Infection control and biosecurity: disinfectant types - transcript

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Welcome everyone to this webinar, which is part of a series of webinars on infection control brought to you by RCVS Knowledge. Today we're very lucky to have Sairéad Wild to talk to us about disinfectant types, a very important part of infection control.

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This webinar, as I say, is part of a series. The first one was about infection control and biosecurity during COVID-19. It was from Alan Radford, talking about the virus itself and from Tim Nuttall talking about biosecurity and infection control. The second webinar was again from Tim Nuttall, talking about organisms of concern and how they're transmitted, which is very important to know, how an organism is transmitted, then we know what to do about infection control. The third part from Liz Branscombe was a very practical webinar on how to have infection control policies and procedures in practice, and having infection control groups or people appointed to look after infection control in the practice.

And today's webinar is the fourth in the series. Today's, as I said before, is about disinfectant types, and we're very lucky to have Sairéad. She is an RVN. She worked in practice and then moved into education and is course director at University College West Anglia in Cambridge. Sairéad is also in the middle of doing a dissertation for a Master's in clinical animal behaviour. Sairéad is also part of our RCVS Knowledge infection control working party. So welcome Sairéad and over to you.

Sairéad Wild

Thank you very much, Pam. Hello everybody. Today, I'll just have a quick overview of what the session is going to cover. What we're going to look at is disinfection terminology just to start off with. So what do the suffixes and such like mean, when we're describing disinfectants. Having a look at the action, how do disinfectants work? Then we'll look at the active ingredients. So we'll look at examples of disinfectants within a range of genres. And then finally we'll think about appropriate selection of disinfectants for the tasks that we have in hand.

So let's start by looking at the terminology. We've got three main areas of disinfectant, cleanliness control, we should say, we've got cleaning and disinfection and sterilisation. Cleaning is a process that physically removes contaminants using a detergent. Contaminants might include such things as dust or soil or large volumes of micro-organisms and organic material such as faeces or blood, for example, which protects them. So cleaning must always precede disinfection and sterilisation.

Disinfection is the process used to reduce the number of microorganisms on a surface to a safe level. But this doesn't usually reduce bacterial spores. High-Level disinfectants will kill some, but not all. The process also doesn't necessarily kill and remove all microorganisms, but it reduces them to a level where they don't pose a threat to health. So terminology-wise, disinfection on skin and living tissues is anti-sepsis.

And then we have the process of sterilisation, and sterilisation refers to any process that eliminates, removes, kills, deactivates all forms of life, including spores and other biological agents like prions, present on a specific surface or in fluid or on an object. And the NHS actually note that standard sterilisation procedures might not eliminate prions such as the CJD (Creutzfeldt-Jakob disease).

The active ingredients or the chemical agents in disinfectant preparations are known as the biocides, and these are generally broad spectrum agents, which means that they're effective next to a large range of organisms rather than honing in on one particular microbe. Biocides kill microorganisms by deactivation of its active property. So that could be by hydrolysis or oxidation or denaturation. And we'll talk about these a little bit more, a bit further in.

And biocides aren't just the things that we have under the sink. They're also pesticides, so insecticides, herbicides, fungicides, slimicides, ant powder, weed killer, insect-repelling wrist bands. Antimicrobials: so antibacterial, antivirus, antifungal. A random example of where we might find antibacterial products includes bacterial socks for somebody's feet. And there's a lovely anecdote which I found at the end of 2018 of a chap in China who went to his doctor because he had chest pains and he was coughing and he went to just have a few diagnostic tests done. So his doctor carried out a series of tests on the man and discovered that his lungs were contaminated with bacteria such as Klebsiella pneumonia and E.coli, which is normally found in used footwear. During subsequent conversations with the doctor, the patient confessed that he actually took deep sniffs of his socks every evening before he threw him into his laundry basket. Interesting, but slightly I digress.

