

# Current understanding in source control management in septic shock patients: a review

Leonel Lagunes<sup>1,2</sup>, Belen Encina<sup>3</sup>, Sergio Ramirez-Estrada<sup>3</sup>

<sup>1</sup>Critical Care Department, Hospital Especialidades Médicas de la Salud, San Luis Potosi, Mexico; <sup>2</sup>Medicine Department, Universitat Autònoma de Barcelona (UAB), Barcelona, Spain; <sup>3</sup>Critical Care Department, Vall d'Hebron University Hospital, Barcelona, Spain

*Contributions:* (I) Conception and design: All authors; (II) Administrative support: All authors; (III) Provision of study materials or patients: All authors; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Leonel Lagunes, MD. Critical Care Department, Hospital Especialidades Médicas de la Salud, San Luis Potosi, Mexico.

Email: leonel.lagunes@gmail.com.

**Abstract:** Sepsis and septic shock is one of the leading causes of death worldwide. Antibiotics, fluid resuscitation support of vital organ function and source control are the cornerstones for the treatment of these patients. Source control measures include all those actions taken in the process of care to control the foci of infection and to restore optimal function of the site of infection. Source control represents the multidisciplinary team required in order to optimize critical care for septic shock patients. In the last decade an increase interest on fluids, vasopressors, antibiotics, and organ support techniques in all aspects whether time, dose and type of any of those have been described. However information of source control measures involving minimal invasion and new techniques, time of action and outcome without it, is scarce. In this review the authors resumes new information, recommendations and future directions on this matter when facing the more common types of infections.

**Keywords:** Source control; sepsis; septic shock; intra-abdominal sepsis; skin; soft tissue infection; empyema

Submitted Aug 01, 2016. Accepted for publication Aug 28, 2016.

doi: 10.21037/atm.2016.09.02

View this article at: <http://dx.doi.org/10.21037/atm.2016.09.02>

## Introduction

Source control is an old term that makes reference to one of the oldest way for controlling an ongoing infection, records from ancient Egypt already mentioned the drainage of thoracic abscess as a source control measure (1). It involves all physical actions taken in the process of care to control a focus of infection and subsequently reduce the favorable conditions that promote microorganism growth or that keep impaired host defenses (2). The importance of source control has been retaken with the surviving sepsis campaign (3), however last recommendations (4) only make four statements on this matter, with low evidence grade endorsing a gap of 12 hours for its achievement when feasible. Most recent studies make emphasis in antibiotics (time, dose) organ support therapies, reanimation (crystalloids versus colloids, vasopressors) and more recently

adjuvant strategies for septic patients, however evidence in the oldest manner to control an infection is scarce. Source control is a cornerstone in the treatment of infectious diseases and it becomes an urgent matter in septic shock patients. Here the authors present a review on the rationale of source control, recent recommendations in this matter and future directions for trials or research.

## Rationale for source control

The process of infection is a complex state that involves both microorganism and host mechanisms to prevail. A local initial inflammatory response attracts neutrophils, macrophages, and other phagocytes promotes the release of cytokines such as IL-8, IL-1 and the activation of the coagulation cascade. In some cases this is accompanied by liquefaction necrosis and the release of pus with replicating

microorganism in this site. Defensive host responses include the formation of fibrin deposits to shield healthy tissues from the dissemination, establishing an abscess (5). This abscess will protect both host and bug, where no drug will penetrate well enough to control the infection. Some other forms of persistent foci of infection have become evident with advances in modern care, aging, comorbidities, invasive procedures, chronic care facilities and in day hospitals have made that some specific population could present differently from abscess alone or with multidrug resistant microorganisms.

This local, initial process is common for almost all complicated soft tissue infections and some of intra-abdominal septic shock patients, and is what gives the basis for source control in those, whereas (I) drainage of infected fluid collections; (II) debridement of infected solid tissue and the removal of devices or foreign bodies; and (III) definitive measures to correct anatomic derangements resulting in ongoing microbial contamination and to restore optimal function conform actions included under this definition and will contribute on outcome (6,7).

### Soft tissue and skin infections

This kind of infections represent the third most frequent cause of severe sepsis and septic shock following pneumonia and intra-abdominal infections (IAIs) in some series (8,9), but one of those that source control measures can be more evident. The spectre of diseases that are included in this group can presents differently and so categorized, according to causative microorganism, or extension or clinical symptoms. A clinical categorization depending on presence of septic shock and the urgency of requirement for surgical procedures in order to achieve source control has been described (10) with worst outcomes in those with inadequate therapy and sepsis. Source control in these infections comprises since topical actions, incision and drainage, debridement, up to amputation. Patients at intensive care unit (ICU) with severe soft tissue and skin infection are mostly represented by those with necrotizing fasciitis (NF), and many times with organ failure associated. Recent recommendations on the approach regarding NF (11) states that in uncertain cases time should not be wasted in extensive clinical diagnosis, or scoring severity of the patient or hesitating on extension of the first incision. A deep incision up to the fascia should be performed and if NF is diagnosed, radical debridement should be implemented. Recent guidelines (12,13) on the management of soft tissue

and skin infections make recommendations on prompt and extensive surgery, and a second debridement when necessary to discard ongoing local extension, among the use of broad spectrum antibiotics. Seems prudent that, whenever possible, source control should be attempted as soon as foci is detected. A delayed first surgical intervention (more than 12 hours) is associated with higher mortality (14), however in a recent report (15) an early intervention (less than 6 hours from diagnosis) was associated with shorter ICU and hospital length of stay but no statistical differences in mortality were founded between early and late surgery. Antibiotics should be given as any septic shock patient in the first 6 hours, and administration of clindamycin is highly recommended in order to inhibit exotoxin production of Gram-positive bacteria. Duration of antibiotic treatment can be between 7–14 days according to guidelines (12,13).

