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Faecal microbiota transplantation in recurrent *Clostridium difficile* infection:**Recommendations from the French Group of Faecal microbiota****Transplantation**

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Abstract

Faecal microbiota transplantation is effective for treating recurrent forms of *Clostridium difficile* infection and its use in this indication is recommended in the most recent European and North American guidelines. In this context, faecal microbiota transplantation is beginning to be performed in France in clinical practice, while the rules governing this procedure have been defined in France only for clinical trials. To unify, secure, and evaluate practice in this field in France, the French Group of Faecal microbiota Transplantation (FGFT) was created in October 2014 with the support of the French National Society of Gastroenterology, the French Infectious Disease Society, and the National Academy of Pharmacy. We present here the deliberations of this group regarding the use of faecal microbiota transplantation for recurrent *Clostridium difficile* infection. The issues addressed are the indications, therapeutic sequence, delivery procedures, donor selection, methods and conditions of specimen preparation, and traceability.

Keywords : *Clostridium difficile*; faecal microbiota transplantation; recommendations

1. Introduction

Many concordant studies, including a recently published randomised trial ¹, have shown that faecal microbiota transplantation (FMT) is effective for treating recurrent forms of *Clostridium difficile* infection (CDI). The use of FMT in this indication is recommended in the most recent European ² and North American ³ guidelines.

In this context, FMT is beginning to be performed in France in clinical practice, while the rules governing FMT have been defined in France only for clinical trials (ANSM March 2014: <http://ansm.sante.fr/S-informer/Points-d-information-Points-d-information/La-transplantation-de-microbiote-faecal-et-son-encadrement-dans-les-essais-cliniques-Point-d-information>). The conditions under which FMT is performed in France are variable and not always optimal, in particular regarding the selection of donors.

Therefore, it appears necessary to provide recommendations to secure and clarify practice in this field in France. To address these issues, the French Group of Faecal microbiota Transplantation (FGFT) was created in October 2014 with the support of the French National Society of Gastroenterology (SNFGE). This initiative was received very favourably by many players in the field in France and also received the support of the French Society of Infectious Disease (SPILF) and the National Academy of Pharmacy.

Physicians, pharmacists and biologists actively involved in FMT in France gathered in December 2014 to develop recommendations to regulate the use of this procedure in clinical practice, especially in cases of multiple recurrent CDI (a recognised indication with international consensus). Indeed, recurrent CDI is frequent and increasing; it represents a real therapeutic problem with significant morbidity (repeated

hospitalisations, sick leave etc.) and substantial mortality. Patients with CDI are 2.5 times more likely to die within 30 days of infection compared to uninfected patients, regardless of their age and co-morbidities⁴. This mortality rate could be greater in patients with the recurrent form compared to those with a single episode⁵. Failure to perform FMT in France within a regulatory framework and according to standard, achievable and secure procedures represents a loss of opportunity for patients in the absence of alternative treatment with similar efficacy. Given the logistical and practical issues of the procedure, particularly with regard to donor testing, it is critical to create reference centres in France and standardised procedures.

After first contact in October 2014, a panel of expert gastroenterologists and infectious diseases specialists, microbiologists, and pharmacists was established to prepare a position statement on faecal transplantation. The panel met on December 10th, 2014 in Paris to define the timeline and milestones of the document. Regular conference calls followed and web-based data exchange were initiated. The following text represents the synthesis of the deliberations of the FGFT. It is based on the practical experience of each participant, the advice of expert microbiologists, the upstream work by the National Academy of Pharmacy, the ANSM and the analysis of practices in Europe and the United States. The issues addressed are the indications, therapeutic sequence, delivery procedures, donor selection, methods and conditions of specimen preparation, and traceability.

2. INDICATIONS

In line with the recommendations of the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) 2014 ², the FGFT finds FMT indicated in multiple recurrent CDI (defined as more than one recurrence). FMT considered in the context of recurrent CDI can only be performed after failure of standard well-conducted treatment with vancomycin or fidaxomicin.

With the current state of knowledge, there are no contraindications for FMT. In particular, recent data reported good safety, even in immunocompromised patients ⁶.

3. THERAPEUTIC SEQUENCE

The treatment sequence involves three steps: (i) oral antibiotic therapy with vancomycin, (ii) bowel preparation, and (iii) the delivery of the faecal suspension itself (Figure 1).

