Optimization of antibiotic prophylaxis: computerized decision support system of the University Hospital Center of Charleroi

BAPCOC WORKSHOP 2 OCTOBER 2019

Antibiotic prophylaxis

- Substantially important to prevent surgical site infections

Compliance with recommandations

Risk of surgical site infections cut in half*

Two of the four quality criteria integrated in the 2014-2019 strategic plan of the BAPCOC
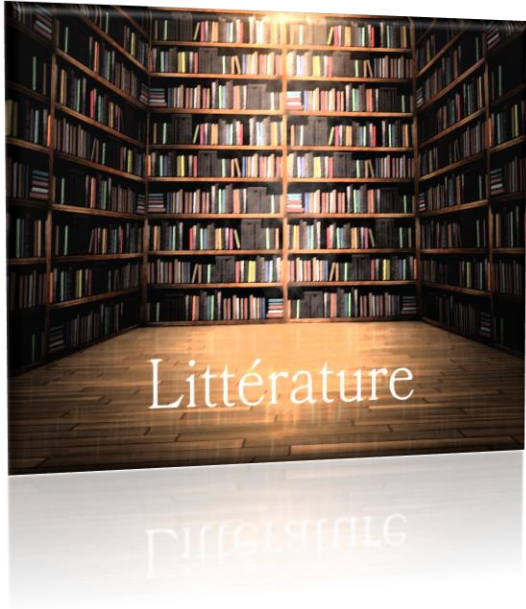
Explicit Targets:
Choice of surgical antibiotic prophylaxis according to local guidelines in at least 90% of cases
Duration of surgical antibiotic prophylaxis according to local guidelines in at least 90% of cases

Bloc opératoire – Hôpital Civil Marie Curie du CHU de Charleroi

*SFAR. Antibioprophylaxie en chirurgie et medecine interventionnelle (patients adultes).Actualisation 2010. Annales Francaises d'Anesthesie et de Reanimation. 2011;30:168–90

Littérature

Multidisciplinary team

Local Guidelines

Audits

Implementation of Guidelines

Indication

Antibiotic molecule

Antibiotic dose

Route of administration

Timing

Number of administrations

Duration of the prophylaxis

Marie Curie 2016-2017

Pre-test Analysis
Antibiotic prophylaxis practices
between January 11, 2016 and April 22, 2016

Inclusion criteria

Patients > 18 years old

Patients who had one of the following 5 interventions:
total hip prosthesis, coronary artery bypass grafting, colo-rectal surgery, transurethral resection of the prostate and endoscopic retrograde cholangiopancreatography

Exclusion criteria

Patients < 18 years old

Patients with a documented infection at the time of the intervention

Risk factors of non-compliance in the pre-test group?
Retrospective observational transversal study
→ using a multivariate statistical analysis (Logistic regression models and Wald Tests)
→ with Odds Ratios (ORs) determination for the relationships between each independent variable and the outcome variables :

INDEPENDENT VARIABLES

- Age
- Obesity
- Gender
- IgE Mediated Penicillin (or Ciprofloxacin) Allergy
- Multidrug-resistant organisms
- American Society of Anaesthesiologists Score > 2
- Length of Preoperative Stay
- Type of Intervention
- Surgeon or Gastroenterologist
- Anesthetist
- Presence of a nurse anesthetist during the intervention
- Duration of the intervention
- Blood loss during surgery ≥ 1,5L

OUTCOME VARIABLES

- **Compliance in terms of the items:**

- Indication
- Molecule(s) (1st administration)
- Dose(s) (1st administration)
- Route of administration (1st administration)
- Time of administration (1st administration)
- Number of administration(s)
- Duration of prophylaxis

Pre-test Analysis
Antibiotic prophylaxis practices
between January 11, 2016 and April 22, 2016

Risk factors of non-compliance in the pre-test group?

Retrospective observational transversal study
→ using a multivariate statistical analysis (Logistic regression models and Wald Tests)
→ with Odds Ratios (ORs) determination for the relationships between each independent variable and the outcome variables

Risk factor of non compliance in terms of Indication (Overall significance of the model : P=0,0001)

Characteristics	Z-test	P	OR (95% IC)
IgE Mediated Penicillin (or Ciprofloxacin) Allergy	-2,383	0,0172	0,0345 (0,0022-0,5502)
Preoperative length of stay (days)	2,7	0,0069	27,5803 (2,4824-306,4210)

Risk factor of non compliance in terms of Molecule (Overall significance of the model : P = 5,96E-10)

Characteristics	Z-test	P	OR (95% IC)
IgE Mediated Penicillin (or Ciprofloxacin) Allergy	-2,012	0,0442	0,1282 (0,0173-0,9481)
Colorectal surgery	-3,233	0,0012	0,0187 (0,0017-0,2086)
Transurethral resection of the prostate	-3,07	0,021	0,0933 (0,0205-0,4243)
Duration of the intervention (HH:mm:ss)	2,316	0,0206	3,3669 (1,2051-9,4068)

Risk factor of non compliance in terms of Dose (Overall significance of the model : P = 6,25E-08)

Characteristics	Z-test	P	OR (95% IC)
Colorectal surgery	-3,321	0,0009	0,0623 (0,0194-0,2007)
Transurethral resection of the prostate	-2,824	0,0047	0,1614 (0,0455-0,5724)
Duration of the intervention (HH:mm:ss)	2,412	0,0159	2,1697 (1,1563-4,0713)

Marie Curie 2016-2017

Pre-test Analysis
Antibiotic prophylaxis practices
between January 11, 2016 and April 22, 2016

Risk factors of non-compliance in the pre-test group?

