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Reducing Veterinary Waste: Surgical Site Infection Risk and the Ecological Impact of Woven and Disposable Drapes

A Knowledge Summary by

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KNOWLEDGE SUMMARY

PICO question

In animals undergoing surgery, does the use of disposable synthetic drapes reduce the risk of surgical site infections when compared to reusable woven drapes?

Clinical bottom line

Current literature on the risk of surgical site infection with disposable and reusable drapes in animals is limited. Three human studies were reviewed, one systematic review and two controlled trials. Both these study types generally provide high levels of evidence; however their individual limitations reduce the quality of their data. Overall the results were mixed, and due to the small number of reviewed papers and the fact that only one study specifically measured surgical site infection as the outcome, it is not possible to conclude that disposable drapes reduce the risk of surgical site infections (SSI) when compared to reusable drapes.

The impact of the veterinary profession on the ecosystem is often ignored. When following the One Health concept, vets must consider the ecological impact of clinical decisions. Choosing reusable drapes for certain clean, elective procedures may be a way to reduce waste without compromising the health of patients.

Clinical Scenario

Current studies show that as of 2015, 6.3 billion metric tons of plastic waste has been produced, of which 79% has ended up in landfills or as litter in the natural environment (Geyer et al., 2017). By 2050 there will be more plastic than fish (by weight) in the oceans (Ellen MacArthur Foundation, 2016). The veterinary profession produces waste which is disposed of by various methods such as medical waste incinerators, recycling plants and landfill sites. All these disposal methods may have effects on the ecosystem. This includes the release of dioxin pollutants from medical waste incinerators (Thornton et al., 1996) and methane emissions from landfill sites (Gollapalli & Kota., 2018). In the veterinary profession one of the primary reasons for using disposable over reusable items is to ensure infection control and to maintain the health and welfare of our patients (Ibbotson et al., 2013). However One Health, a concept in which multiple different sectors communicate to achieve better public health outcomes, recognises that human health, animal health and ecosystem health are inextricably linked and stresses our responsibility to promote and improve all aspects (Ribeiro et al., 2019). As an example, surgical drapes are a consumable commonly used by the veterinary profession of which both reusable and disposable versions are available. Studies have shown that reusable gown systems reduce energy consumption, greenhouse gas emissions and solid waste generation when compared to disposable options (Vozzola et al., 2018). The aim of this knowledge summary is to identify if using disposable drapes decreases the risk of SSI with the view to provide an opportunity to reflect on the waste produced by the veterinary profession.

The evidence

The literature search returned 282 records of which three were reviewed after exclusion; all were human studies (Kieser et al., 2018, Jalovaara & Puranen 1989, Laufman et al., 1975). One was a systematic review of studies involving large sample sizes (Kieser et al., 2018); however few of the reviewed studies gave any indication of the statistical significance of their results, and it was not entirely clear if they used materials applicable to the veterinary industry. Two were non-randomised controlled trials (Jalovaara & Puranen, 1989 and Laufman et al., 1975). None of the studies were entirely comparable due to different interventions and outcomes; and due to the mixed results, it is not possible to make a conclusion as to whether disposable

drapes reduce the risk of SSI when compared to reusable.

