



## ORIGINAL ARTICLE

## Perspectives of vets on plastics in veterinary medicine

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**Introduction** The use of disposable plastics and their subsequent environmental impacts are topics of increasing concern in modern society. Medical, including veterinary, sectors are major contributors to plastic waste production. While there is an existing body of literature on the use and reduction of disposable plastics in the human medical sector, few studies, if any, have specifically investigated the use of plastics within the veterinary field. The overall aim of this pilot study was to investigate Australian veterinarians regarding their attitudes toward the ways in which they use disposable plastic in their work and personal lives.

**Materials and Methods** Seven veterinarians were interviewed, representing a range of demographics and professional backgrounds from multiple states. Thematic qualitative analysis was employed to organise the data into several major themes encompassing many smaller nodes.

**Results** The dataset revealed that most, if not all, veterinarians interviewed agree that disposable plastic is used in excess in veterinary medicine, but that veterinarians will never be able to avoid using plastic entirely. Participants supplied differing opinions with respect to the best strategies for reducing plastic waste production within the veterinary field, including recycling, replacing disposable items or improving education.

**Discussion** Despite different participants suggesting conflicting ideas, most, if not all, of the ideas presented have support in the scientific literature. This supports a hybrid approach involving refining recycling systems, reducing plastic consumption and improving education on plastic waste production. A hybrid top-down-bottom-up approach must include encouraging cooperation among stakeholders, both within and outside the veterinary sector, as this will be a major contributor to progress. In a broader context, this hybrid approach to inciting change at all levels of the veterinary sector will require engagement from many interdependent entities; as such, this study should act as a starting point for an ongoing process of cooperative change. Recommendations for future research include life cycle analyses of reusable versus disposable veterinary materials; exploring ways to expand sustainability education within and beyond the veterinary sector, and examining methods of improving technology and infrastructure.

**Keywords** Australia; disposable plastic; single-use; sustainability; veterinary

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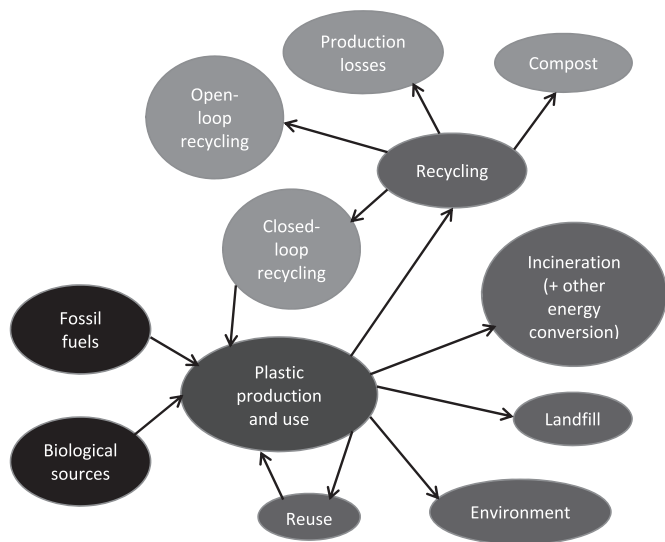
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Over the course of the last century, public opinion toward plastic has undergone several dramatic shifts. Plastic was first conceived in the early 1900s, and by the 1950s it had become one of the most widely commercially utilised materials on Earth.<sup>1</sup> Medical industries, including veterinary medicine, embraced plastic for its ability to maintain sterility and prevent contamination,<sup>2</sup> as well as for its cost-saving potential since it does not need to be re-sterilised. However, as environmental awareness became more prevalent in the late 20th and early 21st centuries, so did public antagonism towards plastics.<sup>3</sup> Plastics draw heavy public criticism because they are derived from fossil hydrocarbons and may persist in the environment for many years.<sup>1,4</sup> Plastic has detrimental environmental implications at many stages of its life cycle (Figure 1).