Retrospective observational transversal study
→ using a multivariate statistical analysis (Logistic regression models and Wald Tests)
→ with Odds Ratios (ORs) determination for the relationships between each independent variable and the outcome variables

Risk factor of non compliance in terms of Route of administration (Overall significance of the model : P=9,03E-09)

Characteristics	Z-test	P	OR (95% IC)
Transurethral resection of the prostate	-4,44	2,37E-09	0,0393 (0,0094-0,1641)
Anesthetist 3	-2,377	1,74E-02	0,0761 (0,0091-0,6365)
Anesthetist 4	-2,074	0,0381	0,0815 (0,0076-0,8713)

(i)Some anesthetists have also emerged as risk factors of non-compliance. However, we cannot exclude a dependence between independent variables (cf. link between practitioners and certain types of intervention).

Risk factor of non compliance in terms of Time of administration (Overall significance of the model : P = 5,02E-12)

Characteristics	Z-test	P	OR (95% IC)
Transurethral resection of the prostate	-6,093	1,33E-09	0,0293 (0,0094-0,0918)

Risk factor of non compliance in terms of Duration of prophylaxis (Overall significance of the model : P = 7,91E-08)

Characteristics	Z-test	P	OR (95% IC)
Total hip prosthesis	-5,002	5,66E-07	0,0602 (0,0200-0,1811)

Marie Curie 2016-2017

Pre-test Analysis
Antibiotic prophylaxis practices
between January 11, 2016 and April 22, 2016

Risk factors of non-compliance in the pre-test group?
Retrospective observational transversal study
→ using a multivariate statistical analysis (Logistic regression models and Wald Tests)
→ with Odds Ratios (ORs) determination for the relationships between each independent variable and the outcome variables :

→These findings are consistent with those described in the literature that also revealed as risk factors of non-compliance: allergy to β-lactams and certain types of surgery as urological surgery and digestive surgery*.

→Lack of education and incomplete professional rules were probably the main barriers associated with the risk factors identified in the pre-test group.

→The results of this observational study indicated that it was necessary to implement improvement actions of practices.

* Muller A, Leroy J, Henon T, Patry I, Samain E, Chirouze C, et al. Surgical antibiotic prophylaxis compliance in a university hospital. Anaesthesia, Critical Care & Pain Medicine. 2015;34:289–94.
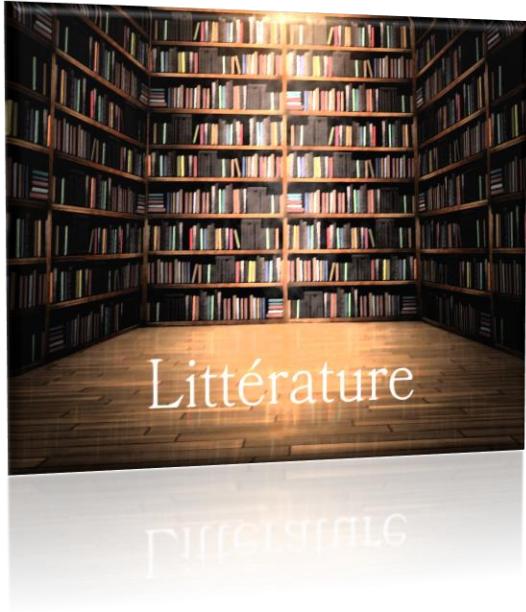
Marie Curie 2016-2017

Multidisciplinary team

Local Guidelines

Audits

Implementation of Guidelines

Pharmacist Interventions

Nominal delivery of antibiotic kits

Informatic tool

Zhang H-X, Li X, Huo H-Q, Liang P, Zhang J-P, Ge W-H. PLoS ONE. 2014;9(2):e88971

Zhou Y, Ma LY, Zhao X, Tian SH, Sun LY, Cui YM. J Clin Phar Ther. 2015;40(4):404-8.

Zhou L, Ma J, Gao J, Chen S, Bao J. Medicine (Baltimore). 2016;95(9):e2753.

Gindre S, Carles M, Aknouch N, Jambou P, Dellamonica P, Raucoules-Aimé M, et al. Annales Françaises d'Anesthésie et de Réanimation. 2004;23(2):116-23.
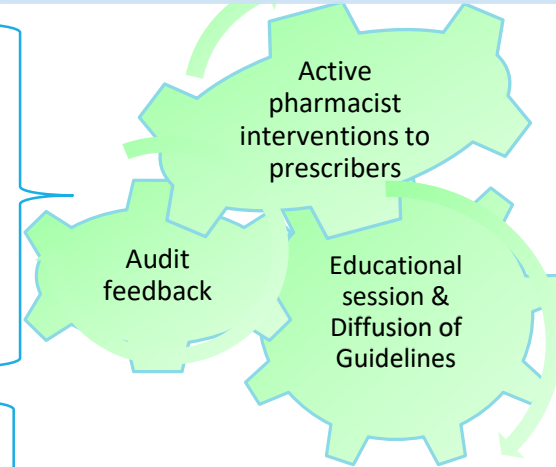
Prado MAMB, Lima MPJS, Gomes IdRH, Bergsten-Mendes G. Am J Infect Control. 2002;30(1):49-56.

Nair BG, Newman S-F, Peterson GN, Schwid HA. SURGICAL INFECTIONS. 2011;12(1):57-63.

Nair BG, Newman S-F, Peterson GN, Wu W-Y, Schwid HA. Anesth Analg. 2010;111(5):1293-300.

Wax DB, Beilin Y, Levin M, Chadha N, Krol M, Reich DL. Anesth Analg. 2007;104(6):1462-6.

