

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

7,000

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



## Chapter

# Lautenbach Irrigation System

*Princess Busisiwe Siphwe Mbatha*

## Abstract

Osteomyelitis is infection of bone and frequently seeds in trabecular areas affecting both bone and bone marrow. Bone infection differs from soft-tissue infection since bone consists of a collection of rigid compartments. Bone is thus more susceptible than soft tissues to vascular damage and cell death due to pressure in acute inflammation. Unless it is rapidly suppressed, bone infection will inevitably lead to necrosis. Chronic infection is seldom eradicated by antibiotics alone. Yet bactericidal drugs are important to suppress the infection and prevent its spread to healthy bone and to control acute flares. The choice of antibiotic depends on microbiological studies, but the drug must be capable of penetrating sclerotic bone and should be non-toxic with long-term use. A different technique is the Lautenbach approach, involving radical excision of all avascular and infected tissue followed by closed irrigation and suction drainage, and an appropriate antibiotic solution in high concentration to allow the 'dead space' to be filled by vascular granulation tissue.

**Keywords:** infection, chronic osteomyelitis, Lautenbach irrigation system, D.R.I, antibiotics

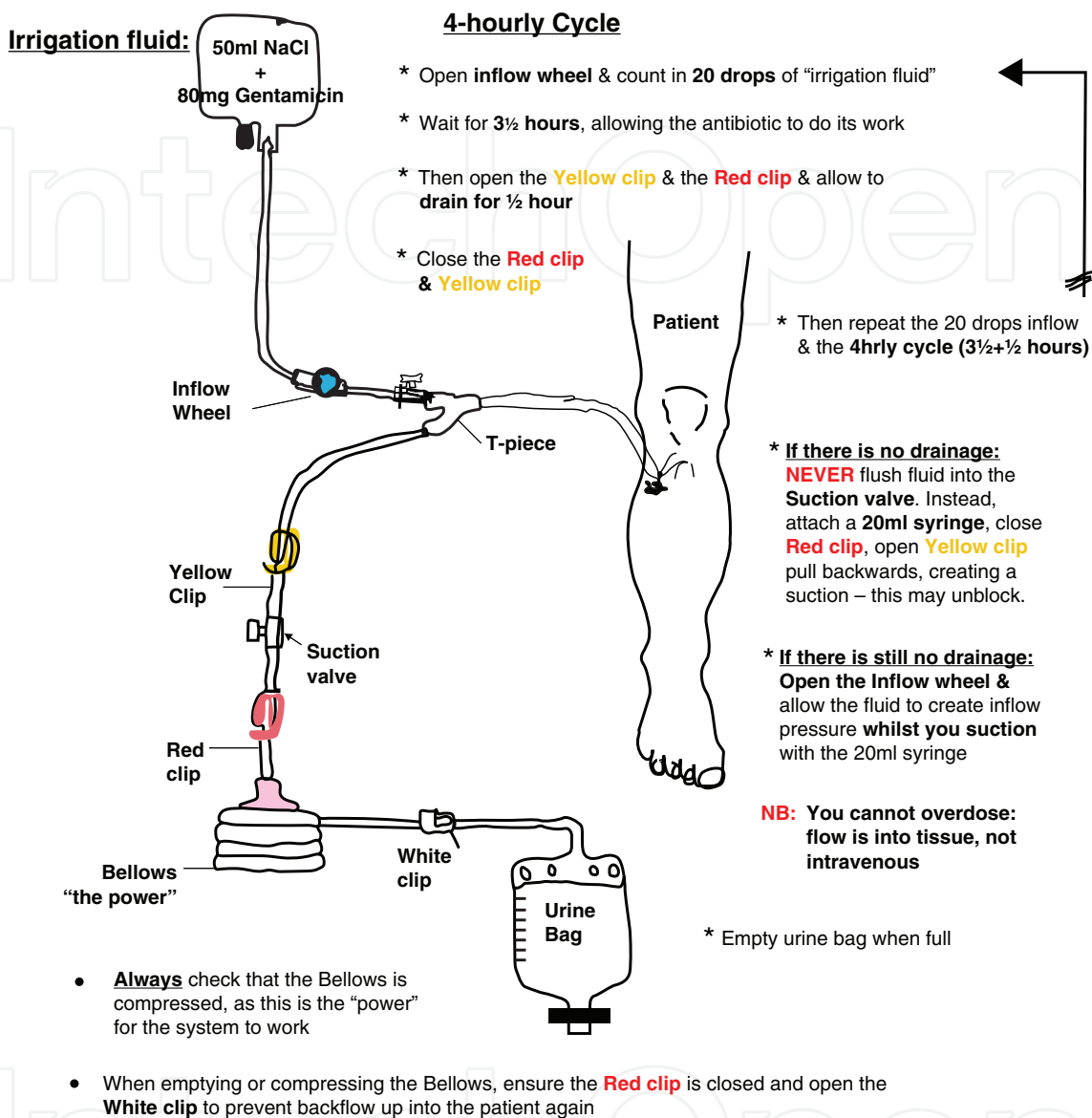
## 1. Introduction

The Lautenbach procedure involves debridement, intramedullary reaming and the insertion of double-lumen tubes to establish both a local antibiotic delivery system and cavity analysis for volume and culture (**Figure 1**). The end-point of treatment is when the irrigate produces three consecutive clear cultures with improvement in the blood indices and obliteration of the cavity volume [1–3].

In theater, the patient's affected limb is debrided, and sequestra are removed and cleaned. After that holes will be made (Reaming) on the bone. These holes will be enough to insert an irrigation tube, which is a double-lumen tube that means the tube has a smaller tube inside. There is one big tube (perforated) which drains the irrigation fluid from the patient and an intra-catheter inside that administers an antibiotic to the bone and its bone marrow. These tubes will stay with the patient from two weeks upwards or until the patient is cleared of infection.

### LAUTENBACH INSTILLATION SYSTEM

\* 50ml saline bag: add 80mg Gentamicin to each bag = "irrigation fluid"



