Selective Gut Decontamination in Intensive Care and Surgical Practice: Where Are We?

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Abstract. Selective decontamination of the digestive tract (SDD) has been widely studied in the intensive care setting. Despite the publication of more than 50 controlled trials, it remains a controversial subject, with widely disparate views on the role of SDD. This article reviews the use of SDD primarily by examining the areas of controversy. The published data seem to show clear evidence that SDD can reduce acquired infection during intensive care. Most individual studies have shown no effect on mortality, but meta-analyses suggest a 10% overall reduction in mortality. Despite the large number of publications to date, there remain several aspects worthy of further study.

There is considerable background literature dealing with the successful use of selective decontamination of the digestive tract (SDD) in severely immunocompromised patients [1–3]. SDD is a prophylactic strategy designed to prevent or minimize the impact of acquired infection. The regimen was introduced to intensive care use by a group from Groningen, The Netherlands, with the first publication in 1983 [4].

More than 50 controlled trials using SDD have been reported. The results of these trials have been discussed in consensus meetings and evaluated in various surveys in microbiologic, pharmaceutical, and critical care journals. In addition, four meta-analyses have been reported [5–8]. Despite this extensive evaluation, to which other techniques used for intensive care have not been exposed, the role of SDD remains controversial. Some of the reasons for this controversy are as follows:

1. Only a few studies have demonstrated a difference in mortality.
2. Not all of the SDD trials were performed in a double-blind fashion.
3. A wide variety of techniques were used in the studies for the diagnosis of pneumonia, the commonest infection in the target group.
4. In general, the use of both parenteral and topical antibiotics is linked to the development of antimicrobial resistance, and there were therefore significant worries about the impact of SDD on resistance.
5. The medications used in the standard SDD regimens have never been combined as one product by a commercial company. This situation has led to medications from a variety of

sources being used including the oral administration of expensive drugs prepared for intravenous administration.

It is not the aim of this report to provide an exhaustive review of the extensive literature to date. Such information can be obtained from the meta-analyses mentioned above or previously published review articles [9, 10]. Rather, it is our intention to discuss the role of SDD in intensive care and surgical practice, particularly examining areas that remain controversal.

Infection rates of 18% to 46% have been reported for general intensive care units (ICUs) [11–14]. There is a high incidence of unit-acquired infection, and surveys have shown that the incidence of unit-acquired infection increases with the length of stay, in one study exceeding 80% in patients admitted for 5 days or more [11].

Classification of Infections

In broad terms infections may already be present or incubating at the time of admission to the ICU; alternatively, they can be unit-acquired. Organisms causing acquired infections frequently colonize the gastrointestinal tract of the patient prior to causing infection of an adjacent organ system. To a large extent SDD is aimed at minimizing or preventing this carrier state.

The terms exogenous, primary endogenous, and secondary endogenous have been used to classify intensive care infections. Although not universally used, these terms are useful as they help focus attention on which aspects of hygiene and infection control are important in preventing various types of infection.

Exogenous infection is relatively rare (comprising up to 20% of ICU infections) but may occur at any time during intensive care admission. The term describes the direct contamination of a normally sterile organ system by organisms from an external (exogenous) source. An example is development of pneumonia after bronchoscopy carried out with a contaminated endoscope. Another is contamination and infection of an open wound due to poor hygiene measures.

Primary endogenous and secondary endogenous infections are both caused by organisms carried in the oropharynx or gut of the patient prior to contamination and infection of adjacent organ systems, such as the respiratory tract or urinary tract. *Primary endogenous* infections are caused by organisms carried in the

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throat and gut on admission to intensive care. Such infections usually occur early during ICU admission. An example is *S. aureus* pneumonia developing in a previously healthy young adult on the second or third day following trauma, as a result of aspiration. *Secondary endogenous* infections are caused by organisms not carried by the patient on admission to the ICU, but again infection of an organ system is preceded by acquisition and colonization within the digestive tract. For example, a trauma patient free from *Pseudomonas* on admission to the ICU may have acquired it there (from other patients) and following a period of oropharangeal carriage subsequently develop pseudomonal respiratory tract infection.

