OPEN ABDOMEN AND TEMPORARY ABDOMINAL CLOSURE

PROTOCOL

INTERSECTION DOCUMENT

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Definitions and Abbreviations

Open abdomen (OA): in this document refers to a technique where the abdominal fascia defect is intentionally left open at the end of the laparotomy. OA is usually part of a staged management approach that entails planned re-laparotomies as part of a damage control concept for trauma, severe abdominal sepsis, or other specific indications.

Temporary abdominal closure (TAC): refers to the method used to protect and seal the abdominal contents and the fascia during OA management.

Primary fascial closure: in the context of OA in this document, refers to any closure of the abdominal fascia within the same hospitalization.

Early primary facial closure: closure of the abdominal fascia within 7 days.

Delayed primary fascial closure: closure of the abdominal fascia later than 7 days but within the same hospitalization.

Intraabdominal hypertension (IAH): sustained or repeated pathological elevation of intra-abdominal pressure ≥ 12 mmHg [1]

Abdominal compartment syndrome (ACS): repeated or sustained pathological elevation of the intra-abdominal pressure (> 20mmHg) that is associated with new onset of organ dysfunction or failure [1]. Untreated ACS has a high mortality.

Negative Pressure Wound Therapy (NPWT): also called vacuum-assisted wound closure, refers to wound dressing systems that continuously or intermittently apply sub-atmospheric pressure to a dressing. In this document, NPTW refers to both commercially available systems and non-commercial, improvised systems that apply suction to a dressing material.

Loss of domain: (or loss of abdominal domain) refers to a state where the volume of the abdominal content exceeds the volume of the abdominal cavity. In the context of the open abdomen, this is a result of progressive fascia retraction. The abdominal contents cannot be reduced into the abdominal compartment without tension.

SWG: MSF intersectional surgical working group

Background

Open abdomen (OA) and temporary abdominal closure (TAC) have become an accepted strategy for severe abdominal trauma and abdominal sepsis [2]. While the reduction in mortality by using damage control strategies and OA has mainly been demonstrated in trauma patients [3], OA is also widely used and accepted in abdominal sepsis and other conditions. However, there is currently no high-quality prospective data regarding the use of OA for the latter indications [4]. In MSF, depending on the mission context, severe abdominal sepsis is likely the main indication for OA, followed by severe abdominal trauma. An OA can potentially reduce mortality in severe surgical pathologies encountered in the MSF field context but has also relatively high complications rates and resource requirements. The OA therefore needs to be used judiciously.

The objective of this document is to provide guidance for surgical teams in typical MSF settings with limited resources on management of the open abdomen and methods for its closure. For a more in-depth introduction into the use of the OA strategy we recommend the recent guidelines published by international surgical expert groups [5], [6].

The rationale to leave the abdominal fascia open and apply a temporal abdominal closure method at the end of a laparotomy aims to achieve one or more of the following objectives [7], [8]:

- Preventing or treating intra-abdominal hypertension (IAH) and acute compartment syndrome (ACS),
- Abbreviating the surgery, avoiding additional surgical trauma in patients with severe physiologic derangement who require damage control strategies
- Avoiding undue tension when closing the abdominal fascia and prevent an uncontrolled breakdown of the fascial closure (burst abdomen)
- Protecting the abdominal fascia, facilitating atraumatic access to the abdominal cavity when staged laparotomies are required
- Removal of pro-inflammatory cytokines and reduction of the systemic inflammatory response by facilitating repeated abdominal lavage (a dedicated effect of NPWT on pathophysiological mechanisms in abdominal sepsis has been suggested as well [9])



Figure 1: Abdominal Compartment syndrome secondary to a pelvic hematoma treated with OA and a commercial NPWT Dressing, Note the temporary loss of domain (Image: C. Heck)

INDICATIONS

Accepted indications for using the OA technique are:

- Severe abdominal infections that require multiple, staged operations for source control
- Acute mesenteric ischemia
- Necrotizing infections of the abdominal wall including the fascia
- Suspected or established Abdominal Compartment Syndrome
- Loss of abdominal wall secondary to major trauma
- Any damage control laparotomy for trauma including simple packing for hemostasis
- Any other situation that will require a second look laparotomy in the next 24-72 hrs.