Fayolle-Pivot L, Weyb P-F, Petitjeans F, Puidupin M, Allaouchiche B, Escarment J. Annales Françaises d'Anesthésie et de Réanimation. 2013;32:241–5.
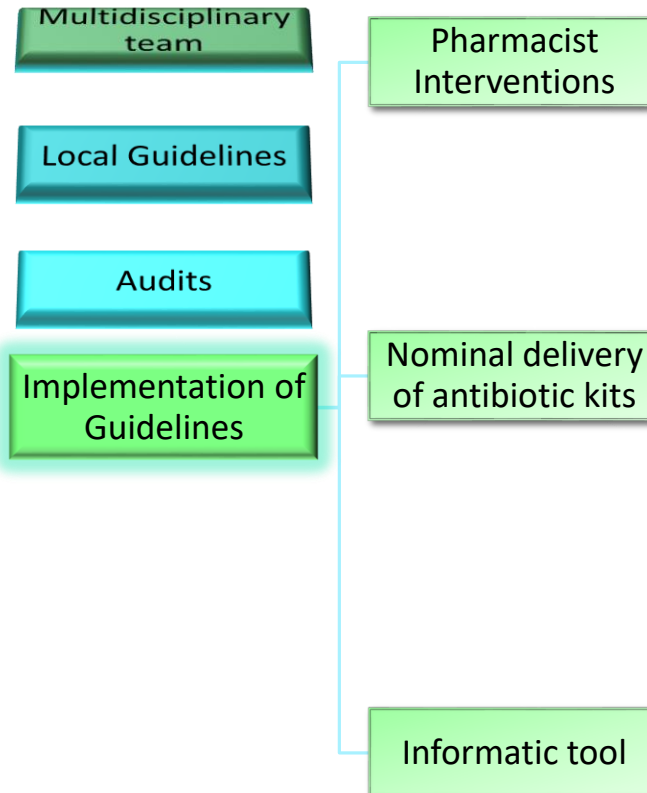
Active pharmacist interventions to prescribers

Audit feedback

Educational session & Diffusion of Guidelines

Prescribing aid

Reminder

Littérature

Marie Curie 2016-2017

Multidisciplinary team

Local Guidelines

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Implementation of Guidelines

Pharmacist Interventions

Nominal delivery of antibiotic kits

Informatic tool

Combination of persuasive interventions:
Strategy tested during 15 weeks
(between January 9, 2017 and April 21, 2017)
at CHU de Charleroi – Marie Curie

Inclusion criteria

Patients > 18 years old

Patients who had one of the following 5 interventions: total hip prosthesis, coronary artery bypass grafting, colo-rectal surgery, transurethral resection of the prostate and endoscopic retrograde cholangiopancreatography

Exclusion criteria

Patients < 18 years old

Patients with a documented infection at the time of the intervention

Nair BG, Newman S-F, Peterson GN, Wu W-Y, Schwid HA. Anesth Analg. 2010;111(5):1293-300.

Wax DB, Beilin Y, Levin M, Chadha N, Krol M, Reich DL. Anesth Analg. 2007;104(6):1462-6.

Fayolle-Pivot L, Weyb P-F, Petitjeans F, Puidupin M, Allaouchiche B, Escarment J. Annales Françaises d'Anesthésie et de Réanimation. 2013;32:241–5.
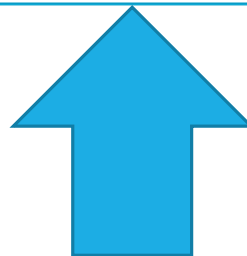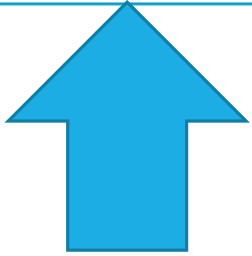
Pre-test Analysis
Antibiotic prophylaxis practices
between January 11, 2016 and April 22, 2016

Test phase
Combination of persuasive interventions
From December 2016 to April 2017

Post-Test Analysis
Antibiotic prophylaxis practices
between January 9, 2017 and April 21, 2017
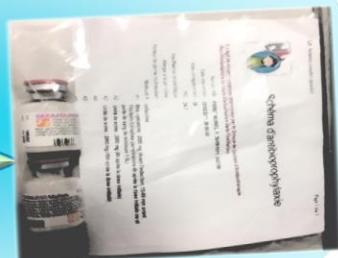
**Tested Strategy
(December 2016-April 2017)**

Encoding of an antibiotic prophylaxis recommendation based on patient parameters
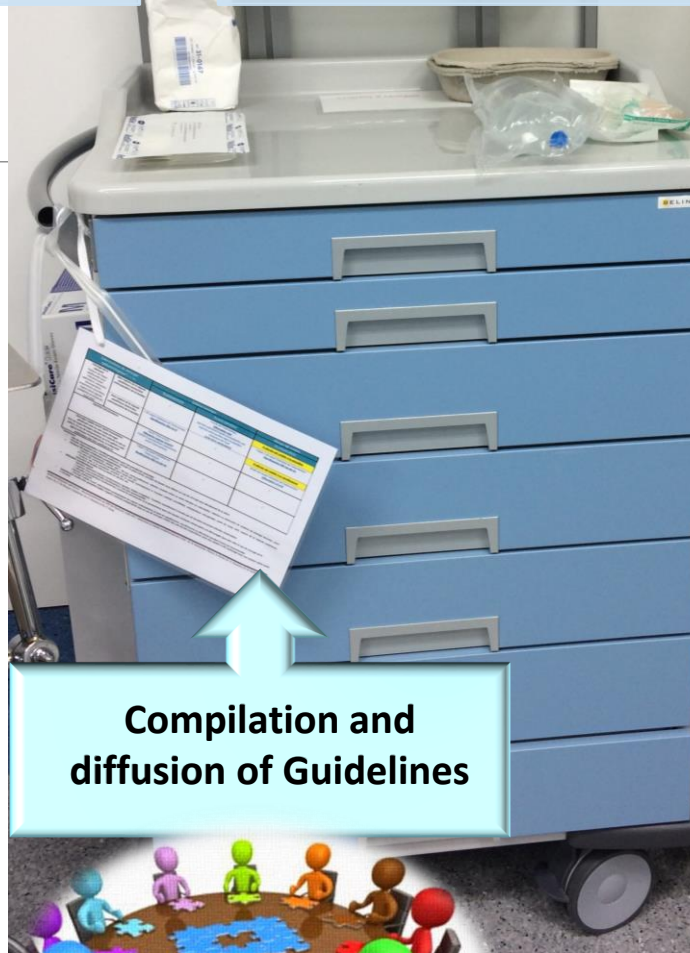→accessible in patients' computerized records