Strategies for control or prevention of these three patterns of ICU infection should be considered for each pattern of infection separately. The key to preventing exogenous infection is a high standard of hygiene including disinfection, sterilization of equipment, hand-washing, and careful aseptic technique throughout the ICU stay. Primary endogenous infection cannot be prevented by normal hygiene measures; Primary endogenous pneumonia, for instance, would be caused by aspiration of oropharyngeal contents, perhaps prior to ICU admission. Some SDD regimens include parenteral antibiotics for the first 3 to 4 days as prevention/treatment of primary endogenous infection. Secondary endogenous infection is often caused by organisms acquired from other patients in the ICU. Therefore traditional hygiene measures including hand-washing do have a role to play. It is known from many studies that most patients in the ICU show significant colonization of the oropharynx with Enterobacteriaceae and *Pseudomonas*. Through topical application of antibiotics within the gastrointestinal tract, SDD aims to prevent the acquisition and carriage of these gram-negative organisms, thereby preventing secondary endogenous infection.

It is important to recognize that SDD has an effect only on secondary endogenous infections. If hygiene measures on a unit are poor and there are a significant number of exogenous infections, SDD is unlikely to have a significant impact on the total incidence of infection. Furthermore, some patient groups, such as trauma patients, have a high incidence of primary endogenous infection, and parenteral antibiotics are required in addition to SDD to prevent and treat infection in such groups.

Selective Decontamination of Digestive Tract

To What Can SDD Be Compared?

There is a widely held view that SDD, representing the widespread, routine use of both topical and parenteral antibiotics, must result in an increased selection pressure for the development of microbial resistance. This fear is based on a false premise because in a traditionally managed ICU considerable quantities of parenteral antibiotics are used therapeutically. We should not be comparing the SDD regimen to a situation in which antibiotics are not used. In an incidence study on a large number of ICUs Meers et al. reported that at any given time 60% of all patients on a general ICU were receiving parenteral antibiotics [15].

The original report on SDD in the ICU in Groningen described a regimen based on polymyxin E, tobramycin, and amphotericin B (PTA), the most widely studied and accepted regimen (Table 1). This original regimen included cefotaxime administered intravenously for the first 4 days of the ICU admission. Evaluation of the

Table 1. Prophylactic regimen based on a combination of topical and systemic antimicrobials.

Topical antimicrobials (PTA regimen): administered throughout the ITU stay
Oropharyngeal cavity: A small volume of a 2% mixture of polymyxin E, tobramycin, and amphotericin B in a paste with carboxymethylcellulose (Orobase) is applied to the buccal mucosa with a gloved finger 4 times daily.
Gastrointestinal canal: 9 ml of a suspension of polymyxin E 100 mg, tobramycin 80 mg, and amphotericin B 500 mg is administered via the gastric tube 4 times daily.
Systemic antimicrobial: administered for the first 4 days of the ITU stay.

PTA: polymyxin/tobramycin/amphotericin; ITU: intensive therapy unit.

published trials is difficult because of the number of variations on this original regimen that have been used. For instance, tobramycin has been substituted by gentamicin, amphotericin by nystatin, absorbable quinolones have been used in place of the essentially nonabsorbable polymyxin and tobramycin, some trials omitted the application of SDD to the oropharynx, and some trials did not use a systemic antibiotic as part of the regimen.

These variations make it difficult to compare results. Fortunately, more than half of the published trials have used the original PTA regimen. An extension of the analysis carried out in one of the meta-analyses [6] suggests that the results from trials using a PTA regimen are better than results from other studies.

Effect on Colonization

A primary aim of SDD is to treat or prevent the acquisition and carriage of pathogenic gram-negative bacteria in the gastrointestinal (GI) tract. Most but not all studies reported sufficient surveillance cultures to allow definition of colonization rates.

As reviewed earlier [9], trials have shown remarkably consistent results in regard to colonization rates despite variations in trial design. Typically, the studies revealed pathogenic gram-negative colonization of the oropharynx and upper GI tract in the control groups, increasing from 10% to 40% on admission to 50% to 100% colonization by 1 week. In all studies reviewed, SDD achieved a consistent reduction in colonization, with rates varying from 0 to 5% at 1 week. Rectal colonization with pathogenic gram-negative bacteria was also consistently reduced, but it took longer to achieve and was never as complete as oropharangeal decontamination. Generally, it appeared to take 10 to 12 days for a significant improvement in rectal colonization rates, presumably related to various degrees of ileus with prolonged transit times.

Gastrointestinal colonization with yeasts have also been reported in some studies [16–19]. In these studies 10% to 20% of study patients had yeast colonization at study entry. This level remains static in the control group but was reduced to almost zero in the treated patients by the fourth to fifth day.

