarction patients had a narrower variance after the pilot, indicating a standardizing effect of clinical pathway



management, which identified adequate patients for pathway entrance, ensured pathway completion rate, and limited the usage of unnecessary drugs and clinical actions.

The COPD hospitalization cost returned to a reasonable level by providing necessary treatments that were often forgone by physicians. Before the pilot, due to the global budget limitation, doctors tended to admit less severe COPD patient and decreased cost by reducing hospital days and clinical actions. This was reflected through continuous reduction in hospitalization days from January to November 2014 before the pilot (Figure 42), with reducing average hospitalization cost. After the pilot implementation, both hospitalization days and cost returned to a reasonable level (Figure 42). The average total hospitalization cost of COPD patient was 15% higher than before the pilot.

Also, the drug cost proportion and OOP proportion both decreased in the four pilot diseases after the implementation. Drug cost proportion reduced by 2.21% from 48.22% before the pilot to 46.10% after. The OOP proportion reduced by 8.02% from 58.56% to 50.54%. This might be due to the controlling effect of clinical pathway on inadequate use of drugs, and on unnecessary treatment that were reimbursed by medical insurance.

(4) Other factors on project impact

This project was implemented under the backdrop of healthcare reform. The impact of project might be influenced by external factors, such as healthcare reform policy, medical insurance policy and hospital management. For OOP reduction, other factors like local medical insurance policy and reimbursement items and coverage rates might contribute.

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