### IAIs

IAIs are the second cause of admission to the ICU in large series (16,17). The number of cases of peritonitis that required admission to an ICU due to organ failure had remained stable during time both community-acquired and nosocomial-related, however this latter group seems to be increasing in recent reports (18). IAI commonly represents the other group of septic shock patients that have an identified foci of infection where source control actions become feasible besides skin and soft tissues infection (7,19–21). As any other supportive action in septic shock patient time is an urgent matter. Time between admission and source control in IAI has been assessed as a critical determinant of survival in patients with GI perforation with associated septic shock (22), and in some intra-abdominal candidiasis cases (23), however in these reports “early” goes from 2 hours up to 5 days.

The quality of source control is difficult to evaluate (24,25) IAIs without it, mortality probably could reach up to 100% (26). The appropriate interventions to determine the adequacy of source control are dictated by the clinical circumstances. High risk patients as such in septic shock with high doses of inotropes or requiring other supportive measures could benefit for new approaches. Nowadays minimal invasive procedures including percutaneous and endoscopic treatments have been described for non-severe cases. It may have a role in well localized abscesses or in surgical inaccessible abdomen. Recent recommendations on source control and peritonitis use the term “damage control” surgery for this kind of critically ill patients with

**Table 1** Source control actions recommended in skin and soft tissue and intra-abdominal infections

Skin and soft tissue infections
Device removal
Incision and drainage
Limited debridement for maximum preservation of vital tissue
Extended debridement for removal of all infected and necrotic tissue
Amputation
Intra-abdominal infection
Prevention in the surgical incision
Drainage of abscesses
Debridement of infected necrotic tissues
Removal of potential infected devices
Extensive intra-abdominal cleansing for decrease peritoneum inoculum
Second time abdominal wall closure
Non-pneumonic thoracic infections
Bedside image assessment (thoracic ultrasound)
Thoracentesis
Placement of chest tubes
VATS or open thoracotomy for chronic/loculated cases

VATS, video assisted thoracoscopy surgery.

inaccessible abdomen (26). Surgery gives opportunity to take first local microbiological samples however some interventions may cause further complications and risk factors associated with the procedures. Current guidelines on the management of IAIs (21,27) discourage systematic reoperations as routine practice. In the other hand assuming risks for patients in septic shock to be carried to the operating room (OR) and the best moment for to take this measures is difficult to assess and evaluate, transfer, surgery, anaesthesia are some of the key players to address. *Table 1* resumes source control actions in skin and soft tissue and IAIs.

### Non-pneumonic thoracic infection

Pleural infection is a non-rare complication for pneumonia, almost 20% of these empyema episodes will require surgical

intervention as source control measure (28). Every patients presenting with a pleural effusion in association with sepsis or pneumonic illness require a prompt diagnostic pleural fluid sampling. In recent years, to employ thoracic ultrasound at the bedside to determine the presence of effusions especially in septic shock patients at the ICU has increased. It is a safe, fast and effective tool to determine volume and accessibility in order to drain abscesses or pleural infected effusions. Recent recommendations on this matter (29,30) suggested as first approach the use of thoracic ecography, following diagnostic sampling thoracentesis, and if necessary the placement of a chest tube. The role of video assisted thoracoscopy and open thoracotomy can be reserved for those chronic or loculated cases.

Mediastinitis is a more difficult to approach infection due to anatomical difficulties, there are discrepancies whether time and surgical approach will lead to better outcomes. A recent large review of descending necrotizing mediastinitis (31) suggested that a prompt and aggressive surgical treatment was related with survival and in extended cases the transthoracic approach was recommended.

### Urinary tract infections

This group of infections account for the third or fourth group of infections admitted to the ICU depending on different reports. It seems of common sense that in those where an abscess is identified or where an obstruction in the usual urinary flow (obstructive pyelonephritis) is the responsible for the infection; the prompt action taken to solve this (drainage or lithotomy and placement of catheters) are recommended as source control measures as mentioned above. A concerning issue are the catheter associated urinary tract infections a common problem in both ICU and non-ICU patients (32) more so because of it probability of preventing it. However a recent multicenter analysis (33) based on an educational program addressing many of the factors involved in this type of infection showed that these programs are efficient only on non-ICU patients when compared to ICU patients in decreasing both use and related infection.

Some other sites of infection such as pneumonia, or bacteremia have a more difficult to achieve source control goals, so probably in this patients, the importance of the correct and prompt initiation of antibiotics along with support measures have a larger effect in their outcome, however further trials are required in this matter.

## Conclusions

Source control remains as a cornerstone in the treatment of septic shock patients. IAI along with soft tissues infections are the sites where a rapid source control seems more feasible. Recommendations and educational efforts should advise a more prompt achievement of source control.

## Acknowledgements

None.

## Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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**Cite this article as:** Lagunes L, Encina B, Ramirez-Estrada S. Current understanding in source control management in septic shock patients: a review. *Ann Transl Med* 2016;4(17):330. doi: 10.21037/atm.2016.09.02