Terminology-wise, the suffix on disinfectant products tell us what the active agent does. The suffix 'cide' refers to agents which target and kill particular organisms. Agents which give an inhibitory effect, on the other hand, are called 'statics'. So to put that into context, a disinfectant might be sporostatic but not necessarily sporocidal. Disinfectants work through three primary actions: hydrolysis, oxidation or denaturation. Each of these has a common sequence of events involving interaction of the disinfectant with the micro surface followed by penetrating into the microbe, and then action at the target site. Hydrolysis refers to a reaction with water, hydro meaning water and lysis meaning literally to unbind. So in simple terms, a molecule of water is introduced to and involves deactivating the microbes by physically breaking down the chemical compounds into two or sometimes more simpler compounds, which then don't pose a threat to health.

Oxidation is the process of loss of electrons during reaction by a molecule or an atom or an ion. Oxidising agents act by oxidising or stealing electrons from the cell membrane of a microbe, which results in a loss of structure and leads to cell lysis and then subsequently to death. Lots of disinfectants actually operate in this way, and Verkon actually is one that springs to mind. Denaturation is the disruption and the possible destruction of secondary and tertiary structures of a microbe's proteins.

These disinfectants, such as alcohol, work by really rapidly denaturing micro proteins, which then inhibits metabolism, and also by just disrupting microbe membranes, which leads to cell lysis.

As I mentioned previously, the purpose of disinfectants is to reduce the number of viable microbes present on apparatus, to a level where they don't pose a threat to health. And this level of reduction is known as the kill count. So you can see here described, 99.99% effectivity presents as a four-log reduction in load. 99.999% is described as five log, so it's stronger. So if a surface, for instance, has a hundred thousand pathogens on it or microbes on it, a five log reduction (so the reduction of the bioload by a hundred thousand times) will reduce that hundred thousand number of microbes down to one.

Disinfectant products are available in several strengths of action and deliver different levels of contamination. For disinfectants to work effectively it must be clear of any gross contamination. So any object or apparatus needs to be thoroughly cleaned using a soap or detergent. Basically it's known as surfactants. Some disinfectants already contain surfactants. Virkon is one of them, these lower the bio burden on the surface. The heavier the bio burden, the greater contact time you need to eradicate it. But what is a surfactant? The name derives from a longer description of surface active agent (I accept that the 'e' is a little dubious in all of that for the eagle-eyed among you).

The surfactant lowers the surface tension of the liquid in which it's dissolved. So surfactants comprise amphiphilic molecules, amphi meaning both sides, philic meaning love, which means that they interact really nicely with the air fluid interface. So it's partly hydrophobic and partly hydrophilic. Surfactants facilitate consistent dampening of a surface, and this prevents beading of the fluid material, and so it optimises the cleaning process. At the air fluid boundary the molecules line themselves up. So the hydrophobic end is in the air and hydrophilic end is in the water and this creates a drop in surface tension.

Surfactants are normally classified by the polar heads. So if these have no charge, the surfactant is non-ionic. And if it has a positive or negative charge, it is anionic or cationic positive, for instance,quaternary ammonium compounds. If it contains positive and negative groups, it's known as zwitterionic. Disinfectants aren't very good at penetrating grime. And this is why detergents are necessary. Using detergents means that the disinfectants and remaining target microbes achieve closer contact and optimise the disinfection of that surface. Detergent use will also minimise the activation of the disinfection if it's affected by organic matter. So when we're selecting disinfectants, we need to take several factors into consideration.

I'm not going to read through this line by line. You're very welcome to pause the presentation, read at your own pace, although many, if not all of these considerations may already be very familiar to you.

The active agent and disinfectants are grouped into several levels of action: low, intermediate, and high.

And so let's look at the low level first. Phenolics. So Dettol, Jayes fluid, mouthwash, medicated lip balm are all carbolic acid derivatives. Carbolic acid actually is one of the oldest disinfectants. Joseph Lister used it in the 19th century to disinfect hair and hands and dressings and such like. And then inspired by Mr Lister an American chemist called Joseph Lawrence developed Listerine, which is an alcohol-based, oral antiseptic mix of several related compounds, which you may be quite familiar with today. Carbolic acid isn't used as a surgical disinfectant because it's irritating to skin, but the chemicals in antiseptic mouth washes and throat lozenges are phenolics.