In agreement with the European guidelines, we recommend antibiotic treatment with vancomycin given orally for a minimum of four days before FMT (125 to 500 mg four times daily). Interruption of antibiotics for 24 to 72 h before FMT is possible but not mandatory. Studies are currently underway to evaluate the use of fidaxomicin as a pre-treatment.

It is recommended to perform bowel preparation the day before FMT by administering 4 L of a bowel cleansing solution containing macrogol (polyethylene glycol [PEG]) 3350 cc or 4000 cc with electrolytes.

After receiving the relevant information, the patient must sign a consent form mentioning the theoretical risks of the procedure, including the risk of pathogen transmission. Consent must be signed in triplicate: one for the recipient, one for the

patient's medical record and one for the archives (see the section below on "Traceability").

It is recommended to monitor the recipient at least 24 h after the FMT procedure.

Performing FMT does not change overall patient monitoring following CDI treatment.

The literature indicates that a second FMT may be necessary in the case of failure, or recurrence after a first attempt¹. This strategy is effective and recommended.

4. DELIVERY PROCEDURES

Three routes of delivery are possible: retention enema, during colonoscopy, or using a naso-duodenal tube.

4.1 Retention enema

Faecal preparation (up to 500 mL) should be placed in a disposable enema bag. The preparation is dispensed by the hospital pharmacy in a disposable enema bag. The pre-lubricated cannula is inserted as far as possible according to the patient's tolerance. The administration is then performed by a nurse as usual for an enema. The patient must retain this enema as long as possible (minimum 2 h). For convenience, the patient should remain lying down after insertion.

4.2 Colonoscopy

Faecal preparation (about 300 mL) is provided by the hospital pharmacy in 50- to 60-mL syringes. Colonoscopy should be performed under low pressure. Ideally, the faecal preparation should be administered upstream of the splenic flexure.

4.3 Naso-duodenal tube

The procedure must be carried out in the morning on an empty stomach in a patient who received treatment with proton pump inhibitors (esomeprazole 20 mg or omeprazole 40 mg) the night before and 2–3 h before FMT. Before FMT, the tube must be placed at least in the duodenum and if possible in the proximal jejunum. The correct tube positioning should be confirmed by X-ray.

Faecal preparation (250–500 mL) is provided by the hospital pharmacy in a 50- to 60-mL syringe (or in an enteral nutrition bag). The preparation should be administered at a rate of 50 mL over 2 min. If the use of a volume greater than 250 mL is intended, a 10- to 15-minute pause is recommended following administration of the first 250 mL. Patients are allowed to drink during the procedure. After administration of the faecal preparation, the naso-duodenal tube will be rinsed with tap water and left in place for 30 min before removal. Patients are then monitored for 2 h.

The naso-duodenal route is not recommended in patients at risk of vomiting or regurgitation, because of the risk of aspiration pneumonia.

5. DONOR SELECTION

Although we propose absolute and relative criteria for donor selection, the severity of the patient's disease remains the prevailing factor; the rigorous application of these criteria remains at the discretion of the multidisciplinary team responsible for the implementation of FMT (doctor, pharmacist, biologist), on a case-by-case basis, depending on the urgency of the situation and on the assessment of the individual risk-benefit ratio.

5.1 General donor pathway

The donor must first meet criteria of the pre-selection questionnaire, to exclude any contraindications (Table 1). The donor must then undergo physical examination by a physician, including the examination of the anal margin to search for lesions attributable to human papillomavirus (HPV) or herpes simplex virus (HSV). Blood and faecal testing is then performed (Tables 2 and 3) to exclude infection with transmissible agents. FMT should be performed within 21 days of the screening. On the day of FMT, the donor must answer a last questionnaire (Table 4) to ensure the absence of inter-current events since the initial clinical and laboratory screening that may represent a contraindication to donation.

The donor stools must be produced on the day of FMT, and stored at 4°C until preparation. The maximum interval between donor stool emission and recipient delivery is 6 h. A macrogol- or lactulose-based osmotic laxative can be administered to the donor the evening preceding FMT, to facilitate stools emission.

5.2 Pre-selection questionnaire

Potential donors should be evaluated thoroughly, through a questionnaire and a medical examination, to reduce the likelihood of transmission of pathogens (infectious and others).