In 2014, 2.5 million tonnes of plastic waste were created in Australia.<sup>6</sup> Veterinary medicine, like all medical industries, is a major contributor to plastic waste production.<sup>7</sup> However, the dependence on disposable plastic is environmentally unsustainable due to the three most common potential fates of disposable plastic used in a clinic.<sup>1</sup>

1. Incineration – may release harmful chemicals into the atmosphere, such as dioxin-like compounds that are released when polyvinyl chloride (PVC) plastic is burned.<sup>8</sup>
2. Recycling – extends the life of disposable plastics; however, medical plastics are ineffectively recycled due to several factors, including potential biohazardous contamination,<sup>9</sup> high operation costs, sorting inefficiency and challenges, and limited recycling infrastructure.<sup>10</sup>
3. Deposition in landfill – where 80% of plastic will end up in Australia;<sup>6</sup> degrading plastic will release methane, a potent greenhouse gas and significant contributor to climate change, as a breakdown by-product and may take up to 1000 years to fully degrade.<sup>4</sup>

One study conducted in a human hospital indicated that many medical professionals prefer reusable materials to disposable ones and that switching to reusables can reduce a facility's waste production by up to 65%.<sup>11</sup> There are many studies from human healthcare facilities that investigate the relative efficacy and environmental impacts of disposable versus reusable materials.<sup>12–15</sup> These studies yielded mixed results regarding the relative efficacy of reusable versus disposable materials at preventing contamination or infection. One found no appreciable difference in contamination rates for reusable and disposable materials overall, particularly for short procedures.<sup>16</sup> However, others observed increased infection or



**Figure 1.** Broad overview of the life cycle and potential fates of plastic.<sup>5</sup>

contamination rates when reusables were used in certain lengthy surgical procedures, such as implant-based breast reconstruction and sternal wound repair.<sup>16,17</sup> Conversely, all that assessed the relative environmental impacts of disposable versus reusable items demonstrated that disposables incur a much higher environmental cost than their reusable counterparts.<sup>13,14,18</sup> These findings suggest that, while there may not be currently a viable alternative to disposable plastics for all circumstances in medicine, there is an imperative need to strive for more prudent use of disposable items where appropriate. However, the ability to implement more sustainable practices hinges on the attitudes of individuals towards sustainability, as these attitudes drive choices and behavior.<sup>19</sup> Despite the veterinary sector's considerable contribution to plastic waste production globally, the scientific literature is devoid of data on the topic of plastic waste reduction within the field.<sup>7</sup> In fact, one review found only three peer-reviewed publications on the topic of sustainability in the veterinary sector: one in anaesthesia, and two related to production animal medicine.<sup>20</sup> In searching for data on the use of disposable plastic within the veterinary scientific literature, no primary research papers were found. Furthermore, no primary data were found regarding the attitudes of veterinarians toward their usage of disposable plastic, which is a crucial component in understanding how to approach this issue.

Thus, the overall objective of this pilot study was to investigate how Australian veterinarians use disposable plastic within veterinary facilities. This includes their attitudes towards the use of disposable plastic and understanding their preferences related to plastic usage in their professional and personal lives.

### Materials and methods

The areas of interest were explored by conducting one-on-one qualitative interviews with veterinarians that use disposable plastic in practice. Invitations to participate in the study were disseminated to Australian veterinarians through the formal and informal networks

of the authors. Those who chose to partake and meet the participant criteria (veterinarians registered to practice in Australia) underwent an interview of 20–40-min duration. The recruitment process aimed to include participants from a wide range of demographics and professional backgrounds, which was done by deliberately contacting a diverse group of potential participants.

Human ethics approval was obtained through the University of Melbourne (2021-21273-18307-3). Semi-structured interviews were conducted by one of the researchers, Peter Siegler, one-on-one via telephone or online video conferencing. The interview guide consisted of 14 primary questions, with many of them containing sub-questions to be used as prompts if needed (Table 1).

Interviews were recorded, and field notes were taken after the completion of the interview to capture any additional observations. Field notes were used to organise data extracts into nodes and themes but were not included in the analysis themselves.

Data were analysed using methods of inductive thematic analysis.<sup>21</sup> After transcribing the data from the audio recordings of the interviews into Microsoft Word™, the first author carefully read and annotated the data, and data extracts relevant to the research question were identified and highlighted. Next, data extracts across the data set were categorised under several major themes, with other extracts pertaining to similar subject matter. After this, the data set was reviewed as a whole to ensure that each theme had an appropriate name and contained all relevant data extracts from the set. Finally, the data extracts were re-read individually and organised into nodes (sub-themes) based on their potential relationships to each other within the greater themes (Figure 2). The organisation of nodes and themes was reviewed, edited and approved by the co-authors of the paper. Direct participant quotes were included to illustrate themes and nodes, and square brackets were added to improve clarity and readability, but did not modify the original tenor.