**Figure 1.** Diagram of the Lautenbach irrigation system. Author: Charlotte Maxeke, Ward 369, Johannesburg Academic Hospital, South Africa. Adapted from original drawing, used with permission.

## 2. Irrigation system contents

- An administration set that almost looks like an intravenous infusion line to which is attached to a 50 ml antibiotic bag. This line which carries the antibiotic connects to the perforated tube through a Y-connection and the same administration set connects to a three-way stopcock and it delivers the antibiotic through the intra-catheter (a smaller tube that goes inside the bigger tube)
- A bellow that looks like a portovac drain but cannot be opened to maintain continuous negative suction.

- A drainage bag that looks like a urine bag but it has a tube permanently connected to the bellow.

### 3. Nursing management

On arrival in the ward from the recovery room, the nurse in charge of a patient post insertion of the Lautenbach irrigation system should do the following:-.

Postoperative vital data monitoring must be done as per hospital protocol. This includes checking of temperature, pulse, respiration, blood pressure, and oxygen saturation, which should be between 94 and 100% on room air. If the patient desaturates; 40% oxygen via face mask should be administered and the orthopedic surgeon on call should be informed to do arterial blood gases and also to take blood for post-operative full blood count and urea and electrolyte. As this is a major orthopedic procedure these patients bleed a lot and might need an intra-operative blood transfusion or postoperative blood transfusion depending on the condition of the patient. The patient may come back from the theatre with one, two, or even three irrigation tubes. These should be labeled, especially if there is more than one irrigation tube as follows; proximal tube, medial tube, and distal tube or tube 1, tube 2, and tube 3. The tube closest to the midline of the body of the patient would be labeled as a proximal tube and the tube that is situated further away from the body is labeled distal tube or tube 3 respectively.

The operated site should be checked as soon as possible so that the patient can be dressed with a pressure bandage to contain the bleeding. Whilst repacking the dressing; another nurse should open the red and yellow clips and let the irrigations drain regardless of time. This means for example; if the patient came back from the theater at around 16 h05 the drains should be drained from approximately 16 h10 till 18 h00, whilst monitoring the drainage. If the drainage is above 250 ml post operatively the irrigation system; (both yellow and red clips) should be closed and the orthopedic surgeon should be informed. That much drainage is concerning.