These results indicate that SDD can indeed reduce gram-negative colonization of the GI tract. Published data also suggest that this effect is selective in that normal commensal organisms are not affected.

Table 2. Respiratory infection in trials of SDD using protected catheter techniques for diagnosis.

Study	No. events/ no. entered		Odds ratio	95% CI
	Treatment	Control		
Brun-Buisson [20]	3/65	6/68	0.52	0.13–1.99
Ferrer [21]	7/39	9/41	0.78	0.26–2.32
Korinek [22]	20/96	37/95	0.42	0.23–0.78
Wiener [23]	8/30	8/31	1.04	0.34–3.24
Winter [24]	3/91	17/92	0.21	0.08–0.54
Total	41/321	77/327	0.46	0.31–0.70

From Liberati [25], with permission.

Effect on Infection

It seems reasonable to judge SDD on the basis of the effect on acquired infection in the ICU. Reduction of acquired infection is, after all, the primary aim behind the regimen. Whether morbidity, as distinct from mortality, should be the endpoint for such trials is discussed in the next section. The effect of SDD on infectious morbidity is clear, and even critics of the regimen do not claim that it is ineffective in this respect. Of the trials published, only two failed to show a reduction in infectious morbidity in the treatment group compared to the control group, and in most of the studies the reduction of infection with SDD was statistically significant.

The four meta-analyses [5–8] report a significant reduction in infection, particularly in the lower airways, where a reduction of up to 65% was reported. The methodology used for the diagnosis of pneumonia in SDD trials has varied widely and been a source of criticism and controversy. In some early studies, such as the study by Ledingham et al. [16], pneumonia was diagnosed on purely clinical grounds. It undisputedly led to a relatively high incidence of pneumonia, but it should be pointed out that the difference between SDD and control groups remains valid because the criteria used were the same for the two groups. Critics of SDD have claimed that the diagnosis of pneumonia should be based on protected specimen techniques (protected specimen brush or bronchoalveolar lavage). Whether such protected techniques should be adopted as the gold standard for the diagnosis of pneumonia remains controversial. Certainly at the moment most ICUs do not use such techniques routinely. In total, five SDD trials have been reported in which protected catheters were used for the diagnosis of respiratory tract infection [20–24]. In a meta-analysis the pooled data from these studies resulted in a total of 321 patients in the SDD groups and 327 in the control groups [6]. Pneumonia was significantly reduced in the SDD group, by 54% (Table 2).

Effect on Mortality

One of the major criticisms leveled at SDD is that despite producing a significant reduction in acquired infection it has, in most studies, not produced a reduction in mortality. This immediately raises the question: To what extent does acquired infection on the ICU contribute to mortality? It is clear that most patients dying of multiple organ failure die with infection present, but in some patients it is not clear whether the patients were dying *with* or *of* infection. The commonest acquired infection on the ICU is pneumonia, but there is remarkably little hard evidence indicating to what extent pneumonia acquired on the ICU contributes to mortality. Clear associations between the incidence of acquired pneumonia and increased mortality have been reported [26–28], but it remains uncertain whether a patient succumbs because of the acquired pneumonia or the infection is merely a marker of the patient's physical deterioration eventually leading to death. One retrospective case-control study demonstrated an attributable or mortality risk ratio for acquired pneumonia of 2.0 (it was 2.5 when acquired pneumonia was caused by *Pseudomonas* species or *Acinetobacter* species) [29].

Most individual studies are simply not large enough to have a chance of showing any mortality difference. A few studies have shown a significant reduction in mortality. The study by Rocha et al. included 101 patients with more than 3 days of mechanical ventilation and more than 5 days of ICU admission without infection at the time of randomization; this group showed a significant reduction in mortality with SDD [30]. The four meta-analyses examine only the randomized SDD trials. The largest of the meta-analyses [6] reported a nonsignificant 10% overall reduction in mortality. The meta-analysis has subsequently been updated with a total of 33 evaluable trials included and the overall mortality reduction is now 12%, with confidence intervals of 0.78 to 0.99, suggesting significance (Table 3). Furthermore, a subanalysis of 16 trials in which the full topical plus systemic regimen was compared with a control group with no prophylaxis revealed a greater reduction in mortality (20% with confidence intervals of 0.68 to 0.93) (Table 4).