### Results

The seven Australian veterinarians selected for participation represented a variety of demographics and professional backgrounds: men (n = 4 participants) and women (n = 3) from rural (n = 2), suburban (n = 2) and urban (n = 3) regions working in small animal general practice (n = 2), mixed practice (n = 1), equine (n = 1), referral emergency (n = 1), wildlife/zoo medicine (n = 1) and shelter medicine (n = 1). The median number of years spent working as a veterinarian was 21, with a range of 4.5–30 years of experience. Most participants currently reside and practice in Victoria and New South Wales.

Participants were asked to estimate how many 10-L buckets they filled with plastic waste in a typical week. Answers ranged from one bucket per week (small animal practice that recycled most of its soft plastics) up to 20–30 in a week (shelter medicine, emergency referral), with most participants approximating that they fill roughly one 10-L bucket with disposable plastic per day. When questioned about which disposable plastic items veterinarians used most frequently, the most common answers were syringes and needles (n = 7

**Table 1.** Primary interview questions on use of disposable plastics of Australian veterinarians

Category	Interview questions
Background information	How long have you been practicing? How long have you worked at your current practice? Are you the owner of the practice or employed by the practice? At what kind of practice do you work (animal species, % of species in mixed practice, number of employees, average number of consultations per day)? What kind of area do you work in (rural, urban, suburban, etc.)?
Plastic use in practice	Thinking about single-use plastic items, which ones do you use routinely during your work? Imagining a typical 10-liter bucket, how many of those do you think would be filled by discarded single-use plastic items during your typical day? Over the course of your career to date, have you noticed any trends in single-use plastic item usage in the clinic?
Attitude towards plastic use in practice	In general, what do you think about the use of disposable plastics in practice? Do you think vet clinics could reduce the amount of disposable plastic they use? Can you think of any disposable plastic tools used in a clinic that could be replaced by a reusable item? If someone tried to implement any changes at your clinic to reduce plastic usage, would you have any concerns?
Plastic use in personal life	What do you think about recycling in general? How do you feel in general about using disposable plastic?

participants), plastic packaging (n = 5), IV lines and extension sets (n = 3) and gloves (n = 3).

Four major themes were identified throughout the dataset (Figure 3). The first theme, which pertained to the current state of plastic usage in the veterinary sector, was comprised of two views that were each represented in all seven interviews: that the veterinary field uses too much disposable plastic overall and that veterinarians will never be able to avoid using disposable plastic altogether.

The remaining three major themes, titled 'Use and Recycle', 'Reduce and Replace' and 'Drivers of Change', pertained to the suggested approaches on how to confront the issue of excessive plastic usage. The relevant data were organised into a total of 19 nodes under these four main overarching themes.

While all participants provided unique insight on the topic of plastic usage, all interviewees shared two major views about the current usage of plastic in veterinary medicine. The first was that the veterinary sector will never be able to avoid disposable plastic entirely, as it is a key component of daily clinical life. One participant summed up this view succinctly:

Because [plastic is] so cheap and it's versatile and it keeps things sterile, I can see how it became used throughout vet practice... I hate it but I can absolutely see why we use it, and at the moment I don't think there's really a practical alternative. Participant (P) 7

Contrarily, the other most consistent finding across all interviews was the belief that the veterinary profession generates too much disposable plastic waste overall. This idea was encapsulated in one statement by another participant:

[plastic is] not like something like glass or metal which can be recycled indefinitely, plastic for me is quite the worry in our industry. P1

While there were different interpretations of this concept, all seven participants stated that they believed that the veterinary sector uses disposable plastics in excess in at least one aspect of daily clinical life, the most common of which was plastic packaging from product manufacturers.