The gold standard antibiotic that is used postoperatively is gentamicin 80 mg in 50 ml of sodium chloride 0.9%. Sometimes in theater, the nursing staff will add 320 mg of gentamicin in 200 ml of sodium chloride 0.9%. This is not totally wrong but it is not ideal in a ward situation. This should be changed from 80 mg to 50 ml of sodium chloride 0.9% as soon as the patient is stabilized in the ward. Gentamicin mixed with sodium chloride will only last for two days at room temperature. So mixing 320 mg with 200 ml of saline is actually wasteful in nature and might as well prolong the patient's hospital stay because what if it is not changed at due time because 200 ml is seemingly enough to run for a few weeks.

Check for any leakage or oozing from the wound site. Do not remove dressings from the theater if oozing is noted. Dressings from the theater will only be removed on the day of removal of the irrigation system as a whole. Apply orthopedic wool and crepe bandage and monitor bleeding. In an ideal situation there should not be any bleeding at all, more often than not the report from the surgeon post operatively would be a space was left on the wound for various reasons [4], that would make exudate escape from the tubes to the dressing itself.

### 4. Protocol for irrigation maintenance

This is a very easy procedure to do as it is repeated every four hours. Even a patient can be taught how to do it without any issues. The disadvantage to this is that the

09H30-10H00	Open yellow clip and red clip. Let it drain for thirty minutes.
10H00	Close yellow clip and red clip. Administer 20 drops of an antibiotic.
13H30-14H00	Open yellow and red clip. Let it drain for thirty minutes.
14H00	Close yellow clip and red clip. Administer 20 drops of an antibiotic.
17H30-18H00	Open yellow and red clip. Let it drain for thirty minutes.
18H00	Close yellow clip and red clip. Administer 20 drops of an antibiotic.
21H30-22H00	Open yellow and red clip. Let it drain for thirty minutes.
22H00	Close yellow clip and red clip. Administer 20 drops of an antibiotic.
01H30-02H00	Open yellow and red clip. Let it drain for thirty minutes.
02H00	Close yellow clip and red clip. Administer 20 drops of an antibiotic.

*These yellow, red, blue, or white clips are also called pinch clamps.*

patients are often in a hurry to get discharged and they would assume that administering more than 20 drops of antibiotics at a go will help them get better sooner than expected, which is never the case. They will be overdosing on the tissues. Instead; the irrigation system will start leaking from the wound site.

## 5. Specimen collection

The specimens are collected three times a week, that is, Mondays, Wednesdays and Fridays [4]. Before collecting a specimen, the nurse responsible for the patient should prepare a trolley. Aseptic technique should be maintained at all times to avoid contaminating the specimen. The trolley should be cleaned with a disinfectant using an S shape. A sterile green cloth should be put on top of the trolley. Two 20 ml sterile syringes should be opened from their packaging and thrown on the sterile cloth. A packet of sterile gloves should also be put on the sterile cloth. An alcohol swab should be put on the bottom of the trolley with specimen bottle. If the alcohol swabs are not available, sterile cotton wool swabs drenched in a disinfectant should be used. A nurse who is taking a specimen should have another nurse who will open an alcohol swab for her, so sterile cotton swabs are better if there is no one to open the readymade alcohol swabs.

The nurse must then wash her hands and don gloves. After wearing gloves, would look for the port (Also called suction valve) between the yellow and red pinch clamp. This port should be cleaned thoroughly with an alcohol swab before opening it. The nurse must remove the cap connect the 20 ml syringe and then open the yellow pinch clamp. The red pinch clamp must not be touched at all during the collection of the



specimen. The nurse must withdraw the first specimen and close the yellow pinch clamp. That specimen must be discarded and a second 20 ml syringe must be connected to the port so as to get a fresh new specimen directly from the wound site. The first specimen must have been sitting there in the tube for a long time and it might give a wrong result, also; using two syringes assists in unblocking of the irrigation system if this is the case. Once enough specimen is collected the yellow pinch clamp must be closed and the port must be closed. It is advisable to clean the cap with the disinfectant before putting it back on the port.