Summary of the evidence

Kieser et al. (2018)	
Population:	Human patients receiving orthopaedic or spinal surgery. Exclusion criteria: • Studies not specifically assessing surgical site infection after surgical intervention. • Studies assessing skin incision drapes. • Studies looking at surgical procedures not performed by orthopaedic or spinal surgeons. After the initial screening and exclusion, there were no articles identified. So the paper summarises results from seven non–orthopaedic or spinal surgery studies, their revised inclusion criteria was not explained.
Sample size:	Seven studies have been reviewed.
Intervention details:	• Each of the studies used different types of disposable and woven drapes. • Five of the studies reviewed used hospital linen drapes which were described as being no longer used by the human medical industry. The systematic review stated that only the studies by Bellchambers et al. (1999) and Showalter et al. (2014), used currently available reusable and disposable drapes. However the exact type of fabrics were not mentioned, and the availability of these fabrics in the veterinary industry is unknown, therefore the results from all seven papers have been detailed. • Study 1 – sample size of 6,388 surgeries. • Study 2 – sample size of 4,362 surgeries. • Study 3 – sample size of 2,253 surgeries. • Study 4 – sample size of 2,181 surgeries. • Study 5 – sample size of 494 surgeries. • Study 6 – sample size of 505 surgeries – Bellchambers et al. (1999). • Study 7 – sample size of 102 surgeries – Showalter et al. (2014).
Study design:	Systematic literature review.
Outcome studied:	• Study 1 – SSI rate. • Study 2 – SSI rate. • Study 3 – SSI rate. • Study 4 – SSI rate. • Study 5 – SSI rate. • Study 6 – SSI rate. • Study 7 – SSI rate, 30 days post-surgery.
Main findings: (relevant to PICO question):	• Study 1 – lower rate of SSI with disposable drapes as opposed to reusable (0.46% to 1.11%). The authors did not report undertaking inferential testing.

	• Study 2 – lower rate of SSI with disposable drapes as opposed to reusable (5% to 6%). The authors did not report undertaking inferential testing. • Study 3 – lower rate of SSI when disposable drapes were used (2.3% to 6.4%) as opposed to reusable drapes (P<0.001). • Study 4 – lower rate of SSI (2.8% to 6.5%) with disposable drapes as opposed to reusable. The authors did not report undertaking inferential testing. • Study 5 – no difference in SSI rate with different drape types. The authors did not report undertaking inferential testing. • Study 6 – no significant difference (5.2% to 5.1%) between SSI rates with disposable or reusable drapes (P=0.87). • Study 7 – significant reduction in SSI rate (12% to 0%) with disposable drapes as opposed to reusable (P=0.012). • Overall the reviewed papers had mixed results with no conclusion as to whether there is a reduction in the risk of SSI when disposable drapes are used compared to reusable.
Limitations:	• Four of the papers reviewed did not have a p-value to determine the statistical significance of their findings. • The studies that were reviewed did not have the same or similar study designs or methods of measuring the outcome. • The quality of the studies were not assessed in detail. • No confidence intervals. Five of the studies used linen hospital drapes which according to the paper are no longer used in the human medical profession. There is little information as to whether they are still currently used in the veterinary profession. • The specific type of drape was not mentioned in all the studies, making it difficult to reach a conclusion as to the relevance to the wider population. • Additional information on when and how the outcomes were measured was only provided for study 7.

Jalovaara and Puranen (1989)	
Population:	Human patients undergoing hip replacements.
Sample size:	16 surgeries.
Intervention details:	Two groups: 1. Synthetic disposable drapes and gowns – n=8 2. Cotton reusable drapes and gowns – n=8 Experimental details: • Air bacterial counts – taken over periods of 4 minutes using Biotest Reuter centrifugal air sampler (RCS) equipment on Tryptic Soy Agar (TSA) strips incubated at 37 degrees Celsius for 48 hours. The colonies were then counted. • Air bacterial counts taken simultaneously at four points in time: during preparation, after gowning and draping, during skin incision, during prosthesis insertion.

Study design:	Non-randomised controlled trial.
Outcome studied:	Air bacterial counts taken at four points in time. The colony count data were then statistically analysed.
Main findings: (relevant to PICO question):	• Air bacterial counts were lower in the disposable group than in the reusable group at every measurement point, these differences were not statistically significant. The bacterial counts in both groups were significantly lower during the operation (3x samples) than during the preparation period ($P<0.05$). • This finding is relevant to the PICO as air bacterial counts have been suggested as contributing to the risk of surgical site infection.
Limitations:	• Not randomised. • Not blinded. • Studied gown material as well as drape material. The inclusion of gown material was an incidental, confounding measure. • No indication of the validity of the Biotest RCS or TSA agar strips. • Small sample size, no evidence in the paper that a power calculation was undertaken to indicate sample size, this makes the results less reliable.