There is currently considerable discussion about the use of mortality as an endpoint on the ICU. It has arisen largely as a result of the negative sepsis trials. The arguments against the use of mortality as an endpoint were set out by Petros et al. [50]. Patients on a general ICU comprise a heterogeneous group. Many factors contribute to mortality, and the death of a patient may be remote from an acquired infection early during the stay on the ICU. The problem with the arguments against the use of mortality as an endpoint is that we have no alternatives that offer the same clear cutoff.

In summary, the larger meta-analyses suggest a small but clinically important reduction of mortality with SDD. It is also clear that the chance of showing a mortality difference in individual trials, even large multicenter trials, is remote.

Effect on Costs

Despite the large number of studies examining SDD, there are unfortunately no adequate cost-benefit analyses of the regimen yet performed. The costs for topical nonabsorbable PTA may vary from country to country. In some countries, polymyxin E and tobramycin can be purchased in bulk at relatively low prices. Suspensions of the drugs and the paste or gel are prepared by the local hospital pharmacy, and in the United Kingdom the current cost of the PTA antibiotics is £17 per patient per day. In other countries antibiotics designed for intravenous use are used for the topical application, significantly increasing the cost. This situation has led to widely varying estimates on the cost of the regimen. A

Table 3. Mortality during SDD trials.

| Study | No. events/no. entered | | Odds ratio | 95% CI |
	Treatment	Control		
Aerdts [31]	4/28	12/60	0.68	0.22–2.17
Blair [32]	24/161	32/170	0.76	0.43–1.34
Boland [33]	2/32	4/32	0.48	0.09–2.57
Brun-Buisson [20]	14/65	15/60	0.97	0.43–2.20
Cerra [34]	13/25	10/23	1.40	0.46–4.29
Cockerill [35]	11/75	16/75	0.64	0.28–1.46
Ferrer [21]	15/51	14/50	1.07	0.45–2.52
Finch [36]	15/24	10/25	2.42	0.80–7.32
Gastinne [37]	88/220	82/225	1.16	0.79–1.70
Gaussorgues [38]	29/59	29/59	1.00	0.49–2.05
Hammond [39]	34/162	31/160	1.10	0.64–1.90
Jacobs (unpublished)	15/35	19/35	0.64	0.25–1.62
Jacobs [40]	14/45	23/46	0.46	0.20–1.06
Kerver [18]	14/49	15/47	0.85	0.36–2.03
Korinek [22]	22/96	17/95	1.36	0.67–2.74
Laggner [41]	9/33	14/34	0.54	0.20–1.48
Lenhart [42]	52/265	75/262	0.61	0.41–0.91
Lignau (unpublished)	13/90	17/177	1.62	0.73–3.62
Lignau (unpublished)	9/90	17/177	1.05	0.45–2.46
Quinio [43]	12/76	10/73	1.18	0.48–2.91
Palomar [44]	14/50	14/49	0.97	0.41–2.32
Pugin [45]	10/38	11/41	0.97	0.36–2.63
Rocha [30]	27/74	40/177	0.54	0.28–1.02
Rodrìguez-Roldàn [46]	5/14	7/17	0.80	0.19–3.34
Sanchez-Garcia [47]	51/131	65/140	0.74	0.46–1.19
Stoutenbeek (unpublished)	42/201	44/200	0.94	0.58–1.51
Stoutenbeek [17]	2/49	8/42	0.22	0.06–0.82
Ulrich [19]	22/55	33/57	0.49	0.24–1.03
Unertl [48]	5/19	6/20	0.84	0.21–3.32
Verhaegen (unpublished)	45/220	40/220	1.16	0.72–1.86
Verhaegen [49]	47/220	40/220	1.22	0.76–1.95
Wiener [23]	11/30	15/31	0.62	0.23–1.71
Winter [24]	33/91	40/92	0.74	0.41–1.34
Total	723/2873	825/3099	0.88	0.78–0.99

From Liberati [25], with permission.