If the patient has more than one tube the same procedure should be repeated on another tube making sure that new gloves and syringes are used. The specimens should be labeled accordingly. The laboratory form should be filled with a patient's name, hospital number, doctor who is in charge of the patient's details, ward number, date and time the specimen was collected, and the diagnosis of the patient. The wound site should also be included in the laboratory form, for example, the right tibia, left humerus, right femur, etc. The specimen type should be marked as Irrigation Fluid, not blood even though it looks like blood a few days postoperatively. The investigation required should be indicated as Microscopy/Culture/Sensitivity in the laboratory form. After that, the specimen should be sent to the laboratory and it would take 24 to 48 hours for the results to come out, depending on the laboratory. If the patient has more than one irrigation tube, a separate laboratory form should be used for each specimen collected on each tube.

A nurse should make a note on the progress notes for doctors that a specimen has been collected. A lab sticker with a reference number for the laboratory should be stuck underneath the signature of the nurse who took the specimen so that it becomes easier for the medical personnel to trace the results for the patient.

Once results are received by the ward a professional nurse can read them and act accordingly. For example, if the patient cultured *Staphylococcus Aureas*, which is sensitive to Cloxacillin the professional nurse should put 1 g of cloxacillin in 50 ml sodium chloride and remove the one that has gentamycin in it. The doctor should be made aware of this development but there is no need to wait for further instructions to change antibiotics as the protocol allows the nursing staff to do so. Precaution should be taken with penicillin drugs and the patient's allergy should be considered. If the patient has MRSA the irrigations should be changed to vancomycin and the patient should be isolated in a private room or placed next to a window in hospitals where there are no isolation rooms. Universal precautions should be abided by at all times. With patients who have cultured MRSA, the surgeon would prescribe vancomycin to be administered intravenously for a week as well. A nurse is not allowed to administer intravenous antibiotics without a prescription. So, the intravenous antibiotics will be initiated after the prescription has been obtained. The patient might be put on Vancomycin 1 g daily or 1 g twice daily taking into consideration the renal function of the patient. If the patient has some renal dysfunction, the nephrologist will be involved to suggest and give guidance on an appropriate renal dose. Vancomycin is not combined with rifampicin as irrigations are not put on a patient with an implant. The Implants are removed before a DRI procedure is done on a patient. Microbiologists and Infectious Diseases physicians are also involved once a patient cultures and is started on antibiotics.

For a patient to be considered cleared of infection; they should have three consecutive negative culture results. If a patient has two negative specimen results and

a third one is positive, the third one will cancel the first two negative ones and the patient will continue with irrigation treatment until they receive uninterrupted three negative specimen results.

## 6. Unblocking the irrigation system

At any given time, the irrigation system can be blocked. This can be observed during drainage times. When the yellow clip is opened there will be no movement of the fluid from the patient to the bellow. A bellow is supposed to provide a continuous negative suction pressure at all times but this would be disturbed due to various reasons. Those reasons might be after physiotherapy, after mobilizing to the bathroom without taking precaution in the handling of irrigation system or a blood clot or fat debris from the bone marrow caught between the outside tube (the tube that drains the irrigation fluid from the patient) and the intra-catheter (the inner tube that administers antibiotic to the wound site).

Before trying to unblock the tubes, the system should be checked if it is still in situ, as the system is only held by one stitch around the insertion area, it is easy for tubes to come out. Once the tubes are out, the whole system must be removed. They must never be pushed back inside the patient as this is a sterile procedure done in theater, so pushing the irrigation system in the patient's wound would be introducing infection to the patient as those tubes would already have been exposed to the unsterile environment.

Another thing that a nurse can do to maintain the continuous negative suction is to open a blue or white clip between the bellow and a drain bag (That looks like a urine bag but without the volume markings) and then put pressure on the bellow until all the contents of the bellow have been drained to the drain bag. If the drain bag is full of air from the bellow, the air can be released without contaminating the system. If the bag is full of fluid drainage it can be emptied and discarded. There is no need to measure the contents of the bag.