Pre-operative delivery of nominative kits
containing the antibiotics with a recommendation paper

Operating room / Care Unit

Compilation and diffusion of Guidelines

Outreach visits

Educationnal Seminar and Feedback of audit

Preoperative pharmaceutical interventions to practitioners

Collaborative Physician-Pharmacist Strategy

Marie Curie 2016-2017

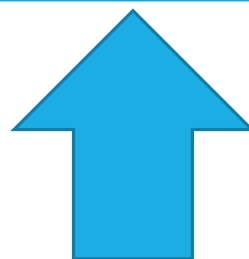## Monocentric quasi-experimental study with a pre-test – Post-test evaluation

Pre-test group Analysis
Antibiotic prophylaxis practices
between January 11, 2016 and April 22, 2016

Test phase
Combination of persuasive interventions
From December 2016 to April 2017

Test group Analysis
Antibiotic prophylaxis practices
between January 9, 2017 and April 21, 2017

Inclusion criteria

Patients > 18 years old

Patients who had one of the following 5 interventions: total hip prosthesis, coronary artery bypass grafting, colo-rectal surgery, transurethral resection of the prostate and endoscopic retrograde cholangiopancreatography

Exclusion criteria

Patients < 18 years old

Patients with a documented infection at the time of the intervention

1) Similarity between the pre-test group and the test group ?

- $\chi 2$ test for categorical variables (number of patients per type of intervention, number of long duration interventions (> 3 hours), number of allergic patients)
- Student's t-test for the age variable

al characteristics of patients in the pre-test group and the test group
larity between the two groups in terms of clinical and demographic characteristics
except for the number of transurethral resection of the prostate)

Characteristics	Pre-te...			
Number of Interventions, n	130			
Age (yr), mean±SD	66,32 ±			
Transurethral resection of the prostate, n (%)	26 (2			
Coronary artery bypass grafting, n (%)	38 (29			
Colorectal surgery, n (%)	17 (13			
Total hip prosthesis, n (%)	30 (23			
Endoscopic retrograde cholangiopancreatography, n (%)	19 (14			
Duration of intervention > 3h, n (%)	48 (36			
IgE Mediated Penicillin (or Ciprofloxacin) Allergy, n (%)	6 (4,62)	6 (5,08)	12 (4,84)	0,86[NS]

(a) Comparing the pretest group with the test group: NS, not significant; *significant

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Monocentric quasi-experimental study with a pre-test – Post-test evaluation

Pre-test Analysis
Antibiotic prophylaxis practices
between January 11, 2016 and April 22, 2016

Test phase
Combination of persuasive interventions
From December 2016 to April 2017

Post-Test Analysis
Antibiotic prophylaxis practices
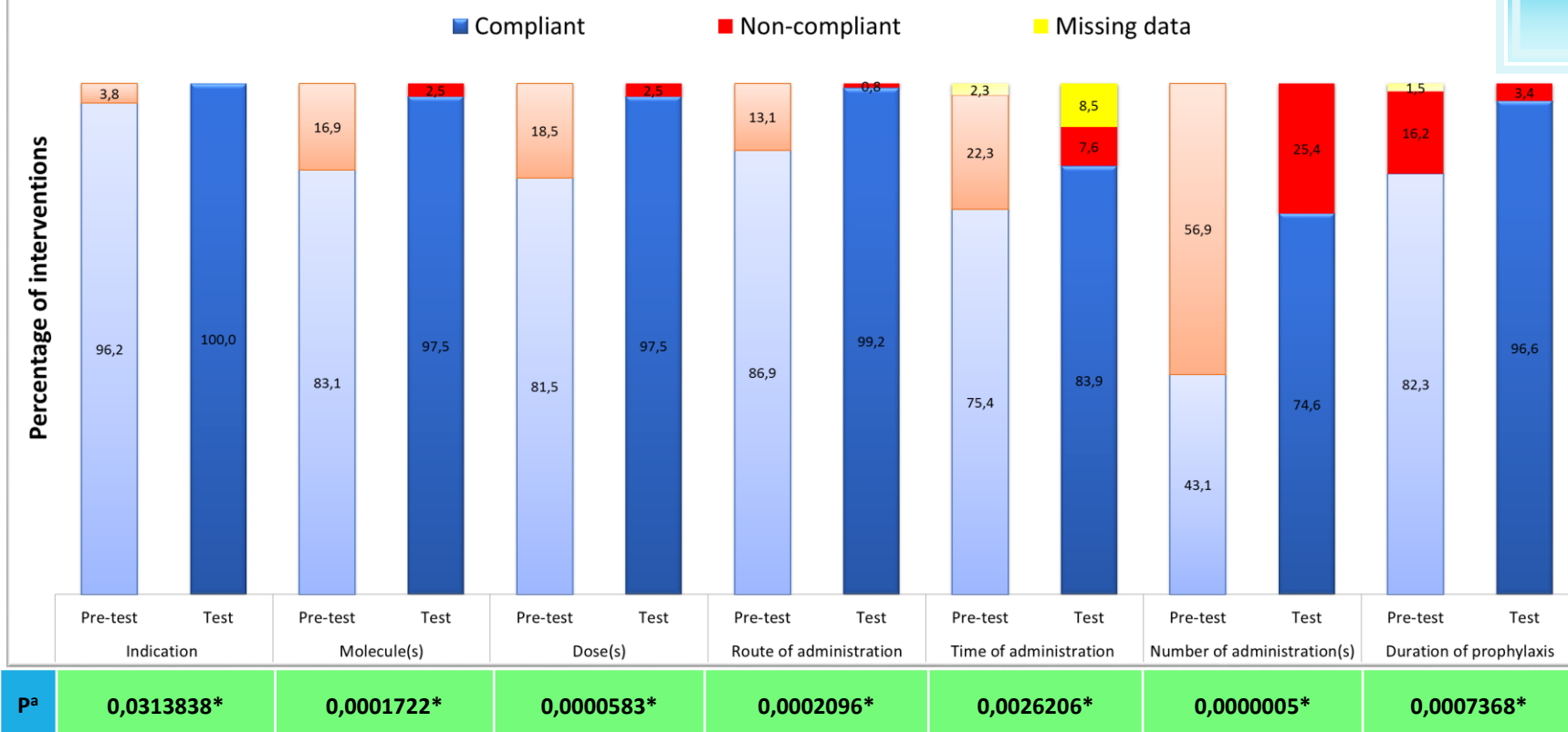between January 9, 2017 and April 21, 2017

Impact of the combined intervention strategy on compliance towards prophylactic antibiotic guidelines?