Methods for Temporary Abdominal Closure

Various methods for temporary abdominal closure (TAC) exist; they vary greatly in resource requirements and reported outcome. The ideal method and materials for TAC should have the following characteristics:

- Protect the viscera and prevent abdominal compartment syndrome
- Protect against heat loss and provide mechanical stability of the abdominal wall
- Provide a means to drain intra-abdominal fluids
- Prevent retraction of the fascia and loss of domain to achieve a high primary facial closure rate while allowing enough expansion of the intra-abdominal volume to prevent IAH and ACS
- Be easy to apply and allow rapid access for abdominal re-exploration
- Allow the patient to be repositioned and mobilized to ease their evacuation and personal hygiene needs, prevent pressure injuries, assist pain management
- Be readily available and affordable

In typical MSF settings, the following TAC methods are applicable and are described below (see Figure 2)

1. Skin only closure
2. Bogota Bag
3. Barkers Technique/Vacuum Pack using abdominal sponges
4. Variations of Bogota Bag or the Barker Technique with mesh mediated fascial traction/closure

Method	Description	Limitations
Skin only closure	Running suture or Multiple towel clips to oppose the skin edges.	▪ Potential for bowel evisceration if large spaces between clips. ▪ Wound permeable to intraperitoneal fluid. ▪ Risk of abdominal compartment syndrome.
Bogota Bag	Pre-sterilized bag (such as sterile IV bag) sewn to the fascia or skin	▪ Loss of abdominal cavity domain. ▪ Low primary fascial closure rate ▪ Fluid accumulation requiring drainage. ▪ Slow to apply.
Barker's vacuum pack	Simple, cheap method of negative pressure closure by placing two drains within sponges/gauze and connecting to suction	▪ Requires some form of continuous or intermittent suction. ▪ Technically demanding ▪ Risk of bowel injury if incorrectly applied
Mesh mediated closure	Prosthetic mesh is used to bridge the fascia, combination with VAC Pac possible	▪ Very slow to apply ▪ Relative high costs ▪ Risk of bowel injury if incorrectly applied ▪ Risk of abdominal compartment syndrome

Fig. 2: practical purposes of TAC methods (adapted from [10])

1. Skin Only Closure

One of the simplest and quickest ways to cover the viscera is to approximate only the skin with a simple running suture or towel clips. This method is quick, readily available and minimizes heat and fluid loss but has a relatively high complication rate. Specific complications include frequent recurrence of ACS (15 -36 %), evisceration of bowel loops, and infection and loss of skin if used over a prolonged time [11].

2. BOGOTA BAG

The Bogota Bag is a low-resource TAC method that is readily available in almost all settings. A non-adherent plastic sheet, fashioned from a sterile IV bags or sterile urine bags, is sutured to the edges of the skin or the fascia using a running suture. Skin staplers should not be used as these can injure the bowel. This technique is not effective in removing fluids from the abdominal cavity but can be combined with abdominal drains for this purpose. The Bogota Bag does not provide any traction for the fascia and primary fascial closure rates are relatively low. There is a risk of evisceration if the sutures tear through the material [12]. Advantages of the Bogota Bag are low costs, high availability, decreased chances of developing an Abdominal Compartment Syndrome and ease of use in conjunction with enterostomies. It is the only method that allows direct observation of the bowel through the dressing in the ward.

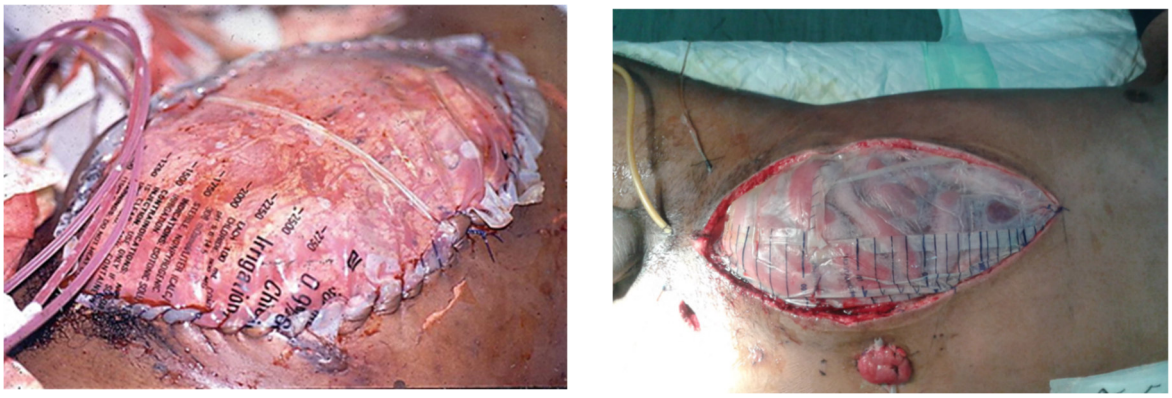


Figure 3: left: sterile urine bag sutured to the skin to create a silo type Bogota bag; right: sterile urine bags tucked under the fascia as a separator for a Barker VAC Pack (image: C. Heck)

3. BARKER TECHNIQUE/VAC PACK

The Barker Technique or VAC Pack as described in 1995 [13] is a modification of the earlier sandwich technique [14]. The original Barker technique consists of:

1. A sterile perforated polyethylene sheet between the abdominal viscera and the parietal peritoneum – this serves as a protective separator
2. Placement of moist abdominal packs over the polyethylene sheet
3. Placement of two closed suction drains over the abdominal pack; the drains are brought out through the skin
4. Placement of an adhesive drape over the entire wound, including a wide margin of the surrounding skin
5. Suction applied to the drains, creating a vacuum and rigid compression of the sandwich layers. Use of wall suction or Redon drains/Jackson Pratt drains described [15]

A variation of this technique uses adhesive plastic film sheets (e.g. Ioban, Opsite) folded over an abdominal pack with the sticky side towards the abdominal pack (See box). This creates a composite dressing that can be placed against the bowel.