And phenolics are effective against bacteria, particularly gram positive bacteria, fungi and enveloped viruses, but not non-enveloped viruses and not spores. They inhibit microbial growth by denaturing proteins and disrupting membranes. Phenolics do remain viable where organic material is present. So we're looking at blood, urine, saliva and such like They're considered generally safe, but they can cause damage to gentler apparatus. And so they're not recommended for semi-critical items. Any residue left on porous materials might also irritate tissues, and that's even after rinsing.

So phenolics aren't recommended for use with synthetics and rubber. They do need to be used promptly because diluting them reduces their stability. Their action is to denature proteins causing lysis of the cell membranes. Phenolics are highly toxic to cats and reptiles. And actually some of the perhaps lesser known substances include clove and tea tree oils.

Quaternary ammonium compounds are probably the most useful disinfectant for a variety of clinical purposes. As well as possessing antimicrobial properties, they're excellent for hard surface cleaning and deodorising. They're broad spectrum and they have a low toxicity, unless they're ingested, when they're highly toxic. And actually that's worth a point just to note that when we consider cats' grooming habits, they'll spend about 25% of their day licking their fur, so perhaps it's something to have in the back of our minds.

QACs are effective against gram positive and gram negative bacteria and enveloped viruses. And they're also fungi, spori and bacteriocidal. They are however deactivated by organic material and hard water and soap and they have been linked to antimicrobial resistance. There's also no evidence regarding their effectivity against parvo or FCV.

Most aldehyde preparations are non-corrosive to metals and other materials. And they are only subject to a small amount of inactivation by organic matter, but they do have a slow penetration rate and they are expensive and also toxic.

Glutaraldehyde is used as a disinfectant and a sterilant particularly with low-temperature disinfection and sterilisation of endoscopes and other delicate surgical equipment. It's a broad spectrum against bacteria and their spores and fungi and viruses. It's an effective disinfectant, but it's not suitable as a skin antiseptic.

Chlorhexidine is widely used for hand hygiene and skin prep. It has a slower antimicrobial activity than alcohols, but it creates an immediate reduction in bacteria. So to compare with povidine-iodine, povidine lacks the cumulative and residual activity of chlorhexidine. Chlorhexidine's activity is pH dependent though and reduced greatly in the presence of organic matter, soap and ionic detergents. It isn't considered to be particularly effective against viruses; with its activity you're limited to lipid envelope viruses and it doesn't inactivate non-enveloped viruses. There are a few interesting points to consider regarding chlorhexidine. Contaminated chlorhexidine has been linked to nosocomial outbreaks, chlorhexidine resistance has been identified. It's oto- and it's ocular toxic, so it should never be used in the eyes or the ears and it's also ineffective against FCV.

So let's move onto intermediate-level disinfectants. Several alcohols have been noted as being effective antimicrobials, for instance, ethanol and isopropyl alcohol. Alcohols have broad spectrum antimicrobial activity against vegetative bacteria and viruses and fungi, but they're not sporicidal, although they do inhibit spore germination. Because of this, they are not recommended for sterilisation purposes, but they are excellent for hard surface disinfection and skin antisepsis.

Some considerations with alcohol include the fact that it's ineffective against parvo virus for up to five minutes. It's non-corrosive but it does damage delicate lens mounts and other similar equipment. Its action is believed to be through membrane damage and rapid denaturation of proteins, causing interference with metabolism and so lysis, ultimately. It's also highly flammable and it's lethal if it's ingested. For this reason, a very bitter taste is added to prevent consumption. The antimicrobial activity is significantly lower at concentrations below 50%,and it's optimal in the 60 to 90% range. Alcohol doesn't penetrate well into organic matter, especially protein-based matter, and it should only be used on physically clean surfaces.