Difference of compliance between the two groups?

$\chi 2$ test comparing the % of compliance between the two groups for each of the 7 items audited

Legend: ■ Compliant ■ Non-compliant ■ Missing data

Y-axis: Percentage of interventions

Item	Pre-test	Test
Indication	96,2 (3,8)	100,0
Molecule(s)	83,1 (16,9)	97,5 (2,5)
Dose(s)	81,5 (18,5)	97,5 (2,5)
Route of administration	86,9 (13,1)	99,2 (0,8)
Time of administration	75,4 (22,3 / 2,3)	83,9 (7,6 / 8,5)
Number of administration(s)	43,1 (56,9)	74,6 (25,4)
Duration of prophylaxis	82,3 (16,2 / 1,5)	96,6 (3,4)

Pᵃ	Indication	Molecule(s)	Dose(s)	Route of administration	Time of administration	Number of administration(s)	Duration of prophylaxis
	0,0313838*	0,0001722*	0,0000583*	0,0002096*	0,0026206*	0,0000005*	0,0007368*

ᵃ Comparing the pre-test group with the test group: *significant

Comparison of antibiotic prophylaxis practices in the pre-test group (n = 130) versus the test group (n = 118)
→ **Significant increase in compliance for all items assessed (test group vs. pre-test group)**
(P <0.05 for all items assessed)

**Combination of persuasive interventions
From December 2016 to April 2017**

Advantages of active persuasive strategies*	Disadvantages of active persuasive strategies*
• ↑ visibility of antimicrobial stewardship program • ↑ collegial relationships • ↑ uptake of guidelines by prescribers • Can be done on less than daily basis if resources are limited • Provides educational benefit to clinicians • ↑ quality of practice	• Success depends on stewardship method • Typically labor-intensive • Prescribers reluctant to change

*From Barlam TF, Cosgrove SE, Abbo LM, MacDougall C, Schuetz AN, Septimus EJ, et al. Implementing an Antibiotic Stewardship Program: Guidelines by the Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America. Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America. 2016;62(10):e51-e77.

Marie Curie 2017-2018

Sustained effect of the strategy implemented?

**Analysis of Antibiotic prophylaxis practices
with stewardship actions
between January 9, 2017 and April 21, 2017**

**Analysis of Antibiotic prophylaxis practices
without stewardship action
between January 8, 2018 and April 20, 2018**

Similarity between the 2017 test group versus the 2018 post-test group ?

- χ2 test for categorical variables (number of patients per type of intervention, number of long duration interventions (> 3 hours), number of allergic patients)
- Student's t-test for the age variable

Inclusion criteria

Patients > 18 years old

Patients who had one of the following 5 interventions:
total hip prosthesis, coronary artery bypass grafting, colo-rectal surgery, transurethral resection of the prostate and endoscopic retrograde cholangiopancreatography

Exclusion criteria

Patients < 18 years old

Patients with a documented infection at the time of the intervention

est group

**f clinical and demographic characteristics
(p> 0.05 for all variables analyzed)**

Characteristics	Group 2017	Group 2018	Total	P (a)
Number of Interventions, n	118	124	242	
Age (yr), mean±SD	68,36 ± 13,75	65,78 ± 13,63	67,29 ± 13,72	0,15[NS]
Transurethral resection of the prostate, n (%)	11 (9,32)	9 (7,26)	20 (8,26)	0,56[NS]
Coronary artery bypass grafting, n (%)	34 (28,81)	30 (24,19)	64 (26,45)	0,42[NS]
Colorectal surgery, n (%)	22 (18,64)	19 (15,32)	41 (16,94)	0,49[NS]
Total hip prosthesis, n (%)	34 (28,81)	38 (30,65)	72 (29,75)	0,76[NS]
Endoscopic retrograde cholangiopancreatography, n (%)	17 (14,41)	28 (22,58)	45 (18,6)	0,10[NS]
Duration of intervention > 3h, n (%)	52 (44,07)	48 (38,71)	100 (41,32)	0,40[NS]
IgE Mediated Penicillin (or Ciprofloxacin) Allergy, n (%)	6 (5,08)	11 (8,87)	17 (7,02)	0,25[NS]

[a] Comparing the test group with the post-test group: NS, not significant; *significant

Marie Curie 2017-2018

Sustained effect of the strategy implemented?

Analysis of Antibiotic prophylaxis practices with stewardship actions between January 9, 2017 and April 21, 2017

Analysis of Antibiotic prophylaxis practices without stewardship action between January 8, 2018 and April 20, 2018

Difference of compliance between the two groups?