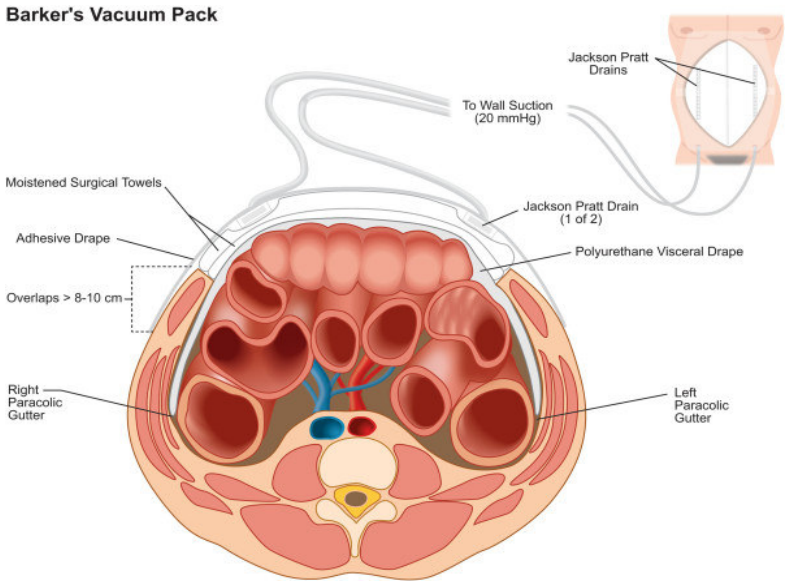


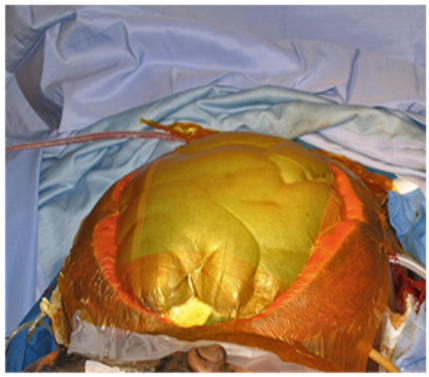
Figure 4: Schematic of Barker Vacuum Pac, Image from [16]; Creative Commons License CC By 4.0, no changes were made to the image

The applied suction allows removal of excess fluid and keeps a moderate amount of tension on the fascia. One study reported primary fascia closure rate of 68.1% with a total complication rate of 15% using the Barker technique [17] The initial method described the use of wall suction with a limitation to -20 mm Hg but other authors have described suction settings up to -150mmHg, the use of passive negative suction drain bellows (i.e. Redon or Hemovac/Jackson Pratt) or electronic regulated pumps for chest drain systems [15]. Faulconer *et al* described a variant the Barker VAC Pack adapted to low resource environments using chest drains connected to a Heimlich valve to maintain the vacuum in the dressing [10]. Because of the valve mechanism, this method does not rely on continuous suction.

Important: The suction should not exceed 20-50 mmHg negative pressure. The SWG currently does not advise the use wall suction without a safety mechanism that limits negative pressure for this purpose due to inherent risks when higher suction levels are used. If wall suction is used, it must allow a reliable calibration not exceeding – 50 mmHg, and nursing staff must be capable to monitor proper functioning of the system and detecting problems. Instead of continuous wall suction, the use of large redon drains or chest tube drains with a Heimlich valve and intermittent manual suctions is recommended. In projects that have access to the Medela Thopaz+ pump or single use chest drainage systems with an in-build security valve that limits excessive negative suction, these can be considered as well (check manufacturer specifications and discuss with technical referents).