The existing questionnaires provided for the screening of blood donors (<http://www.dondusang.net/rewrite/nocache/site/37/etablissement-francais-du-sang.htm?idRubrique=756>) represents a solid basis to limit the risk of infection.

However, additional measures should be considered to adapt the questionnaire to stool donation. In particular, it is important to collect the information specified in Table 1, in addition to the information required for blood donation.

After analysing the information gathered in the pre-selection questionnaire and during the interview that follows, the clinician decides whether the candidate can be selected to perform the biological screening.

This screening interview is also an opportunity to educate potential donors about the importance of limiting contamination before donation by providing recommendations in this regard (including food, travel, high-risk behaviours).

Considering the possible contamination window between the screening date and the actual FMT date, a second questionnaire and a medical interview are performed on the day of the donation. All items listed in Table 4 must be collected. After the second medical interview, according to the results of the biological screening and at the discretion of the investigator leading the interview, the donor can definitively selected for donation.

5.3 Standard donor screening

Blood tests should be performed in the pre-selected donor and must include: fasting glycaemia, creatinine, liver function tests (aspartate aminotransferase, alanine aminotransferase, gamma-glutamyl transpeptidase, alkaline phosphatase, bilirubin), C-reactive protein, complete blood count, coagulation tests.

5.4 Screening for infectious agents

In FMT, the screening tests for communicable disease listed in Tables 2 and 3 should be performed in the donor. This list is not static and must be regularly reassessed on the basis of the data available in the medical literature. It was elaborated taking into account the risk of transmission of infectious agents, the means available to detect these agents on solid stools from asymptomatic individuals, and the potential severity

of a hypothetical transmission to the recipient. The rationale for these tests is detailed in Appendix B (Supplementary Methods).

The prevention of transmission of infectious agents from a donor to a patient receiving FMT is based on history and microbiological testing.

None of the procedures fully guarantees against the possible transmission of a pathogen present in very small quantities and/or excreted intermittently. The likelihood of such a residual presence is impossible to quantify, but is considered low and without serious consequences at the present state of knowledge. This is mentioned in the informed consent for the recipient.

Characteristics of the ideal donor profile include: age 18–65 years, BMI <30, no chronic disease, no long-term medical treatment, no travel abroad (in tropical countries at risk of infection) in the 3 months before donation, no hospitalisations abroad (in tropical countries with a risk of infection) in the 12 months before donation, normal macroscopic appearance of stools, and negative screening for infectious agents.

5.5 Optimal timing for each procedure step (Figure 2)

5.5.1 Between screening and donation

Using fresh stools for FMT, the faeces screened for pathogens are not those actually administered to the recipient.

The time between screening and donation must match the turnaround time for test results and be as short as possible without exceeding 21 days, to minimise the risk of contamination during this critical period.

Ideally the use of frozen donor faeces would allow microbiological testing directly on the material administered to the recipient, and would thus minimise the risk of

transmission of infectious agents. However, no validated protocol is available regarding preparation and storage of FMT from frozen stools, although some data on effectiveness exist⁷⁻¹⁰.

5.5.2 Between donation and transplantation

Once prepared, the faecal suspension should be administered within 6 h of the bowel movement.

5.6 Anonymous vs. directed donation

For the indication of recurrent *C. difficile* infection, there is currently no scientific argument in favour of an anonymous donation versus a directed donation (from household contacts or relatives).

Although a directed stool donation may be possibly easier for the recipient to accept psychologically, two issues must be considered:

First, the veracity of the answers provided by the donor could be compromised by the fear of not being selected for the donation. The safety of the donation is based partly on the transparency of information provided by the donor during the medical interview and on the completeness of the questionnaire.

Second, one should consider the potential difficulty of communicating the exclusion of a close relative, and its consequences.

Conversely, one can also consider that if donor and recipient are close relatives or husband and wife, they largely share the same exposure to infectious agents. The risk of microbiological transmission could therefore be reduced.

Consequently, no specific recommendation is made and the donor can be the spouse, a family member or have no relationship with the recipient. In all cases, the same screening tests should be carried out.

5.6 Number of donors and recipients

5.6.1 One donor for multiple recipients

The donation from one donor can be intended for different recipients. At the current state of knowledge, there are no data available that allow the identification of a preferred microbiota in healthy subjects and there is no argument in favour of a single donor directed to a single recipient.