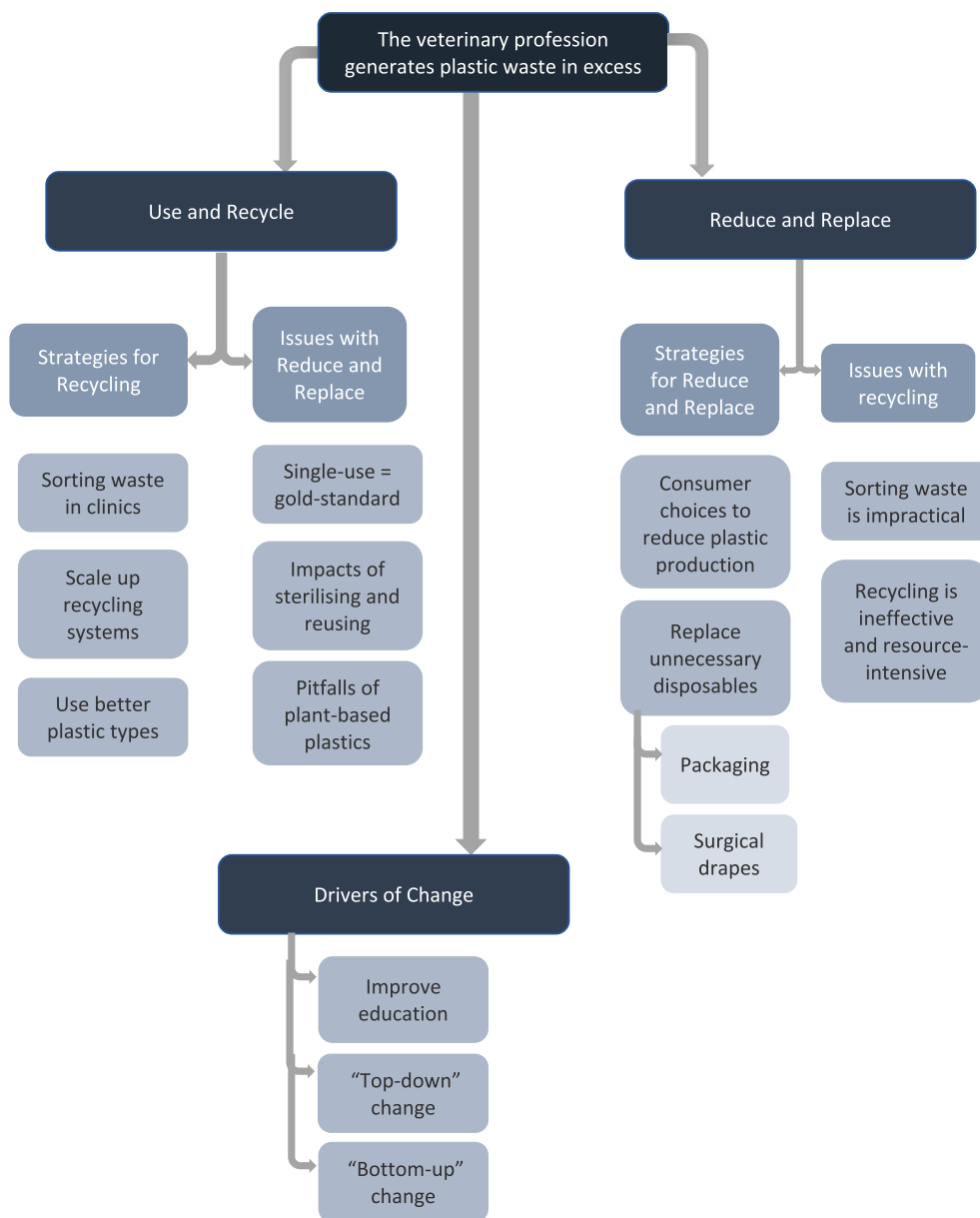
Beneath the theme relating to current plastic use, inductive thematic analysis of this data set elucidated three further themes regarding the ways which the veterinary field should approach the issue of excessive plastic usage: 'Use and Recycle', 'Reduce and Replace' and 'Drivers of Change'.

#### **Use and recycle**

This theme represents the view that veterinary clinics cannot drastically reduce their disposable plastic consumption, so energy should be focused on improving recycling. This view was epitomised by one participant:

Single-use aspect is sterility- to prevent contamination between products, we use a lot because of the nature of the work. P6

The stance of 'Use and Recycle', which was presented by several participants, is predicated on two main principles: that there are fundamental issues with the proposal of reducing and replacing plastic used within the veterinary profession; and that there are indeed strategies through which recycling could substantially reduce the amount of plastic ending up in landfill.