As an evolution of the Barker Vacuum Pack, commercial dressing systems where developed (e.g. KCI ABTHERA™), that follow the same principles. Data suggests that these systems result in improved primary facial closure rates and survival compared to the traditional Barker technique [9], [18], [19]. However, costs and maintenance requirements for the proprietary electronic pumps are currently prohibitive for regular use in low resource settings [18]





Figures 5 and 6: two different examples of the Barker VAC Pac, note the different position of drains

Box 1: Creating the VAC Pac/Barker Technique with MSF standard equipment

Technique 1:

- Place a large sheet of sterile, adhesive drape sticky side up on a flat surface
- Place an abdominal sponge on the sticky side, leave some free drape on all the sides
- Fold the edges of the drape inwards, the aim is to create a composite dressing with a membrane on one side and a fluid absorbing pad on the other, do not make perforations in the membrane
- The size should be large enough that, when inserted into the abdominal cavity, the sheet will extend laterally in the paracolic gutters and 5-10 cm cranial and caudal to the incision
- Place the pack with the plastic membrane towards the bowel, tuck margins as far laterally, cranially, and caudally as possible like described above
- Place two large bore Redon-drains or thoracic drains between the sponges OVER the pack, bring them out through separate stab incisions as far laterally as possible
- Use a second large adhesive dressing to cover the incision and abdominal sponges
- Evacuate air and excess fluid, using the surgical suction and check for air leaks before connecting the drains; chest tubes can be used with Heimlich valves to maintain negative pressure
- Connect to continuous suction with 20-50mmHG negative pressure, always use the lowest suction setting possible:
    - Large Redon drain bellows (will need frequent checking and emptying by nursing staff)
    - If chest tubes with a Heimlich valve are used, connect them to a urine bag to collect abdominal fluid, intermittent suction can be applied for example with a large bulb syringe to maintain the vacuum seal
    - Wall suction should only be used with a safety valve limiting negative pressure to under -50mmHg (e.g. single use chest tube drainage system – check with technical referent if applicable)

Technique 2:

- use any sterile soft plastic material cut into shape (e.g. cut from a double packed [!] sterile urine bag or a cut open sterile IV bag, see Fig. 3)
- Tuck the plastic sheet bilaterally into the paracolic gutters- the bowel underlying the incision should be completely covered and the plastic should overlap the incision for at least 5 cm on all sides. If a stoma is present, slit the sheet to tuck it around the stoma

4. MESH MEDIATED FASCIAL TRACTION

Schein et al. [14] described suturing a prosthetic mesh to the edges of the fascia in the original sandwich method for the OA. Many variations evolved using either absorbable or non-absorbable meshes.

The prosthetic mesh bridges the fascia defect and prevents the loss of domain by providing traction on the free edge of the fascia. In conjunction with negative pressure wound therapy, mesh-mediated fascial traction has provided relatively high primary closure rates of 60-100% [20]–[22].

Important: Only absorbable meshes should be used for OA management in MSF projects. Currently, Vicryl mesh is available for this purpose.

In the initial operation, a sterile plastic sheet is placed over the bowel separating the mesh from the viscera and maintain the mobility of the abdominal wall in relation to the intestines. This plastic sheet is changed at every re-laparotomy. Consecutively, the abdominal cavity is entered by incising the mesh in the midline. This incision is closed at the end of every re-laparotomy without compromising the fascia. The mesh can be further tightened by gathering up more material until the fascia comes together with minimal tension and primary fascial closure is completed.

At re-laparotomies, adhesions between the abdominal wall and viscera are carefully divided by gentle finger dissection. Adhesiolysis between bowel loops is not performed to prevent injury and perforation. Over time an intestinal block forms but the abdominal wall remains relatively mobile due to the plastic separator. This method has expanded the time frame for successful primary fascial closure from 7 days to up to 32 days [20] but is highly resource intensive. The complex dressing changes and the stepwise re-approximation of the abdominal fascia require general anaesthesia and should be performed under sterile conditions every 48-72 hours.

Box 2: Using mesh mediated abdominal closure together with the Barker VAC pack with *MSF standard equipment*

- Place a VAC pack or plastic separator on the bowel (see Box 1: *Creating the VAC Pack*)
- Suture a large absorbable Vicryl mesh to the free edge of the fascia using a continuous absorbable suture with a tapered needle, only put gentle tension on the fascia
- Fill the incision with additional packs and place the drains as described above
- On consecutive laparotomies, incise and close the mesh in the midline using a running vicryl suture
- On each consecutive laparotomy, slowly tighten the mesh by gathering up more material in the midline until the fascia comes together with minimal tension for fascial closure
- Before definitive closure, make sure to remove any packs and plastic barriers previously placed in the abdomen!

CHOOSING A METHOD FOR TEMPORARY ABDOMINAL CLOSURE

Outcomes between TAC methods are variable. Data from the International Register of Open Abdomen (IROA) suggest that outcomes differ for trauma and non-trauma indications [6], [23].

Preliminary data from IROA suggest that NPWT methods including Barkers VAC Pack are advantageous in patients with abdominal sepsis while Bogota Bag and skin only closure show better results in a trauma population [28]. However, this non-randomized register data needs to be interpreted with caution.

The recent WSES guidelines for the open abdomen suggest negative pressure wound therapy with continuous fascial traction as a preferred method for TAC, acknowledging that methods without negative pressure (e.g. Bogota Bag) can be applied in low-resource settings, accepting a lower delayed fascial closure rate [6].