The choice of an anonymous donor donating to multiple recipients would provide standardised material and alleviate the logistical constraints associated with the selection of donors.

5.6.2 Multiple donors for one recipient

Similarly, there is no argument in favour of a unique donation over “pooled” donations (i.e., a mixture of stools from several donors to prepare a single specimen). However, using “pooled” donations further complicates the problem of traceability.

6. PREPARATION OF FMT MATERIAL

6.1 Setting for preparation of faecal suspension

The pharmaceutical preparation status in France¹¹ requires the preparation of faeces for the FMT to be carried out under the responsibility of the institution pharmacist.

For health facilities whose pharmacy lacks the technical means and/or appropriate equipment or local logistical requirements, a subcontracting agreement can be signed with another pharmacy.

If a medical biology laboratory within the institution has the resources required to process stool, a subcontracting agreement can be made by the pharmacist, provided that the latter conducts the pharmaceutical validation at preparation release and dispensation.

6.2 Organisation for preparing faecal microbiota

Standardisation of the preparation method is required.

6.2.1 Stool collection

The stools are collected in a disposable container with a wide opening and a tight lid.

The sample for FMT must not contain urine.

Given the short time (less than 6 h) between the emission of stools and delivery of the preparation, a coordinated mobilisation of the pharmaceutical team (treatment of FMT sample), the biological team (collection of blood and faecal test results), and the clinical team (delivery of FMT preparation to the recipient) is needed.

6.2.2 Dedicated room and equipment

Preparation of stool is carried out in a dedicated room. It is performed in a biosafety cabinet to avoid the risk of cross-contamination and ensure the protection of personnel.

Operators should be protected by wearing a cassock, a cap, a disposable protective mask, protective glasses and disposable gloves.

All preparation steps are performed at room temperature.

6.2.3 Dilution

The stools are diluted in sterile NaCl 0.9% to meet the isotonicity of the sample (sterile NaCl 0.9% can be refrigerated to minimise organoleptic imbalance).

A minimum of 50 g up to a maximum of 150 g of stool can be used.

Homogenisation of the dilution is carried out using a dedicated materials in which elements in contact with faeces are autoclavable or disposable.

The dilution must result in a suspension with a "liquid slurry" consistency and a final volume between 200 and 500 mL.

6.2.4 Filtration

The preparation is filtered through sterile gauze compresses placed on an autoclave-ready or disposable funnel to remove large particles such as undigested food debris that may block the delivery systems.

6.2.5 Packaging

For delivery by naso-duodenal tube or colonoscopy, packaging is carried out in 50 to 60 mL syringes (3–10 syringes). When delivered via naso-duodenal tube, the faecal suspension can also be packaged in an enteral nutrition bag, opaque if possible, for better acceptability.

For delivery via enema, the packaging is a disposable enema bag (500 mL) with an incorporated lubricated tube.

The preparation is labelled as a pharmaceutical preparation and reports the administration route (rectal or duodenal) and formulation batch number. A welded

labelled polyethylene overpack is used to facilitate transport. Transportation to the ward performing delivery is preferably carried out in a container at 2 °C to 8 °C.

7. TRACEABILITY

It is essential to ensure rigorous traceability of the FMT. For this purpose, biological samples from the donor should be stored and a batch file must be created and archived.

7.1. Biological samples

For each FMT, two samples from the donor are stored at -80 °C:

Stool collection: 1–2 g of stool collected at the time of the donation, in a polypropylene tube

Sample collection: 1–5 mL of preparation administered to the recipient in a polypropylene tube

7.2 Batch record data

For each FMT, the batch record must contain:

Biological data: Stool specimen validation, blood collection validation

Relevant paperwork: First donor screening questionnaire, second donor screening questionnaire on the day of donation, informed consent of the recipient

Pharmaceutical data: origin of stools (donor identification, date and time of the donation), all technical data on preparation (manufacturing records, inspection sheet).

Samples must be stored under conditions of optimal stability at -80°C for at least 3 years for each delivered sample (required to monitor possible adverse effects) and at

least 5 years for stool (time to satisfy additional epidemiological and microbiota studies).

Recording of clinically relevant events occurring within 2 weeks of the donation is highly recommended for both donor and recipient (i.e., any infectious disease in the donor).