χ2 test comparing the % of compliance between the two groups for each of the 7 items audited
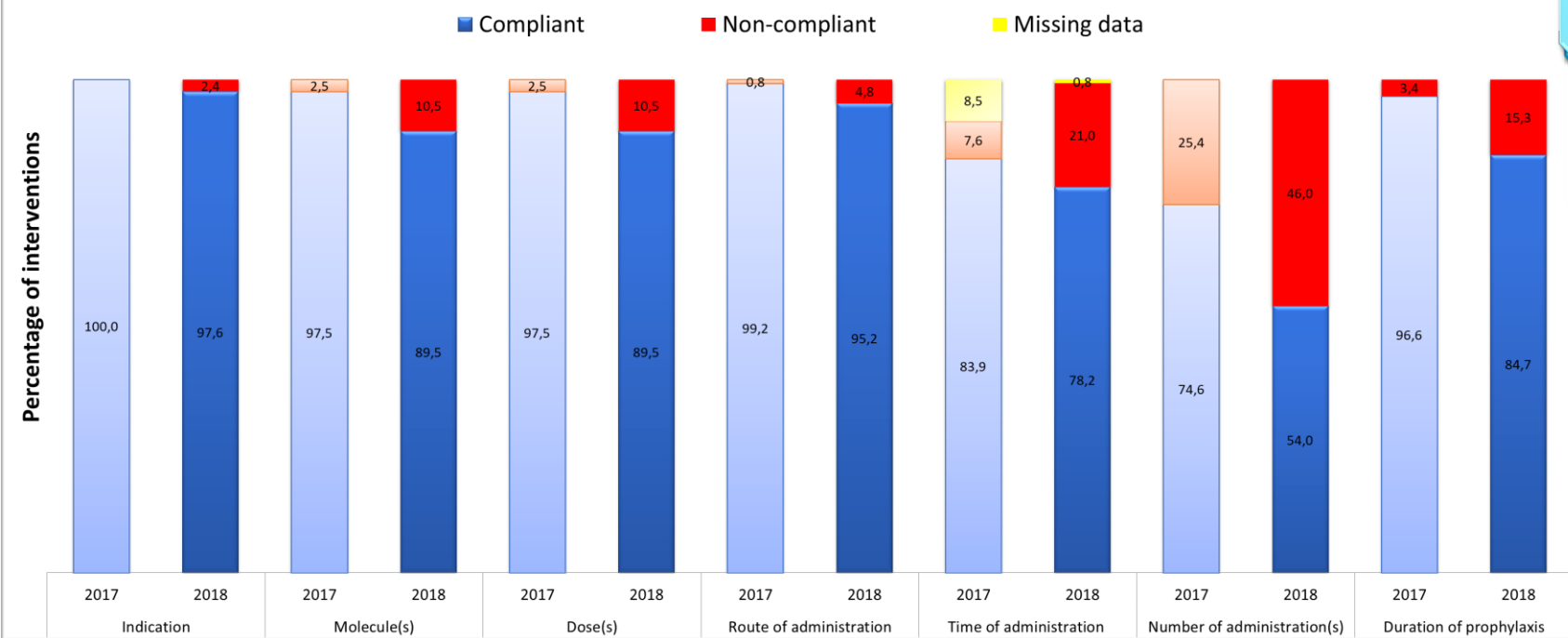
Comparison of antibiotic prophylaxis practices in the 2017 test group (n = 118) versus the 2018 post-test group (n = 124)
→ Significant decrease in compliance for 4 out of 7 items assessed (test group vs. Post-test group)
(P <0.05 for 4 items assessed)

Legend: ■ Compliant ■ Non-compliant ■ Missing data

	Indication	Molecule(s)	Dose(s)	Route of administration	Time of administration	Number of administration(s)	Duration of prophylaxis
Pa	0,08909367NS	0,0129507*	0,0129507*	0,06405966NS	0,26094642NS	0,00087145*	0,00155704*

a Comparing the pre-test group with the test group: *significant   NS, Not significant

Multidisciplinary team

Local Guidelines

Audits

Implementation of Guidelines

Pharmacist Interventions

Nominal delivery of antibiotic kits

Informatic tool

Combination of persuasive interventions:
Strategy tested during 15 weeks
(between January 9, 2017 and April 21, 2017)
at CHU de Charleroi – Marie Curie

Inclusion criteria

Patients > 18 years old

Patients who had one of the following 5 interventions: total hip prosthesis, coronary artery bypass grafting, colo-rectal surgery, transurethral resection of the prostate and endoscopic retrograde cholangiopancreatography

Exclusion criteria

Patients < 18 years old

Patients with a documented infection at the time of the intervention

Developed based on guidelines recently updated and validated by the hospital antibiotic group (GGA) and on specific patient criteria

https://db.serv-idb.net/antibioproph

A. PARDO

Tool presented to the hospital antibiotic group (GGA) on March 20, 2018

Tool made available for all the staff members in the Medical Information System of CHU Charleroi:

- at sharepoints of the concerned medical disciplines including anesthesia and all surgical units
- in the Scientific Portal (in Consensus & Recommendations for Clinical Practice)

How was the tool presented?

Via a video broadcast:

- by email on December 20,2018
- in the Medical Information System of CHU Charleroi on December 21, 2018

Results

Marie Curie 2018-2019

Pre-test group Analysis
Antibiotic prophylaxis practices
between January 8, 2018 and April 20, 2018

Diffusion of the computerized decision support system
December 20-21, 2018

Test group Analysis
Antibiotic prophylaxis practices
between January 7, 2019 and April 19, 2019

Inclusion criteria

Patients > 18 years old

Patients who had one of the following 5 interventions: total hip prosthesis, coronary artery bypass grafting, colo-rectal surgery, transurethral resection of the prostate and endoscopic retrograde cholangiopancreatography

Exclusion criteria

Patients < 18 years old

Patients with a documented infection at the time of the intervention

Similarity between the 2018 pre-test group versus the 2019 test group ?