Laufman et al. (1975)	
Population:	Different types of gown and drape material used in human surgeries.
Sample size:	15 different types of woven and disposable drapes.
Intervention details:	Two groups: 1. Woven materials (seven types): • Linen cotton, new. • Linen cotton, laundered and sterilised twice. • 100% cotton, new. • 100% cotton, treated with Quarpel, new. • 100% cotton, Quarpel treated, laundered and sterilised 55 times. • 100% cotton, Quarpel treated, laundered and sterilised 75 times. • 100% cotton, Quarpel treated, laundered and sterilised 100 times. 2. Nonwoven materials (eight types): • Wet laid fabric laminated to polyethylene film. • Scrim reinforced, embossed tissue. • Scrim reinforced, creped tissue. • Spunlace nonwoven fabric. • Spread tow plastic film composite. • Spunbonded ethylene. • Wet-laid nonwoven. • Fiber reinforced tissue. <u>Methodology</u> The study used an unopposed weight support test:

	• Two identical squares of material were cut out of the different types of materials. They were both suspended from metal rods to form hammocks with a one inch sag. • ½ ml of a liquid bacterial suspension (*Serratia marcescens*) were pipetted onto both hammocks. Weights of 200 g, 500 g and 2 kg were placed on one hammock whilst the other had only the suspension. This was to imitate the weight of a surgeons elbow leaning on the drape during surgery. • After 5, 15 and 30 minutes, a Rapid One-Step Disposable Agar Contact plate (RODAC) was touched to the underside of both hammocks. They were cultured for 48 hours.
Study design:	Non-randomised controlled trial.
Outcome studied:	The RODAC plates were used to measure the wet bacterial strike through for different materials and weights.
Main findings: (relevant to PICO question):	1. Woven materials: • Linen cotton, new – bacterial penetration in 1/1 tests. • Linen cotton, laundered and sterilised twice – bacterial penetration in 1/1 tests. • 100% cotton new – bacterial penetration in 1/1 tests. • 100% cotton treated with Quarpel, new – no bacterial penetration in 5/5 tests. • 100% cotton, Quarpel treated, laundered and sterilised 55 times – no bacterial penetration in 2/2 tests. • 100% cotton, Quarpel treated, laundered and sterilised 75 times – bacterial penetration in 1/2 tests. • 100% cotton, Quarpel treated, laundered and sterilised 100 times – bacterial penetration in 2/2 tests. 2. Nonwoven materials: • Wet laid fabric laminated to polyethylene film – no bacterial penetration in 5/5 tests. • Scrim reinforced, embossed tissue – bacterial penetration in 2/5 tests. • Scrim reinforced, creped tissue – bacterial penetration 2/5 tests. • Spunlace nonwoven fabric – bacterial penetration in 2/5 tests. • Spread tow plastic film composite – no bacterial penetration in 6/6 tests. • Spunbonded ethylene – bacterial penetration in 2/5 tests. • Wet-laid nonwoven – bacterial penetration in 5/5 tests. • Fiber reinforced tissue – bacterial penetration in 6/6 tests. Not all woven and nonwoven surgical drape materials are impermeable to moist contamination for equal periods of time, there were no statistical comparisons made.
Limitations:	• Many surgeries last longer than 30 minutes and strike through was not tested after 30 minutes. • It was unclear how the results on the RODAC plates were

	measured. • The test does not take into account the effect of blood and other fluids which are present in surgeries. • It is not clear if the types of materials used in the study are used currently in the veterinary industry. • The study does not state what the sterilisation and washing cycles were. • The study does not take into consideration dry bacterial transfer which could also contribute to SSI. • The sample size in the subgroups were very small, ranging between one and six tests per subgroup. This greatly reduces the power of the study and our ability to draw conclusions from it. • The number of tests performed on each type of drape were not consistent.