Given the very heterogeneous data and the variation in context between MSF projects, the SWG can only give conditional recommendations for TAC in MSF settings. These recommendations are based on the available evidence and expert opinion related to the field context. We recommend discussion of these cases with the relevant surgical advisor of each section if there is doubt in which technique may be best suited to an individual patient.

Factors influencing the choice of TAC are:

- Available resources
- Underlying pathology
- Experience of the surgical team
- Expected duration of OA
- Experience of the receiving facility and the mode of transfer if the patient is transferred with OA

Temporary abdominal closure on the initial laparotomy

In MSF settings, the simplest and fastest method that is feasible with the available resources should be used. Bogota bag or Barker VAC Pack are the preferred methods when there is any risk for ACS. Avoid mesh interposition in the trauma setting on the first laparotomy. Skin only closure is only advisable when there is no concern for increased intra-abdominal pressure/ACS.

Risk factors for ACS include [6] :

- Acidosis with pH ≤ 7.2, lactate levels ≥ 5 mmol/L, base deficit (BD) ≥ − 6 in patients older than 55 years or ≥ − 15 in patients younger than 55 years
- Core temperature ≤ 34 °C,
- Systolic pressure ≤ 70 mmHg,
- Estimated blood loss ≥ 4 L during the operation
- Transfusion requirement ≥ 10 U of packed red blood cells in the pre-, peri- or intraoperative setting,
- Severe coagulation derangements (INR/PT > 1.5 times normal, with or without a concomitant PTT > 1.5 times normal)

Consecutive laparotomies

Re-exploration should be scheduled not later than 24-48 hours after the initial and every consecutive laparotomy. If the patient becomes unstable again, earlier re-exploration must be considered immediately.

During re-laparotomy, carefully finger-fracture adhesions to the abdominal wall but allow adhesions between the bowel loops to form if it does not interfere with source control. Avoid direct contact of the bowel with sponges.

To prevent traumatization of the bowel loops, aggressive adhesiolysis should be avoided on re-laparotomies

The fascia should be closed as soon as possible (see below: ***Definitive Closure of the Open Abdomen***). If tension free, definitive closure is not possible, the Barker technique together with mesh-mediated traction using a Vicryl mesh should be considered (see box 2 above). The mesh can be used as soon as the patient is hemodynamically stable; there is no need for ongoing aggressive fluid therapy or an increased risk of IAH

Postoperative Management of the OA

Monitoring

- Monitor for clinical signs of abdominal compartment syndrome, monitor bladder pressure every 4-6 hours if possible
- Monitor and prevent hypothermia
  (see Manual of Nursing Care Procedures)
- Patients should be managed in a high acuity or ICU setting
- Keep a meticulous fluid balance, including fluid intake, urine output and drain fluids

Fluid management

- Fluid management in the open abdomen needs special attention; over-resuscitation is associated with increased intra-abdominal pressure and failure to achieve primary fascial closure
- Discuss fluid management with the intensivist, overaggressive fluid administration should be avoided after resuscitation
- Depending on patients' condition, try to restrict IV fluid intake to achieve a slight negative balance and reduce bowel edema before closing the OA
- All inputs and outputs should be monitored and documented by the nursing team. This includes the checking of all drainage systems. For further information see: MSF Manual of Nursing Care Procedures
- Patients treated with Barker technique and Bogota bag can be carefully mobilized to a sitting position under close clinical supervision
- To prevent pulmonary complications, nursing with a 30° head elevation (Semi-fowlers) is encouraged in the absence of other contraindications
- Follow standard procedures for prevention of pressure-induced skin and soft tissue injuries (see MSF Manual of Nursing Care)

Nutrition

- All patients with OA are hyper-catabolic and at risk of malnutrition
- OA is no contraindication for enteral feeding as long as the bowel is not left in discontinuity
- Early enteral nutrition should be started as soon as possible in the presence of a viable and functional gastrointestinal tract [6]
- Oral feeding is not contraindication and should be preferred if possible
- Early enteral nutrition has been associated with reduced complication rates and higher primary closure rates in OA [24]
- Enteral nutrition with 20 to 30kcal/kg non-protein calories with 1.5- to 2.5-g/kg proteins per day is usually sufficient to maintain a positive nitrogen balance

Antibiotic Therapy

- There is currently no evidence that OA in itself requires prolonged antibiotic coverage [25]
- Follow MSF guidelines for the underlying pathology

Pain Management

- Treat pain as per MSF protocol in conjunction with the anesthesia team

- Pain assessment should be considered as one of the vital signs that should be (re)assessed and documented by the nursing team.
- The survivability and quality of life of the patient should always be considered, judicious use of palliative/symptomatic rather than curative treatment should be considered as appropriate

Definitive Closure of the Open Abdomen

Direct fascial closure

The abdominal fascia should be closed soon as possible, ideally within 7 days after the initial laparotomy [26]. Early fascial closure is associated with reduced mortality and complication rates [6].