- χ^2 test for categorical variables (number of patients per type of intervention, number of long duration interventions (> 3 hours), number of allergic patients)
- Student's t-test for the age variable

al characteristics of patients in the pre-test group and the test group

→ **Similarity between the two groups in terms of clinical and demographic characteristics**

($p > 0.05$ except for the number of Coronary artery bypass grafting)

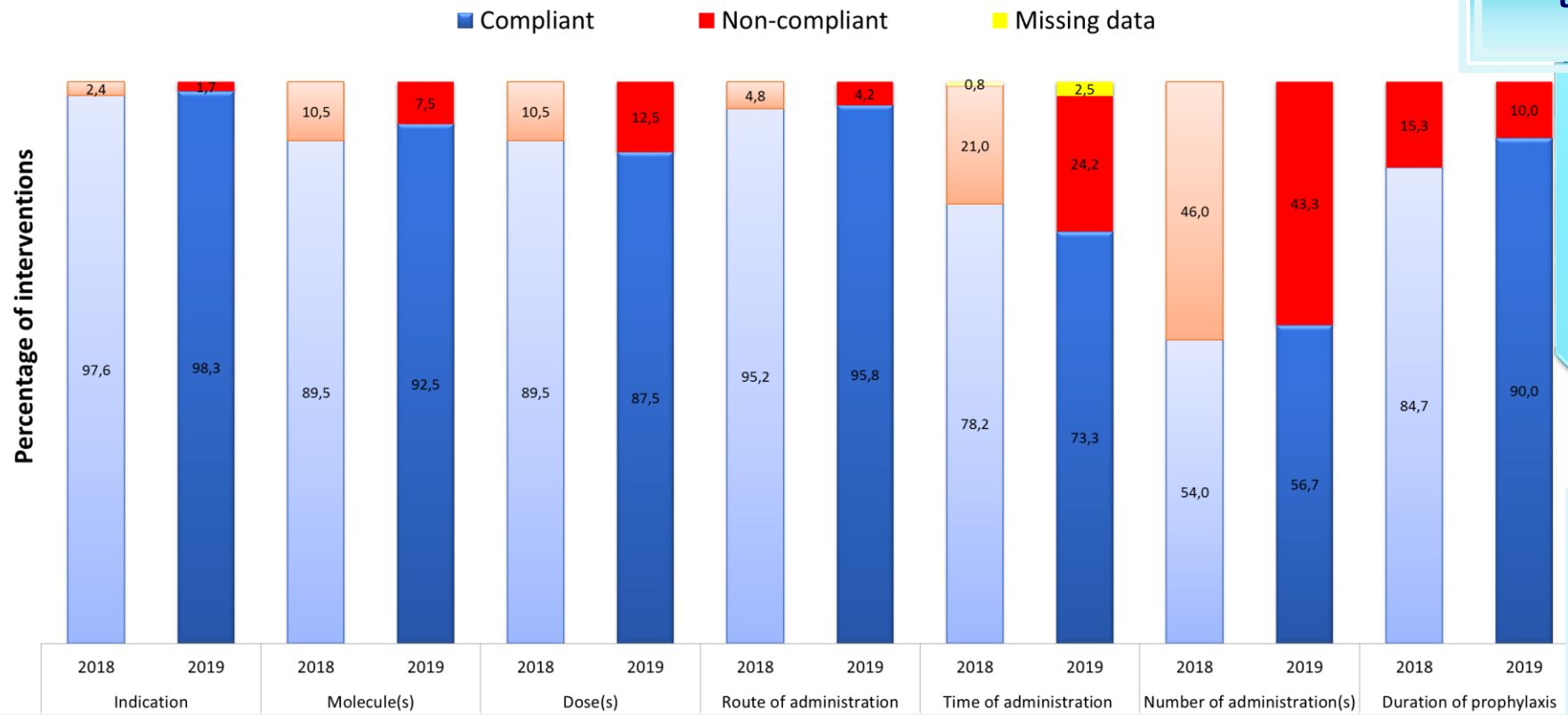| Characteristics	G			
Number of Interventions, n				
Age (yr), mean±SD	65			
Transurethral resection of the prostate, n (%)				
Coronary artery bypass grafting, n (%)	30 (24,19)	46 (38,33)	76 (31,15)	0,02*
Colorectal surgery, n (%)	19 (15,32)	12 (10)	31 (12,7)	0,21 NS
Total hip prosthesis, n (%)	38 (30,65)	31 (25,83)	69 (28,28)	0,40 NS
Endoscopic retrograde cholangiopancreatography, n (%)	28 (22,58)	19 (15,83)	47 (19,26)	0,18 NS
Duration of intervention > 3h, n (%)	48 (38,71)	55 (45,83)	103 (42,21)	0,26 NS
IgE Mediated Penicillin (or Ciprofloxacin) Allergy, n (%)	11 (8,87)	6 (5)	17 (6,97)	0,24 NS

[a] Comparing the group 2018 with the group 2019: NS, not significant; *significant

Pre-test group Analysis
Antibiotic prophylaxis practices
between January 8, 2018 and April 20, 2018

Diffusion of the computerized decision support system
December 20-21, 2018

Test group Analysis
Antibiotic prophylaxis practices
between January 7, 2019 and April 19, 2019

Impact of the computerized tool on compliance towards prophylactic antibiotic guidelines?

Legend: ■ Compliant ■ Non-compliant ■ Missing data

Y-axis: Percentage of interventions

	Indication		Molecule(s)		Dose(s)		Route of administration		Time of administration		Number of administration(s)		Duration of prophylaxis	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Compliant	97,6	98,3	89,5	92,5	89,5	87,5	95,2	95,8	78,2	73,3	54,0	56,7	84,7	90,0
Non-compliant		1,7		7,5		12,5		4,2		24,2		43,3	15,3	
Missing data	2,4		10,5		10,5		4,8		0,8 / 21,0	2,5	46,0			10,0

P^a	0,67822624^NS	0,41589813^NS	0,62132075^NS	0,80031384^NS	0,37222988^NS	0,67901438^NS	0,21199591^NS

^a Comparing the pre-test group with the test group: ▮*significant ▮ NS, Not significant

Difference of compliance between the two groups?