If putting pressure on the bellow is not working a 20 ml syringe can be used as the same procedure of taking a specimen to try and provide manual suction. This can be done several times if the patient is complaining of pain. The clot; unless it is not big might come and may be seen in the syringe after being caught. The port must be closed and then the two pinch clamps (the red and yellow one) must be open to check if there is any drainage. If the clot was properly removed, the system might be seen running properly at this moment.

If those two avenues have been exhausted it could mean there is a clot somewhere that could not be removed with a mere 20 ml syringe. A 50 mg of Actilyse (alteplase) should be mixed with 50 ml of sterile water for injections. After that 2 ml of that solution should be added to an already prepared new solution of 50 ml sodium chloride and a relevant antibiotic. The 2 ml of alteplase solution should not be added to an already running antibiotic. A new solution must be prepared and an old one must be discarded so that 2 mg of actilyse is added into 50 ml of sodium chloride with for example 1.2 g of Augmentin.

Streptokinase 1,500,000 international units is another drug of choice in the unblocking of irrigation systems depending on the hospital pharmacy availability. It also should be added in 50 ml water for injection and 2 ml withdrawn and added into the antibiotics.

Two cycles of irrigation procedure should be enough to clear any clot and the solution should be removed unless the problem is persistent. The patient should also be

monitored for any bleeding on the wound site. The solution should be discontinued if the bleeding is concerning or if it is disproportionate to the amount of antibiotic solution administered.

Sometimes the irrigation system will stop running and restart during the next cycle on its own without any interference from the nursing staff. The assumption is that there might be nothing to drain from inside especially after taking a specimen. Remember  $\pm$  40 ml is taken during specimen collection and during the administration of antibiotics only 20 drops are administered, which is not a lot by any account.

## 7. Discussion

Patients are discouraged from mobilizing unnecessary to prevent pulling out of irrigation tubes. If a patient wants to go to the bathroom a plastic bag can be used to put the tubes, bellow, and drain bag in and the patient can carry it with the hand that is on the side of the limb with irrigations, for example, if the irrigations are on the left leg, the plastic bag should be carried on the left hand. The irrigation system should not be made to move across to the other side.

The patient is encouraged to reduce smoking; though this is a difficult thing to do the patient should be made aware that smoking will delay the process of wound healing [5].

If possible; the patient should not sleep on his own pajamas or blankets. They should use hospital linen, which can be changed daily so that the patient is nursed on a clean environment at all times. As the world has been engulfed by COVID-19 pandemic, most hospitals have changed their rules as far as visiting relatives are concerned, so it might be impossible for the family to bring clean pajamas every day for their relatives. The patient is also encouraged to take high protein foods to promote wound healing.

### Author details

Princess Busisiwe Sipiwe Mbatha  
Charlotte Maxeke Johannesburg Academic Hospital, Department of Orthopedics,  
Johannesburg, South Africa

\*Address all correspondence to: [bathaphiwe@gmail.com](mailto:bathaphiwe@gmail.com)

### IntechOpen

---

© 2022 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 



## References

[1] Blom A, Warwick D, Whitehouse M. Apley and Solomon's System of Orthopaedics and Trauma. 2018. pp. 31-43

[2] The Management of Chronic Osteomyelitis using Lautenbach Method [Internet]. National Library of Medicine. Bethesda; 2004. Available from: <http://www.pubmed.ncbi.nlm.nih.gov> [Cited: 11 December 2021]

[3] Modified Lautenbach Technique in the Treatment of an Open Infected Non-union of the Clavicle—A Case Report [Internet]. Acta Orthopaedica. United Kingdom: Nordic Orthopaedic Federation; 2012. Available from: <http://www.ncbi.nlm.nih.gov> [Cited: 17 November 2021]

[4] Local Antibiotic Instillation and Suction Drainage after Surgery for Bone & Soft Tissue Infection [Internet]. South Africa; 2006. Available from: [http://www.boneinfection.co.za/Irrigation\\_HandOut\\_v107.pdf](http://www.boneinfection.co.za/Irrigation_HandOut_v107.pdf) [Cited: 10 December 2021]

[5] Smoking Greatly Increases Risk of Complications after Surgery [Internet]. Switzerland: WHO; 2020. Available from: <https://www.who.int/news/item> [Cited: 12 December 2021]