**Figure 2.** The 19 nodes categorised under each major theme identified in the data.

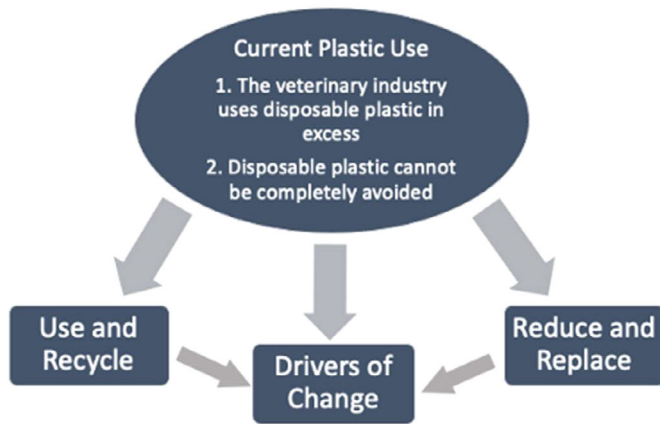
Several participants claimed there were issues with recycling. The first issue raised was the concern over implementing waste sorting into clinic life. They stated that many clinicians spend their entire work days strapped for time, so the idea of introducing another policy that could slow them down was unsettling. While one participant stated that they had worked in a clinic that successfully sorted its waste, they acknowledged that this would not work for all clinics. One interviewee, who works in an emergency referral centre, addressed the issue:

In emergency situations what are you going to do, pile all your rubbish in a corner until someone has enough time to go through it all? Sure, if there are a few people who are super motivated that might happen, but it's never going to happen 100% because there are some people who just wouldn't care,

there are locums regularly that don't always stay up-to-date with everything we're doing, so there's some hurdles on the floor in that way. P4

While emergency referral clinics may have less time available than the average clinic to sort waste, this concept would likely apply to many clinics, particularly in the COVID-19 era when the veterinary sector is stretched dangerously thin. This sentiment was echoed by another participant, whose clinic separates their soft and hard plastics for recycling, when they said,

I found it really difficult during COVID because the amount of disposable stuff just rose up- we're having masks and shields, and I don't know, the amount of disposables just seemed to go up... with infection control and people being



**Figure 3.** The major themes identified in the data. The circle contains the two statements made by all seven participants: (1) that the veterinary sector utilises too much disposable plastic and (2) that disposable plastics will never be completely avoided. The three themes in rectangles represent different suggested approaches on how to address the issue of excessive plastic usage, as well as their relationships to each other.

really scared, especially initially... I had to kind of not be as stringent with all the recycling and waste control. P7

If clinics are unable to adequately meet the challenge of sorting their waste, the chances of recycling and fixing the issue of plastic waste production are slim. The second major point made by participants who were dubious about recycling related to the questionable environmental impact of recycling systems.

One interviewee said of recycling,

We keep looking at recycling being the solution, but recycling doesn't just have this golden, beautiful, positive side to it- it's really intense, from a water perspective, for cleaning, washing processes, it produces a lot of chemical effluents itself through the process, and plastic, despite being recyclable, always requires the addition of virgin plastic to it. P1

Another participant offered a similar viewpoint on plastic recycling:

it's an option but it's the last thing we should be doing, we should be trying to avoid using the product in the first place. I think recycling has been kind of emphasised as a big savior. I don't think people realise the link between plastics and petrochemicals and the fossil-fuel industry. P7

Several suggestions were provided on how the 'Use and Recycle' approach could be implemented. One suggestion was to improve waste-sorting on the clinic floor. To avoid biohazardous contamination, one common recommendation was to become more meticulous about sorting waste in the clinic. One participant, who previously worked in a small animal clinic that sorted all its waste, spoke on the issue,

We had bins for soft plastic and [recycling] in most areas ... [we] got in the habit of sorting waste- paper would go in paper recycling bin and plastic would go in [plastic recycling] bin, didn't take a lot of effort for us to get into that habit... In the beginning it took much longer to sort waste because people were putting the wrong things in the wrong bins, so someone had to sort through to make sure everything was in the right place; probably over a 6-month period that wasn't really happening anymore where someone had to sort through. P4

Other proposals included more holistic approaches to improving recycling efficiency. Several participants suggested influencing product distributors to move to those disposable plastic types that are more easily recycled, as not all plastic types are recycled equally:

[We] could move away from a lot of the larger recycling numbers, like if we said we cannot use type 5 [plastic], must use type 1 since it can be recycled quite well and doesn't require a lot of virgin plastic to be added to it, and pressure manufacturers to veer toward lower number plastics. P1

Using recycled plastic or monopolymer plastic as opposed to a laminate plastic, which is different types of plastic in one barrier, is the cleanest. P3

Most of the participants who advocated for recycling also stated that recycling systems would need to drastically improve to meet the demands of the veterinary sector. They claimed that these systems are ill-equipped to handle the amount of plastic that is generated as a medical field and as a society, and that improving these systems is a key component to improving recycling efficacy. One participant said of one of the plastic recycling programs:

[It] is great- but they are totally overwhelmed and stockpiling plastic film because they do not have enough resources to deal with demand- we need to be scaling organisations like that, which are doing a fantastic job but just can't keep up with demand, up and providing more support avenues and similar programs. P3

### **Reduce and replace**

'Reduce and Replace' was the second main theme emerging from the data regarding how to reduce plastic waste production in the veterinary field. Its primary viewpoint is that recycling alone is not sufficient to significantly reduce the amount of plastic ending up in landfills, and that a more impactful strategy would be to reduce the amount of plastic used by replacing it with sustainable or reusable alternatives. This is consistent with the concept of the 'Waste Hierarchy', which prioritises that avoidance and reduction of waste over other methods of waste mitigation.<sup>22</sup> There are two fundamental beliefs within this camp: that using plastic materials indiscriminately and funneling them into recycling is not a viable solution,

and that reducing plastic consumption through replacement will result in a dramatic decrease in plastic waste production.

Participants that have worked for multiple decades noted that disposable plastic usage has increased overall due to 'higher client expectations for hygiene and sterility'. Some participants suggested several reasons why reducing and replacing disposable plastic is not a viable strategy. The main issue mentioned was that disposable plastics have become synonymous with 'gold-standard medicine' because plastics are a cheap and effective method of ensuring that sterility is not compromised. This places an added mental burden on veterinarians, who must make daily choices to either reduce plastic usage or prioritise improving sterility, a type of dilemma Koytcheva et al. describe as 'tragically ironic'.<sup>20</sup> Several noted that, while veterinarians could previously reuse materials to reduce waste production, in the present day they:

don't think there's any way around single-use syringes, IV lines; in these days of gold-standard medicine I don't think that would be an acceptable practice. P6

Another reiterated this sentiment:

[I've observed] increased [plastic usage] overall- higher client expectations for hygiene and sterility. P2

These participants recognise the need for disposable plastic in the veterinary profession and therefore believe that it is not realistic to drastically reduce its use through replacement. When asked about concerns related to potentially replacing a disposable plastic item with a reusable alternative, one participant responded,

To be honest [...] I don't think you could reduce the use of plastic without impacting something. P2

Several participants expressed concerns that any reusable replacement would incur other costs, including time, labour and environmental. When asked about potential roadblocks to reducing the amount of plastic used in the clinic, one participant stated,

One of them is time- especially the way the industry is at the minute where everyone seems to be apparently understaffed, having trouble getting more vets, to put forward a proposal at your clinic that you want to [sterilise and reuse materials] but you're going to increase labour of the clinic, that would be a hurdle. P4

Concerns about increasing the amount of labour in the clinic by re-sterilising used tools were a consistent theme across several interviews. Participants also noted that re-sterilising and reusing items does not occur without the input of additional resources and energy.

It's just a matter of taking time to clean and reuse or re-sterilise, where environmentally one aspect might offset the other; for example, single-use drapes and washing drapes, you've got water and electricity usage, and while it can be done more sustainably ...like with rainwater, less electricity... a lot of practices don't. P5

Not just labour, but energy- if we're doing something else that's affecting the environment- hot water, detergent- you must consider cost-benefit analysis- do we end up burning more coal to save more plastic that could potentially be recycled? Need to look at this more holistically. P2

This concern relates to the uncertainty of whether sterilising and reusing materials really is more sustainable than using disposable plastics, particularly considering energy and water usage.

Participants also addressed the notion of replacing petroleum-based plastic with plant-based or biodegradable plastics.