The fascia should be closed as soon as the following conditions are met:

1. Definitive surgical treatment is completed - no further access to the abdominal cavity is planned
2. Patient is hemodynamically stable – no ongoing fluid resuscitation is needed
3. When used for abdominal sepsis: Abdominal source control is achieved
4. Tension free closure is possible, no concerns about Abdominal Compartment Syndrome, ventilation pressure remains normal when closing the abdomen (not exceeding 35mmHG in adults)

In line with recommendations from the European Hernia Society (EHS), a slow absorbable continuous monofilament suture with a wound-length to suture- length ratio of at least 1:4 is recommended [5]. A suture that fits this purpose in MSF projects is PDS strength 1.

In situations with a high risk for surgical site infections, the fascia can be closed, and the skin left open for delayed closure or healing by secondary intention.

If the early fascial closure is impossible after 7 days of OA treatment management options in MSF Settings are:

1. Continuing the OA treatment with continuous or dynamic fascial traction to achieve delayed fascial closure as described above, see ***Box 2*** *Using mesh mediated abdominal closure together with the Barker VAC pack with MSF standard equipment*

2. Planned ventral hernia

Planned ventral hernia

A planned ventral hernia is a viable option in OA complicated by severe illness, persistent infection, or loss of substance of the abdominal wall. Especially in severely ill patients with exhausted physiological reserves or situations where source control is delayed, it can be the preferred approach in the low resource environment.

For a planned hernia, the abdominal cavity is closed either in the form of a primary skin-only closure or a split skin graft covering the viscera (see Fig.6). If tension free closure of the skin is possible, a skin-only closure is performed over the mesh or directly over the viscera. Otherwise, moist dressing changes are continued until granulation tissue has formed. If possible, the bowel should be covered with omentum before closure to protect the intestine during dressing changes [5]. If an absorbable mesh is used it can remain in place and the mesh is allowed to fully integrate into the granulation tissue [12], [15]. The remaining defect is then covered with a split skin graft.

It is of utmost importance to protect the viscera until stable granulation tissue has formed. Injury of the bowel by traumatic dressing changes and adherence of the dressing material are the greatest danger leading to entero-

atmospheric fistula. Depending on the available resources, silicon dressings or perforated polyethylene sheets can be used to protect the bowel. If NPWT therapy is used, the bowel must never be in direct contact with NPWT sponges or gauze dressings.



Figure 6: (From left to right) Burst abdomen after abdominal GSW. Left: multiple attempts to close the fascia, including component separation and a free fascia lata flap had failed in this malnourished and physiologically exhausted patient. Middle: stable granulation after debridement and multiple dressing changes. Right: split skin graft on the intestinal block resulting in a planned ventral hernia. Note: feeding jejunostomy on left abdomen. (Image: C. Heck)

Once the patient has fully recovered physiologically and adhesions are allowed to mature, the abdominal wall defect can be repaired in an elective procedure. Elective abdominal wall reconstructions frequently are challenging procedures following severe intra-abdominal sepsis or trauma and might not be feasible at all in low resource settings.

Other Methods: Component separation technique and myofascial flaps

Component separation (CS) has been used to achieve tension free fascial midline closure in elective abdominal wall reconstruction. Several variations of the technique exist. The original method described by Ramirez includes the creation of bilateral adipo-cutaneous flaps from the incision toward the lateral border of the rectus sheath. A longitudinal incision of the external oblique fascia allows medialisation of rectus muscle and a tension free direct midline closure [27].

Data on the early use of CS for OA closure during the index hospitalization is limited. Two small observational studies with 8 and 16 patients respectively, describe the use of CS in the acute setting [28], [29]. Although some surgeons appreciate the potential of CS, especially in a low resource setting, the available data is still limited and there are concerns about the safety of CS in the acute setting in patients with compromised physiology [5].

Important: Due to the limited clinical data, the technical complexity of the procedure and the additional surgical trauma, the SWG currently does not recommend component separation or other fascio-myoplasty techniques for the early closure of the OA in the field. In individual cases, CS can be discussed with the surgical advisor or referred to telemedicine.

Outcomes and comparison of different TAC methods

Outcomes between TAC methods are variable. Data from the International Register of Open Abdomen (IROA) suggest that outcomes differ for trauma and non-trauma indications [6], [23].

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traction as a preferred method for TAC, acknowledging that methods without negative pressure (e.g. Bogota Bag) can be applied in low-resource settings, accepting a lower delayed fascial closure rate [6].