Table 4. Mortality during trials using full topical systemic regimen.

| Study | No. events/no. entered | | Odds ratio | 95% CI |
	Treatment	Control		
Aerdts [31]	4/28	12/60	0.68	0.22–2.17
Blair [32]	24/161	32/170	0.76	0.43–1.34
Boland [33]	2/32	4/32	0.48	0.09–2.57
Cockerill [35]	11/75	16/75	0.64	0.28–1.46
Finch [36]	15/24	10/25	2.42	0.80–7.32
Jacobs [40]	14/45	23/46	0.46	0.20–1.06
Kerver [18]	14/49	15/47	0.85	0.36–2.03
Lenhart [42]	52/265	75/262	0.61	0.41–0.91
Palomar [44]	14/50	14/49	0.97	0.41–2.32
Rocha [30]	27/74	40/177	0.54	0.28–1.02
Sanchez-Garcia [47]	51/131	65/140	0.74	0.46–1.19
Stoutenbeek (unpublished)	42/201	44/200	0.94	0.58–1.51
Ulrich [19]	22/55	33/57	0.49	0.24–1.03
Verhaegen (unpublished)	45/220	40/220	1.16	0.72–1.86
Verhaegen [49]	47/220	40/220	1.22	0.76–1.95
Winter [24]	33/91	40/92	0.74	0.41–1.34
Total	417/1721	503/1772	0.80	0.68–0.93

From Liberati [25], with permission.

good cost-benefit analysis including assessment of infectious morbidity would be a useful addition to the literature on SDD.

Effect on Microbial Resistance

Since the introduction of SDD to the ICU there has been understandable concern about the possible development of microbial resistance as a result of the routine administration of large quantities of antibiotics. As already pointed out, this concern ignores the fact that in a traditionally managed ICU most patients are, at any given time, receiving intravenous antibiotics.

The PTA regimen, though probably the best available, is not ideal. It covers a wide spectrum of pathogenic gram-negative aerobic bacilli, but it has a few areas of weakness related to intrinsic resistance. *Serratia* species and *Acinectobacter* species may be resistant to tobramycin. Polymyxin E is inactive against *Proteus* and *Morganella* species. *Acinetobacter* species and many pseudomonads are often resistant to cefotaxime. *Pseudomonas cepacia* is resistant to both tobramycin and polymyxin E. Polymyxins are rarely used parenterally; and although they are often used topically, the development of resistance is rare. Also, plasmid-encoded resistance to polymyxin has not been reported. Tobramycin, however, is vulnerable to plasmid-encoded aminoglycoside

resistance. To date, the intrinsic weaknesses in the regimen have not been a problem clinically, but it should be emphasized that the use of an SDD regimen requires rigorous surveillance cultures to ensure early detection of drug-resistant strains and allow prompt institution of control procedures if required.

Evaluation of acquired antimicrobial resistance in an ICU is complex. Calculating percentages of resistant strains may give a false impression. For example, if the total number of *Pseudomonas* isolates has been reduced by SDD, a few resistant strains might represent a substantial proportion of the total number of isolates, even though there is a decrease in absolute numbers. Furthermore, if the number of isolates is counted, rather than the number of patients with a given isolate, a false impression can be obtained. For example, a patient colonized with a resistant isolate staying on the ICU for several weeks may result in a large number of isolates being reported, but essentially we are dealing with the situation of one organism in a single patient. This phenomenon is known as "copy strains." In a recent review 42 trials of SDD were evaluated, and 24 were found in which resistance had been examined [51]. Of the 24 studies, 22 showed no increase in resistance. Two studies [30, 52] reported emergence of resistance against the parenteral component cefotaxime and the oral non-absorbable tobramycin among *Staphylococcus aureus* infections in the patient groups receiving SDD. It is unclear from the two studies whether the analysis excluded "copy strains."

The PTA regimen is not active against coagulase-negative staphylococci and enterococci. Selection and possible overgrowth of such microorganisms is a consequence of SDD. The PTA regimen also increases selection pressure on methicillin-resistant *S. aureus* (MRSA), which is a potentially serious problem if the organism is present on the ICU. If early surveillance cultures reveal MRSA, two options are suggested: (1) addition of oral vancomycin to the PTA regimen and (2) withdrawal of SDD [53].

Although there have been no significant problems to date with antimicrobial resistance resulting from SDD usage, it is important to maintain a high level of awareness. Certainly surveillance

cultures play an essential role in the application of an SDD regimen.

Specific Categories of Patients

Several studies of SDD with *liver transplantation* have been reported. A study by Arnow et al. [54] is typical. These authors reported a lower incidence of infection in patients undergoing the SDD regimen for 3 days or more prior to transplantation. A problem is that the regimen is less applicable to urgent cases. In addition, it is usually thought necessary to add ampicillin or another agent to cover enterococci in these patients.