Biodegradable plastics are a mess- they biodegrade into microplastics or only biodegrade in things we don't have in Australia like massive landfills with specific conditions... they dissolve and are much poorer at preventing contamination. P3

If you go into plant-based plastics or polymers, they still require a crop to be grown on arable land to produce plant-based plastic, so I'm not sure of the footprint of a plant-based plastic vs normal plastic, how big is the difference between the two...[you have] a plastic that is potentially more dangerous because if it gets into the recycling system it contaminates normal petroleum-based plastics. P1

While some participants expressed interest in the concept of replacing petroleum-based plastics with plant-based alternatives, others dismissed it as a dead-end.

Proponents of the 'Reduce and Replace' ideology provided several suggestions for how to apply this concept in practice. The first strategy, which was agreed upon by almost all participants, is to eliminate disposable plastic items that are unnecessary or redundant. A consensus among the participants highlighted two main areas in which veterinarians could reduce disposable plastic consumption: product packaging and surgical materials. Nearly all participants mentioned excessive plastic wrapping or packaging as areas where plastic is used unnecessarily.

Sometimes it is totally unnecessary, some of the things they wrap in single-use plastic, sometimes manufacturers will send out products with a whole lot of packaging inside it - plastic, noodles, polystyrene - bunch of nonsense packaging. P3

While many recognised the potential need for plastics in specific situations to protect certain products, all interviewees agreed that much of the plastic wrapping used by manufacturers is unnecessary and could easily be replaced by a more recyclable alternative. Most participants suggested that disposable surgical drapes and gowns could be easily replaced without compromising sterility or patient welfare.

There is not much sterile benefit to using [disposable surgical drapes and gowns] as opposed to getting reusable gowns made up...and sterilising them- I think referral clinics need to get on-board with that a little bit more... animal surgeries don't routinely go for 6-8 hours long, whereas in human hospitals some are 12 or more hours long, in that scenario I think that may be a factor, but I don't think that's applicable in vet medicine. P4

Other participants extended this view to include all personal protective equipment (PPE), with one stating,

Disposable PPE would be a good thing to get rid of- unless working with highly infectious pathogens. P1

### **Drivers of change**

The final major theme that emerged through thematic analysis pertains to suggestions for how change should be implemented. This remains a discrete theme because the concepts represented within it can be applied regardless of whether a clinic adopts the Use and Recycle or Reduce and Replace approach. Several interviewees expressed that one of the keys to reducing plastic waste production in the veterinary sector is to improve education. This idea was presented by participants who advocated for both approaches to resolving this issue. Regarding the 'Use and Recycle' approach, one participant stated that they had held an educational tutorial on how to properly sort waste in the clinic:

I think it's how you frame it- I did a talk on sustainability in front of everyone, and we had a bit of a [tutorial] with all the different bins... I think most people care enough about plastics to go 'ok this can be recycled, is it a hard plastic or a soft plastic- I'll put it in the appropriate bin'. P7

Similarly, a proponent for the 'Reduce and Replace' approach proposed:

What we need to do is educate veterinarians about where their plastic is going to, rather than creating this false sense that you're doing good when your plastic is either being disposed of or contaminating good-quality plastic that could still be recycled. P1

Two major conflicting approaches were identified regarding how to drive change, described in the following as 'top-down' and 'bottom-up' approaches. The 'top-down' approach refers to implementing

change on a macro level, by governing bodies enforcing regulations on the amount of plastic that is used.

It's either got to come in as a policy-maker from the top to make a ban... I don't know why the government doesn't talk to big companies and put the onus back on them to deal with the waste that's created through their product... if they knew they were responsible for dealing with their waste at the product's end of life, then they would change their packaging. - P7.

A contradictory viewpoint emerged from other interviews, characterised by a 'bottom-up' approach. This refers to the idea that change is driven by motivated individuals pushing for reducing plastic waste within veterinary facilities.

There are plenty of people and plenty of vets who care quite a bit, and you only need one vet in a clinic to care enough to speak out and try and make some changes- these days most clinic owners will say 'if there's a legitimate alternative then we'll do it'. P5

This position depends on the efforts of many passionate individuals to create positive change within their clinics, which would collectively result in a significant impact on plastic waste production.