Chlorine-based halogens, such as sodium chloride and household bleach, are broad spectrum disinfectants too. Bleach is really the disinfection of choice against envelopes and non-enveloped viruses. It's effective against fungi, bacteria and algae, but again, not against spores. It oxidises proteins, lipids and carbohydrates. But there is a paucity of work describing how microorganisms are destroyed. Its biocidal properties are deactivated by organic matter, particularly at low concentrations, and it also loses potency if it's left standing. Although chlorinated compounds are pretty effective disinfectants, they do have disadvantages. Some will irritate the skin and the nose and the eyes, and they may not completely eliminate certain organisms from drinking water, for example, cryptosporidium, for instance, is resistant to chlorinated disinfectants. It is though relatively safe to use around cats.

And finally on to high-level disinfecting. And this is where we return to our oxidising agents. So hydrogen peroxide for example, these are also broad spectrum and they embrace enveloped and non-enveloped viruses, vegetative bacteria, fungi and spores. Hydrogen peroxide is widely used for disinfection, sterilisation, and antisepsis. And it comes in concentrations ranging from 3 to 90% with high concentrations and longer contact times required to eliminate sporicidal activity. It's actually considered to be environmentally friendly because it degrades very quickly into water and oxygen. And unlike the QAC it doesn't leave a residue.

And then finally we come on to sterilisation, which is obviously steam under pressure, heat and steam, the ultimate broad spectrum method of disinfection. And it's the most efficient way to sterilise. The optimal temperature for sterilisation is pathogen led. So 56 degrees C will kill 99% of giardia cysts and 60 degrees or above will inactivate FCV. Parvo virus can survive over an hour at temperatures of 80 degrees C. So most disinfectants are toxic and some are also corrosive. So they're all governed by the control of substances hazardous to health regulations 2002 and licensed by the EU biocides regs 2012. Risk assessments are always carried out before disinfectants are launched for use. Within the veterinary environment, a disinfectant agent should be ideally selected, which is not harmful to staff or patients and it doesn't cause corrosion, irritation or toxicity in the environment.

We've seen that disinfectants are not all-rounders and selection should reflect the nature of the decontamination tasks that you require. Choice should also take into consideration the effectiveness of the products. It needs to be low hazard to patients, to the team, and also to the wider environments. And the germicidal requirement needs to be identified to make an educated choice.

So low-risk areas, such as reception or waiting rooms and so on, will be served really well by QAC, but high-risk areas, so theatre for example, would benefit from oxidising agents to ensure high effectivity against most microorganisms, but it won't leave a toxic residue on critical surfaces. Clean and dirty areas hold different bioburdens and infection rates. So it's really important to ensure that when you're selecting a disinfectant: you use the correct dilution, which is going to minimise microbial resistance; you have the correct application, so you're enabling optimum disinfection; and prompt use of the disinfectant, so as we said, bleach loses potency within quite a short space of time. So prepare your disinfectants as they're required.

I hope you found this helpful. Thank you very much for listening. I'll pass you back now to Pam. Thank you, Pam.

Pam Mosedale

Thank you very much Sairéad, that was really, really interesting. I think they're one of these things that we kind of take for granted, you know, the disinfectant is disinfectant, but obviously it certainly isn't; there's lots of different disinfectants for the right thing and it fits in so well with the webinar that Tim gave about the different organisms too. So that was brilliant. Thank you so much.

Those of you who want to know more about infection control, as I said earlier, there are the three webinars already there and coming up, we're going to have the last part, which is actually I think five, not part four, which is auditing infection control. If you have any questions, then please email them to the email address on the screen there: ebvm@rcvsknowledge.org.

And if you're interested in looking at our infection control resources, please go to the RCVS Knowledge website and the QI quality improvement section. There's a whole infection control section, which has got lots of resources about infection control and lots of examples. So thank you again, Sairéad, and thanks everyone.

For more free infection control resources, please visit rcvsknowledge.org/qi/infection-control