Finally, the creation of a national registry is strongly recommended, to record the effectiveness of the procedure and clinical events in the short and long term in both donors and recipients.

Conflict of interest: none declared

Appendix A: French Group of Faecal Transplantation (FGFT)

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Figure Legends

Figure 1: Faecal microbiota transplantation: treatment sequence

PEG, polyethylene glycol; FMT faecal microbiota transplantation

Figure 2: Timeline for faecal microbiota transplantation donor screening, stool

donation and sample preparation

FMT faecal microbiota transplantation

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Table 1 : Screening Questionnaire (specific items for stool donation)

INFORMATION	EXCLUSION CRITERIA	SELECTION CRITERIA WITH PERSONAL ASSESSMENT
Co-morbidities	Digestive disorders (acute or chronic diarrhea) within 3 months prior to donation Known chronic disease History of typhoid fever	Donors with family history of: - Inflammatory bowel disease (relation) - Autoimmune diseases (relation) - Colon cancer (relation and age at onset) Donors with personal history of uncomplicated hypertension or hypercholesterolemia
Drug Treatment	Donor under long term medical treatment. ¹ Antibiotic intake within 3 months ¹	Treatment of uncomplicated hypertension or hypercholesterolemia
Travels	Living in tropical areas during the 3 months prior to donation Long-term residence in tropical areas Hospitalizations abroad longer than 24 hours in the 12 months prior to donation (including members of the donor's entourage) ²	Game consumption (trichinosis screening mandatory)
Age	Minor donor ³	Aged donor (>65 years) ⁴
Weight status	Non limiting	Donor with Body mass index>30 ⁵

¹ For reasons of efficiency: the microbiota may be altered

² To avoid multiresistant bacteria colonisation

³ In the absence of scientific evidence, minors should not be included, applying the general principles governing the donation and use of elements and products of the human body (art. L. 1241-2 and L. 1121-7 of the public health code)

⁴ In the elderly, the microbiota may be modified and the risk of co-morbidities is more important

⁵ Obese subjects have a modified microbiota and preclinical results have shown that it is possible to transfer disorders such as obesity and diabetes through the microbiota

Table 2 : List of infectious agents to screen in donors

	Blood (serology)	Stools
Bacteria	Treponema pallidum (TPHA, VDRL)	Clostridium difficile Standard stool culture : Salmonella, Yersinia, Shigella, Campylobacter Multiresistant bacteria ¹
Virus ¹	HIV HTLV HAV, HBV, HCV, HEV CMV ³	Norovirus ² Rotavirus ² (only if the donor is a child <8 years)
Parasites	Strongyloides stercoralis ⁴ Ameobosis ⁴ Trichinella sp. ⁵	Strongyloides stercoralis Cryptosporidium sp. (immunocompromised patients). ⁶ Cyclospora sp. ⁶ Entamoeba histolytica ^{6,7} Giardia intestinalis ⁶ Isospora sp. ⁶ Microsporidia ⁶

¹ Swab on stool samples, search for glycopeptide resistant enterococci (GRE), Extended spectrum beta-lactamase producing bacteria and Carbapenemase producing enterobacteria

² stool is examined for viruses in using molecular biology tests (PCR)

³ Only to exclude sero-discordance with the recipient

⁴ Serology if reported travel to high-risk areas

⁵ reported game consumption only

⁶ Parasitological examination of stool on three different samples.

⁷ In case of travel to amoeba endemic areas, PCR for E. histolytica is recommended

TPHA, Treponema Pallidum Hemagglutininations Assay; VDRL, Venereal Disease Research Laboratory;

HIV, Human Immunodeficiency Virus; HTLV, Human t-cell Leukemia Virus; HAV, Hepatitis A Virus;

HBV, Hepatitis B Virus; HCV, Hepatitis C Virus; HEV, Hepatitis E Virus; CMV, Cytomegalovirus

Table 3: Bacterial screening methods in healthy donor stool

Bacteria	Recommended method (on stool) ¹
Carbapenemase-producing bacteria	Culture on two different specific media (or validated molecular method)
Extended spectrum beta-lactamase producing bacteria	
Campylobacter sp.	Culture on specific medium
C. difficile	Culture on specific medium allowing spore germination (or validated molecular method)
Salmonella sp.	Culture on specific medium after enrichment
Shigella sp.	Culture on specific medium
Yersinia sp.	Culture on Cefsulodin-Irgasan-Novobiocin medium

¹Each procedure uses commercialized material and should be performed following the manufacturer's recommendations. The techniques for identifying pathogens or antibiotic-resistant bacteria mentioned below should take into account the specificity of isolation on formed stools of asymptomatic donors.