In patients with *head and neck cancer*, mucositis following therapeutic irradiation is a significant problem, leading to pain and difficulty eating, drinking, and speaking. At least two studies have examined the use of SDD in the prevention of mucositis and reported a significant reduction in the incidence of the problem [55, 56].

In patients with *severe acute pancreatitis* SDD has been used to prevent infection of pancreatic necrosis. It is believed that infection of pancreatic necrosis occurs at least partly due to translocation from the GI tract. In a controlled trial SDD was reported to reduce gram-negative colonization of the digestive tract, preventing subsequent pancreatic infection and significantly reducing morbidity and mortality [57].

There is currently interest in the role of gut-derived endotoxemia in the systemic inflammatory response syndrome. In a human volunteer study SDD has been shown to reduce significantly intestinal endotoxin concentrations [58]. Although SDD causes killing of gram-negative bacteria, endotoxin levels were reduced because of binding to polymyxin. The use of SDD has been reported in patients undergoing elective *esophageal resection* with a reported reduction in postoperative infections [59].

It was used in a small study of patients undergoing *cardiac surgical procedures*, with a reported reduction in mortality [60]. The authors pointed out that the sample size in this study was small, but that the regimen seems worthy of further investigation.

In a recent presentation of a new meta-analysis Nathans [61] suggested that SDD performs better in surgical than medical ICU patients. Pneumonia was significantly reduced in both the surgical and medical ICUs. Bacteremia was significantly reduced only in the surgical ICU patients. Mortality was significantly reduced in trials including surgical ICU patients [odds ratio (OR) 0.70, confidence interval (CI) 0.520.93] but not in medical ICU trials (OR 0.91, CI 0.531.06).

Conclusions

The published data regarding ICU patients seems to provide indisputable evidence that SDD can reduce acquired infection on the ICU. It was shown by most of the individual studies and confirmed by all four of the meta-analyses. The results regarding mortality are less clear, but the meta-analyses suggest that SDD produces a 10% overall reduction in mortality.

Despite the large number of publications on SDD there has not yet been an adequate cost-benefit analysis. Two types of study seem to be required to answer some of the remaining controversy. First, a large study looking at prevention of pneumonia using protected specimen techniques for the diagnosis of pneumonia and concentrating on the cost-benefit aspects would be useful.

Second, a well designed study to look at the effect on microbial resistance over a prolonged length of time would be useful.

Before a clinician considers introduction of SDD to a unit, it is essential to make an inventory of the type of infection seen on the unit, remembering that SDD can be expected to have an effect only on secondary endogenous infections. SDD is not a solution for poor traditional infection control measures.

Some interesting work has been and continues to be carried out in specific subgroups of patients, such as those with pancreatitis or undergoing cardiac surgery. These areas are worthy of further evaluation.

It appears that few of the techniques used in daily ICU practice have been subjected to the extensive critical evaluation SDD has received. Although the effect of SDD on mortality is relatively modest, compared with the results of trials of biomodulation of sepsis SDD seems to be a resounding success.

Résumé

La décontamination sélective du tube digestif (DST) a été largement étudiés dans le cadre des Soins Intensifs. Malgré la publication de plus de 50 études contrôlées sur le sujet, la DST est controversée et son rôle largement débattu. Cette revue souligne ces controverses. D'après la littérature, il semble que la DST pulsse réduire le taux d'infection acquise en soins intensifs. Si l'on ne démontre aucun effet sur la mortalité dans les travaux individuels, la métanalyse suggère une réduction de 10%. En dépit de l'abondante littérature, il reste à approfondir plusieurs aspects de la question par des études plus approfondies.

Resumen

La descontaminación selectiva del tracto digestivo (DSTD) ha sido ampliamente estudiada en el contexto del cuidado intensivo. Pero a pesar de la publicación de más de 50 ensayos clínicos controlados, sigue siendo motivo de controversia, con posiciones muy diferentes en cuanto a su valor. El propósito del presente artículo fue revisar el uso de la DSTD, principalmente a través del análisis de las áreas de controversia. La información que aparece en la literatura parece proveer evidencia clara de que la DSTD puede disminuir la tasa de infección adquirida en las unidades de cuidado intensivo. La mayoría de los estudios individuales ha demostrado que no tiene efecto sobre la mortalidad, pero los meta-análisis sugieren que hay una reducción del 10% en la mortalidad. Aunque se dispone de un gran volumen de información publicada hasta la fecha, todavía existen aspectos que merecen investigación adicional.

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