Appraisal, application and reflection

There is evidence to show that reusable textiles in the medical profession have significant ecological benefits when compared to disposable systems (Vozzola et al., 2018). However there is little evidence about the ecological cost of consumables used in the veterinary profession. The purpose of this knowledge summary was to investigate whether disposable drapes reduce the risk of surgical site infections (SSI). Furthermore, if reusable drapes could be used instead as a method to reduce veterinary waste.

The purpose of a surgical drape is to reduce external contamination and provide a barrier to avoid migration of contamination from the skin of the patient to the surgical site (Kieser et al., 2018). Wound infection rates are thought to be between 2.5% and 5.8% for clean elective surgical procedures in animals (Delisser et al., 2012) and SSI are an issue in terms of animal welfare, financial implications, antimicrobial usage and clinician/owner stress (Kieser et al., 2018). Drapes can be broadly categorised into disposable synthetic and reusable woven. There are many types of disposable drapes, such as adhesive and incision, and reusable drapes can be made from various fabrics with varying levels of permeability. Disposable drapes are assumed to be impermeable and therefore able to provide a better barrier to reduce bacterial contamination and SSI when compared to woven reusable drapes (Delisser et al., 2012). However there is little evidence to prove this, and when thinking of ways to reduce veterinary waste without compromising patient care, we should investigate the reasons for choosing disposable over reusable drapes.

Three papers were reviewed in this knowledge summary; one was a systematic review (Kieser et al., 2018) and two non-randomised controlled trials (Jalovaara & Puranen, 1989 and Laufman et al., 1975). In general, controlled trials and systematic reviews both provide good levels of evidence; however these studies all had various limitations in terms of their experimental design and in terms of their relevance to this PICO. All three were human studies, there is likely to be variability in the efficacy of drapes in animals compared to humans due to differences in hair density and the amount of surface debris and bacterial load (Owen et al., 2009). The PICO also specified an outcome of surgical site infection risk; however the reviewed studies included those investigating wet bacterial strike through and air bacterial counts. The paper by Laufman et al. (1975) may have shown that not all disposable drapes are impermeable to wet bacterial strike through and Kieser et al. (2018) concluded that there was no statistically significant difference in air bacterial counts between both groups, however SSI are inevitably multifactorial and it is not clear how much these factors contribute to the risk of a surgical site infection.

All of the papers reviewed included data from before 2000, since then technology regarding drape design and permeability will have developed meaning that their evidence may not be entirely applicable to the current modern products. Two of the papers also studied both drapes and gowns, only the paper by Kieser et al. (2018), was specific to surgical drapes. In the large systematic review by Kieser et al., (2018), it was not always clear how the outcomes had been measured in the reviewed articles and the papers were limited by the lack of clarity in the original data.

Overall the results were mixed, however when a difference was seen, it was the disposable drape group that had a reduced risk of SSI and air bacterial counts. Overall, due to the limitations and relevance of the reviewed studies we are unable to conclude if disposable drapes reduce the risk of SSI in animals. However based on the current evidence, it seems possible that vets could use reusable drapes for low risk surgeries, such as elective clean procedures, to reduce waste without compromising the health and welfare of the patients. There is a need for a veterinary specific, randomised controlled clinical trial to confirm or reject this assumption. Prior to commencement of the trial a power analysis should be conducted. This would allow the researcher to estimate the smallest sample size that is suitable to detect the effect of disposable versus reusable drapes on SSI. A current trial is also required to account for the use of modern reusable drape materials and the impact of washing/reuse of the drape material over time. It is also possible for there to be variation between animal species and this should also be considered.