Complications of the Open Abdomen

Leaving the abdominal cavity open for several days or weeks has physiologic repercussions that must be recognized and managed during perioperative care. Furthermore, early closure of the open abdomen often remains a challenge [7], [31] and failure to achieve early fascial closure is associated with increased mortality, morbidity and prolonged hospitalization [32].

The average rate of primary fascial closure was 62% in a recent systematic meta-analysis [31] . This finding highlights the importance of judicious use of the open abdomen strategy, especially in low resource settings with the absence of higher-level intensive care therapy and advanced temporary abdominal closure (TAC) devices that offer greater safety in protecting the viscera and promote higher primary fascial closure rates.

Specific problems or complications encountered with the OA are:

- Complications secondary to physiologic consequences of the open abdomen:
    - Loss of fluids via the open abdomen wound leading to fluid imbalance
    - Heat loss via the open abdomen wound leading to hypothermia (which can aggravate the patient's condition)
- Entero-atmospheric fistula formation: often secondary to repeated trauma to the intestine
- Secondary intraperitoneal infections
- Bleeding: In cases of incomplete hemostasis, continuous blood loss, especially over the wound edges of the abdominal wall can occur. NPWT may aggravate bleeding, especially if higher negative pressure settings are used [33]
- Failure to achieve early or delayed primary closure of the abdominal fascia, resulting in an abdominal hernia. This is mainly the result of:
    - Retraction of the abdominal wall and fascia edges resulting in loss of domain
    - Development of a frozen abdomen with dense adhesions of the viscera and the abdominal wall
- Abdominal compartment syndrome (ACS): OA aims to prevent and treat IAH and ACS. However, ACS can still occur in the presence of OA [33] especially if skin only closure, mesh mediated fascia traction or negative pressure wound therapy (NPWT) are utilized.

Institutional Monitoring and Data collection

OA is a relatively new strategy in MSF, and we have no data on its utilization and outcome. Therefore, systematic monitoring on an organizational level is necessary.

Report all cases of OA to the relevant surgical advisor/referent for the project in which it is performed. Report information should include:

- Anonymized patient data including sex, age, ASA, relevant comorbidities
- Date of admission and initial laparotomy
- Indication for the OA
- TAC method used
- Time between initial laparotomy and definitive closure
- Observed complications during hospitalization
- Hospitalization outcome

A report template is included in annex 4 of this document.

LITERATURE

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ANNEXES:

Annex 1. Signs and symptoms of abdominal compartment syndrome

A comprehensive discussion of ACS is beyond the scope of this document. For clinical purposes, ACS is defined as repeated or sustained pathological elevation of the intra-abdominal pressure that is associated with new onset of organ dysfunction or failure [1].

Clinical signs and symptoms associated with ACS are unspecific and overlap with other pathologies frequently encountered in critically ill surgical patients such as sepsis and hypovolemic or obstructive shock. Most patients with ACS are severely ill and often already require ventilatory support making the clinical examination difficult.

Clinical signs that might prompt the diagnosis of ACS:

- Worsening abdominal pain
- Abdominal tenderness and distension
- Progressive oliguria despite adequate fluid resuscitation
- Respiratory distress and, if mechanically ventilated, rising ventilation pressure
- Hypotension, tachycardia, distended jugular veins and peripheral edema due to reduced venous return and impaired cardiac function

Measuring intraabdominal pressure

Measurement of the intraabdominal pressure can be done indirectly by measuring the pressure in the urinary bladder. The equipment is the same as for central venous pressure (CVC) measurement. However, there is currently no standard equipment available in MSF and abdominal compartment syndrome can only be diagnosed or suspected on clinical grounds alone.

If equipment for measuring CVC pressure is available, bladder pressure is measured following these steps:

- Clamp the Foley catheter distally to the aspiration port
- Instill 25 ml of sterile normal saline via the aspiration port of the Foley catheter
- A pressure transducer (as part of the multiparameter monitor) or a pressure manometer is connected to the Foley catheter via a 18G needle
- Bladder pressure is measured in end-expiration with the patient in supine position and the transducer or manometer zeroed at the level of the midaxillary line, ensure that muscle contractions are absent

The bladder pressure may not be accurate in the presence of intraperitoneal adhesions, pelvic hematomas, pelvic fractures, abdominal packs, or a neurogenic bladder because accurate measurement requires free movement of the bladder wall [34].

No intra-abdominal pressure can predictably diagnose ACS in all patients. Intraabdominal pressure below 10mmHg makes the diagnosis of ACS highly unlikely while an intraabdominal pressure above 25mmHg is very likely associated with ACS. Intraabdominal hypertension (IAH) is usually defined as sustained or repeated pathological increase of intra-abdominal pressure ≥ 12 mmHg [1]. Note that morbidly obese and pregnant individuals can have chronically elevated intra-abdominal pressure (as high as 10 to 15 mmHg) without adverse sequelae.