Table 4 : Screening questionnaire / Events since the screening visit

EXCLUSION CRITERIA	SELECTION on the basis of individual assessment
<p>Diarrhoea (> 3 loose or liquid stools/day)</p> <p>Situations at risk of contamination :</p> <ul style="list-style-type: none"> - Travel in tropical areas - Contact with human blood (sting, wound, showing, piercing*, tattoo*) - Sexual high-risk behaviour - Presence of anal lesions caused by Human papilloma virus or Herpes Simplex Virus 	<p>Specific events to be investigated:</p> <p>Medical consultation (reason)</p> <p>Contracted disease (type, date and duration)</p> <p>Medication (type, date of last intake)</p> <p>Travel abroad</p> <p>Diarrhoea (> 3 loose or liquid stools/day) among members of the entourage (including children) within 4 weeks of donation.</p>

*if not performed in France

Table 4 : Screening questionnaire / Events since the screening visit

EXCLUSION CRITERIA	SELECTION on the basis of individual assessment
<p>Diarrhoea (> 3 loose or liquid stools/day)</p> <p>Situations at risk of contamination :</p> <ul style="list-style-type: none"> - Travel in tropical areas - Contact with human blood (sting, wound, showing, piercing*, tattoo*) - Sexual high-risk behaviour - Presence of anal lesions caused by Human papilloma virus or Herpes Simplex Virus 	<p>Specific events to be investigated:</p> <p>Medical consultation (reason)</p> <p>Contracted disease (type, date and duration)</p> <p>Medication (type, date of last intake)</p> <p>Travel abroad</p> <p>Diarrhoea (> 3 loose or liquid stools/day) among members of the entourage (including children) within 4 weeks of donation.</p>

*if not performed in France

Figure 1

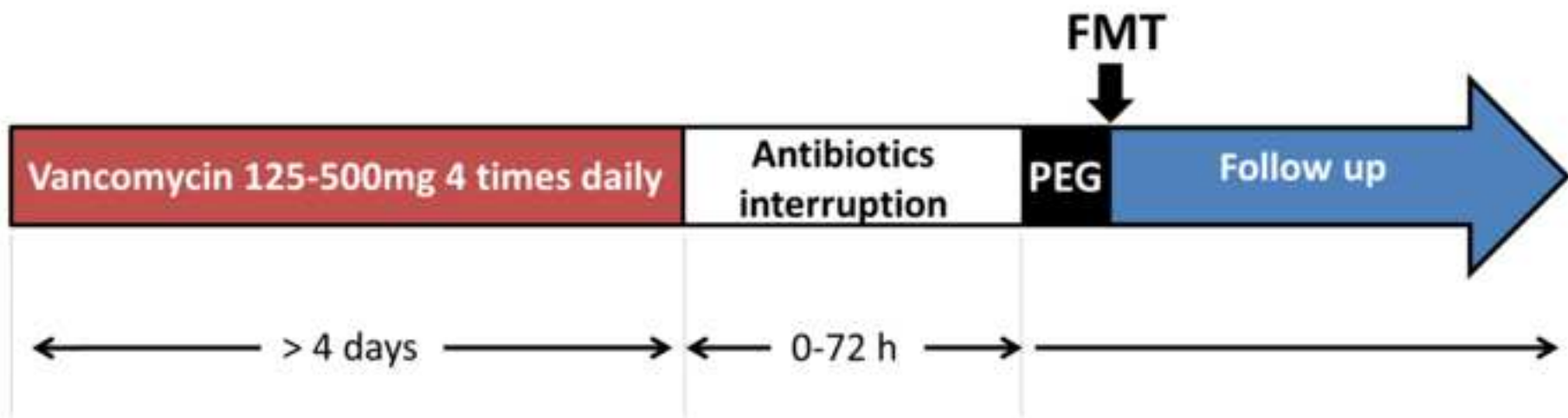




Figure 2