Overall there is little information on the amount of waste produced by the veterinary profession. In the medical profession, operating theatres produce one third of hospital waste (Stall et al., 2013), and the US health care industry is the second largest industrial contributor to landfill (DiConsiglio, 2008). Whilst large scale commitment and support is needed for global improvement, immediate action can be taken by individuals and their practices (WHO, 2018). The basic principles of waste reduction are to reduce, reuse and recycle. Successful waste management strategies in hospitals have relied on the establishment of stewardship teams where all stakeholders can put forward their ideas on the greening process. Increased awareness underlies the success of attempts to decrease the impact of health care on the ecosystem (Stall et al., 2013). Within the veterinary profession, further studies are required, firstly to benchmark the amount of waste produced. Then waste management strategies can be implemented to identify ways to reduce this waste. Eco-efficiency analyses (EEA) have been carried out within the medical profession to assess the various costs of different reusable and disposable products over their entire life cycle. They have proven to be useful when choosing products with the lowest economic and ecological cost (Ibbotson et al., 2013). Overall the veterinary profession must be more aware of the ecological cost of our efforts to improve and maintain animal welfare, and strive to implement a One Health approach to our decision making processes.

Methodology Section

Search	
Databases searched and dates covered:	Web of Science Core Collection database 1900 to 2019 CAB Abstracts on OVID Platform 1973 to 2019 week 08
Search strategy:	**Web of Science Core Collection database** 1. Surgery or surgeries or surgical 2. Surgical drape or surgical drapes or woven drape or woven drapes or adhesive drape or adhesive drapes or disposable drape or disposable drapes or reusable drape or reusable drapes or drap* 3. surgical site infection or surgical site infections or SSI or SSI's or infect* or contamination or bacteria* 4. 1 and 2 and 3 **CAB Abstracts** 1. Surgery or surgeries or surgical 2. Surgical drape or surgical drapes or woven drape or woven drapes or adhesive drape or adhesive drapes or disposable drape or disposable drapes or reusable drape or reusable drapes or drap* 3. surgical site infection or surgical site infections or SSI or SSI's

	or infect* or contamination or bacteria* 4. 1 and 2 and 3 **Hand search** After carrying out the database search and excluding papers based on the below criteria, no relevant papers were found. A hand search was subsequently performed by looking through the references of excluded reports and finding papers that were relevant to the PICO and fit the inclusion/exclusion criteria.
Dates searches performed:	Date search performed 10/02/2019

Exclusion / Inclusion Criteria	
Exclusion:	More than 2 interventions as they are incidental confounding measures, use of wound protector drapes, no full text available, not relevant to PICO, non-English language publications, textbooks, articles that are not primary studies or systematic reviews
Inclusion:	Intervention comparing reusable versus disposable drape material, studies involving gown material as well were also included but this was considered an incidental variable, English language papers relevant to PICO, full text available, papers relevant to human and veterinary literature, primary studies and systematic reviews

Search Outcome

Database	**Number of results**	**Excluded – not relevant to PICO**	**Excluded – replicated data**	**Excluded – Wound protector drapes**	**Excluded – Too many interventions**	**Excluded – Not primary study or review paper**	**Excluded – no full text available**	**Total relevant papers**
Web of Science	248	222	3	3	4	10	6	0
CAB Abstracts	31	28	0	0	1	1	1	0
Hand search	3	0	0	0	0	0	0	3
Total relevant papers when duplicates removed								**3**

CONFLICT OF INTEREST

The author declares no conflicts of interest.