χ2 test comparing the % of compliance between the two groups for each of the 7 items audited

Comparison of antibiotic prophylaxis practices in the pre-test group (n = 124) versus the test group (n = 120)
→ **Increase in compliance for 5 out of 7 items assessed (non-significant)**
Test group vs. Pre-test group
P >0.05 for all items assessed

Informatic tool Advantages

- Integrates the guidelines recently updated and validated by the different actors of antibiotic prophylaxis → specific patient criteria can be integrated
- Recommendations accessible via a computer link (also from outside the hospital →accessible to other hospitals)
- A help with the decision: allows rapid and efficient decision-making adapted to the patient's parameters and in compliance to guidelines
- Stewardship strategy non labor-intensive
- A help to decrease the variability of interindividual prescription and sensitize the teams to the importance of antibiotic prophylaxis

Informatic tool Disadvantages

- Not connected to the computerized record of the patient → manual encoding required by practitioners
- Absence of reminder recalling the injection of antibiotic in preoperative
- Underused by practitioners

Conclusion

It is reported* that computerized decision support systems appear useful for improving compliance with antibiotic prophylaxis guidelines BUT over time, it is observed a gradual re-increase in the rate of non-compliance of antibiotic prophylaxis
→Computer tools are considered useful in a global strategy but without the incorporation of an active interventions, they don't appear sufficient over time to improve the frequency of compliance of practices

Thanks to the combination of stewardship strategies implemented, the Marie Curie Civil Hospital reached the explicit targets of 90% set by the BAPCOC :
Choice of surgical antibiotic prophylaxis according to local guidelines : 92,5% in 2019 vs. 83,1% in 2016
Duration of surgical antibiotic prophylaxis according to local guidelines : 90% in 2019 vs. 82,3% in 2016

Perspectives

For anesthesiologists and surgeons: increase communication about the existence of the computerized decision support system

Connect the tool with the computerized records of the patients and integrate a reminder recalling the injection of antibiotic in preoperative

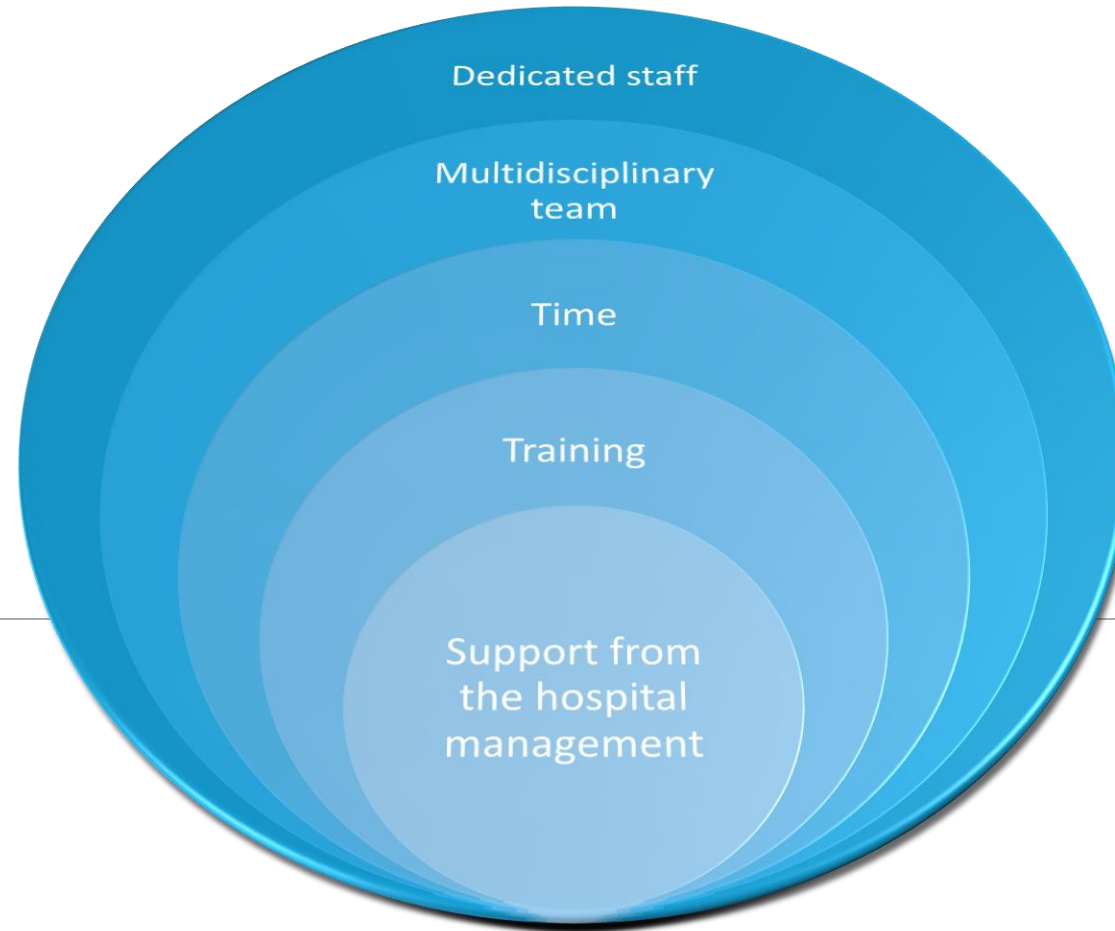Maintain updated guidelines and updated computer tool

Repeat active interventions and audits

*Fayolle-Pivot L, Weyb P-F, Petitjeans F, Puidupin M, Allaouchiche B, Escarment J. Contribution of information technologies to assess and improve professional practice: Example of management of surgical antibiotic prophylaxis. Annales Françaises d'Anesthésie et de Réanimation. 2013;32:241–5.

*Fayolle-Pivot L, Weyb P-F, Petitjeans F, Puidupin M, Allaouchiche B, Escarment J. Contribution of information technologies to assess and improve professional practice: Example of management of surgical antibiotic prophylaxis. Annales Françaises d'Anesthésie et de Réanimation. 2013;32:241–5.

Thank you for your attention