Annex 2. Suggested material for OA

Standard Laparotomy set	KSURBABD58S- ABDOMINAL SET, 61 instruments
Basic surgery or Caesarean Section set can be used if only a dressing change is planned for consecutive laparotomies	KSURBSUR27- BASIC SURGERY SET, 25 instruments KSURBCES23- CAESAREAN SECTION SET, 23 instruments
Abdominal sponges/compresses (2-3 packs)	
At least 3-5l of warm sterile irrigation fluid	
2 x Redon Drain System, CH16 Or 2 x Thoracic drain + Heimlich valve Or Tube, silicon autoclavable 8mm	SCTDREDP416-REDON, 450ml, bellows + ALENE NEEDLE ster. s.u. + DRAIN CH16 SCTDTUBE081 TUBE, silicone, autoclavable, int. Ø 8 mm, 10 m
Optional: Electronic NPTW pump (depending on TAC method used, high volume projects, NST Item)	EEMDNPWE11-- THORACIC SUCTION PUMP (Medela Thopaz+)
2x Large sterile adhesive dressing, semipermeable,	ELINDRSAI8456; DRAPE, STERILE, adhesive, to incise, s.u., 84x56cm
Optional: Absorbable Mesh (Vicryl or Dexon), wide pores preferred	SSUTMESA3426 - MESH ABS., flat, knitted, pore 9, 34x26.5cm
Slow absorbable suture for fascial closure	SSUTSAMD1T1 – SUT. ABS. mono PDO 1, needle 1/2, 40mm taper PDO

Annex 3: Useful links to MSF Nursing Care Procedures and SOPs

Pain assessment	- https://msfintl.sharepoint.com/:b:/r/sites/msfintlcommunities/nccg/Manual%20of%20Nursing%20Care/1.5.%20Pain%20Assessment.pdf?csf=1&web=1&e=DbvISJ
Prevention of pressure-induced skin and soft tissue injuries	- Risk assessment procedure: https://msfintl.sharepoint.com/:b:/r/sites/msfintlcommunities/nccg/Manual%20of%20Nursing%20Care/11.2.%20Pressure%20Injuries%20Risk%20Assessment.pdf?csf=1&web=1&e=R12UJV - Skin assessment, prevention and care procedure: https://msfintl.sharepoint.com/:b:/r/sites/msfintlcommunities/nccg/Manual%20of%20Nursing%20Care/11.2.%20Pressure%20Injuries%20Skin%20Assessment%20Prevention%20and%20Care%20V1%202021.pdf?csf=1&web=1&e=gAh4hW
Pain management	- Pain assessment procedure https://msfintl.sharepoint.com/:b:/r/sites/msfintlcommunities/nccg/Manual%20of%20Nursing%20Care/1.5.%20Pain%20Assessment.pdf?csf=1&web=1&e=DbvISJ - Pain management procedure https://msfintl.sharepoint.com/:b:/r/sites/msfintlcommunities/nccg/Manual%20of%20Nursing%20Care/12.5.%20Pain%20management%20V1%202021.pdf?csf=1&web=1&e=6WWJY

Annex 4: MSF data collection template and follow-up forms for patients with an open abdomen

Institutional Monitoring and Data collection

1. Hospital/Country: Ward/Unit:
2. No. ID patient Initials Only:
3. Gender: Age: ASA:

4. Indication for Open Abdomen / Temporary Abdominal Closure (TAC):
   A. Damage control surgery
   B. Generalized peritonitis due to ruptured bowel
   C. Abdominal compartment syndrome
   D. Others: specify cause _____

5. TAC method used (check box or specify if others)

   □ Bogota Bag □ Skin only □ Barker VAC □ Mesh interposition

6. Antibiotics:
   There is currently no evidence that OA requires prolonged antibiotic coverage. Follow MSF guidelines on antibiotics for the underlying pathology.

   □ no antibiotic therapy used □ antibiotic therapy used (indicate which one and why)

_____
_____
_____
_____

7. Definitive closure performed: □ Yes □ No

   If yes describe closure type:

   - □ Direct fascial closure
   - □ Planned hernia:
     - o Skin only
     - o Split skin graft
   - □ Other (specify) :

   If no definitive closure achieved, describe reason:

_____
_____
_____
_____

8. Time between initial laparotomy and definitive abdominal closure (specify hours/days if possible):

9. Date of hospital admission and initial laparotomy DD/MM/YYYY:
_____

10. Observed complications during hospitalization
    A. Abdominal compartment syndrome
    B. Enteric fistula
    C. Retraction of the fascia
    D. Wound dehiscence.

Others (specify)
_____
_____
_____

11. Hospitalization Outcome:

□ Death
□ Discharged alive
□ Referred to another facility
□ Permanent Sequelae □ No □ Yes

(Describe)_____

12. Date of Discharge DD/MM/YYYY:

_____