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REFERENCES

1. BELLCHAMBERS, J., HARRIS, J., CULLINAN, P., GAYA, H., PEPPER, J. (1999). A prospective study of wound infection in coronary artery surgery. *European Journal of Cardio-thoracic Surgery.* 15 pp.45–50. DOI: https://doi.org/10.1016/S1010-7940(98)00255-3
2. DELISSER, P.J., SINNETT, D.E., PARSONS, K.J., FRIEND, E.J. (2012). A survey of surgical draping practices in small-animal practice in the UK. *Veterinary Record.* 171(13) DOI: http://dx.doi.org/10.1136/vr.100406
3. DICONSIGLIO, J. (2008). Reprocessing SUDs reduces waste, costs. *Materials management in health care.* [online] 17(9) pp.40–42. Available at: https://www.ncbi.nlm.nih.gov/pubmed/18972859
4. Ellenmacarthurfoundation.org. (2019). *The New Plastics Economy: Rethinking the future of plastics*. [online] Available at: https://www.ellenmacarthurfoundation.org/publications/the-new-plastics-economy-rethinking-the-future-of-plastics
5. GEYER, R., JAMBECK, J.R., LAW, K.L. (2017). Production, use and fate of all plastics ever made. *Science Advances.* 3(7). DOI: https://doi.org/10.1126/sciadv.1700782
6. GOLLAPALLI, M., KOTA, S. (2018). Methane emissions from a landfill in north-east India:Performance of various landfill gas emission models. *Environmental Pollution.* 234 pp.174–180. DOI: https://doi.org/10.1016/j.envpol.2017.11.064
7. IBBOTSON, S., DETTMER, T., KARA, S., HERRMANN, C. (2013). Eco-efficiency of disposable and reusable surgical instruments-a scissors case. *The International Journal of Life Cycle Assessment.* 18(5) pp.1137–1148 DOI: 1007/s11367-013-0547-7
8. JALOVAARA, P., PURANEN, J. (1989). Air bacterial and particle counts in total hip replacement operations using non-woven and cotton gowns and drapes. *Journal of Hospital Infection*. 14, pp.333–338. DOI: https://doi.org/10.1016/0195-6701(89)90073-X
9. KIESER, D., WYATT, M., BESWICK, A., KUNUTSOR, S., HOOPER, G. (2018). Does the type of surgical drape (disposable versus non-disposable) affect the risk of subsequent surgical site infection? *Journal of Orthopaedics*. 15(2), pp.566–570. DOI: https://doi.org/10.1016/j.jor.2018.05.015
10. LAUFMAN, H., EUDY, W., VANDERNOOT, A., LIU, D., HARRIS, C. (1975). Strike-through of moist contamination by woven and non-woven surgical materials. *The Annals of Surgery.* 181(6) pp.857–862. DOI: 1097/00000658-197506000-00018

11. OWEN, L., GINES, J., KNOWLES, T., HOLT, P. (2009). Efficacy of Adhesive Incise Drapes in Preventing Bacterial Contamination of Clean Canine Surgical Wounds. *Veterinary Surgery*. 38(6), pp.732–737. DOI: https://doi.org/10.1111/j.1532-950X.2009.00537.x
12. RIBEIRO, C.D., VAN DE BURGWAL, L.H.M., REGEER, B.J (2019). Overcoming challenges for designing and implementing the One Health approach: A systematic review of the literature. *One Health.*DOI: 10.1016/j.onehlt.2019.100085
13. SHOWALTER, B.M., CRANTFORD, J.C., RUSSEL, G.B. MARKS, M.W., DEFRANZO, A.J., THOMPSON, J.T., PESTANA, I.A,. DAVID, L.R. (2014). The effect of reusable versus disposable draping material on infection rates in implant-based breast reconstruction: a prospective randomized trial. *Annals of Plastic Surgery.* 72(6) pp.165–169. DOI: 1097/SAP.0000000000000086
14. STALL, N.M., KAGOMA, Y.K., BONDY, J.N., NAUDIE, D. (2013). Surgical waste audit of 5 total knee arthroplasties. *Canadian Journal of Surgery.* 56 (2) pp.97–102. DOI: 1503/cjs.015711
15. THORNTON, J. MCCALLY, M., ORRIS, P., WEINBERG, J. (1996). Hospitals and plastics. Dioxin prevention and medical waste incinerators. *Public Health Rep.* 111(4) pp.298–313. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1381872/
16. VOZZOLA, E., OVERCASH, M., GRIFFING, E. (2018) Environmental considerations in the selection of isolation gowns: A life cycle assessment of reusable and disposable alternatives. *American Journal of Infection Control.* 46 (8) pp.881–886. DOI: https://doi.org/10.1016/j.ajic.2018.02.002