Several participants also suggested the strategy of using consumer choices to make changes in the amount of plastic one uses. This involves preferentially choosing products that use less plastic to incentivise companies to abide by these desired changes.

it's interesting that [McDonald's] now uses paper utensils and wooden utensils, and straws are paper- it'd be nice to be able to say, 'hey [another company] still uses plastic straws so let's not go there', so if consumers can make the right choice, we can hopefully gradually influence it. P5

Drug, equipment deliveries historically have a fair bit of plastic involved with that, although we've been pretty proactive about seeking out recyclable packaging materials- now most of it's all recyclable so that's been a big improvement. P6

These interviewees propose that this application of the concept of consumer choice (choosing manufacturers that use less plastic in their packaging) could be a 'bottom-up' vehicle for reducing the amount of disposable plastic consumed by the veterinary profession.

### Discussion

This study sought to examine qualitative data on the attitudes of Australian veterinarians toward the ways they use plastic in their clinical work. The veterinary sector will never be able to avoid

disposable plastic altogether; participants agreed, however, that it is currently used in excess.

The idea that recycling plastic will reduce the environmental impact of those plastic items has support in the literature; for example, a South African study in 2020 found that plastic grocery bags incur a lower environmental cost the more times they are either reused by the consumer or commercially recycled.<sup>23</sup> While there are few data in the scientific literature regarding waste sorting within veterinary facilities, in human healthcare facilities, the best method of preventing contaminated waste from entering non-contaminated disposal (and vice versa) is proper point-of-disposal waste sorting.<sup>24</sup> Recycling programmes encounter challenges when attempting to recycle mixed plastic types,<sup>25</sup> so sorting waste at the point of disposal will potentially improve the efficiency of plastic recycling facilities. Soft plastic recycling programmes often do not accept soft plastics from medical facilities (e.g., REDcycle, <https://redcycle.net.au/>),<sup>26</sup> which makes recycling currently a less viable solution to the issue of soft plastic waste production in veterinary facilities. Several participants in this study mentioned that they transport the uncontaminated clinical soft plastic waste to a soft plastic recycling collection bin in their free time. However, to see significant improvements in the recycling of veterinary plastic waste, these programmes would have to become more accessible for veterinarians so that even individuals who are less motivated to reduce plastic waste could still make sustainable decisions. Access to commercial recycling programmes could be further limited in the veterinary sector due to the low volume of waste produced in comparison to human health sectors, as this may disincentivise waste contractors from collecting waste. For example, the PVC Stewardship programme run by Vinyl Council Australia, which requires member facilities to provide minimum PVC waste volumes of 2 X 240 L bins per month to participate (Vinyl Council Australia, <https://vinyl.org.au/>). More data will be necessary to determine the actual impact of this potential limitation.

The view of biodegradable plastics as a dead-end was introduced by several interviewees. In order to be classified as 'biodegradable', 'oxo-degradable' or 'compostable', plastic materials must pass several criteria, as outlined by Australian Standards 4736-2006 (for industrially compostable plastic) and 5810-2010 (for home composting of plastic).<sup>27</sup> However, these plastic types cannot be recycled with fossil-derived plastics, and this therefore introduces more opportunity for inappropriate sorting of plastic waste. Further public education and the expansion of relevant infrastructure would be necessary for bio-derived plastics to make a material impact on plastic waste production.

In addition to the 'Reduce and Replace' approach, which argues that it will be most effective to reduce or eliminate plastic production at the source, there is also some support within the scientific literature that we will never be able to recycle enough plastic to make a material difference in the amount ending up in landfill. The 2020 National Waste Report by the Department of Agriculture, Water and the Environment indicated that only 13% of plastics are successfully recycled in Australia.<sup>28</sup> As previously stated, recycling is inefficient for plastic in general, and is especially unsuccessful at recycling medical waste due to risks of contamination, as well as other complicating factors.<sup>9</sup> Further, and as pointed out by some participants,

plastic recycling may not be as environmentally sound as many would like to believe. Plastic recycling requires the addition of unused plastic to it in order to preserve the physical and mechanical properties of plastic that are distorted through use.<sup>29</sup> It should be noted, however, that replacing electricity from fossil fuels with renewable energy in the future may improve the carbon footprint of the recycling process.

Another question posed by the 'Use and Recycle' philosophy is whether reusable materials are as effective at preventing contamination compared to disposables. There is mixed evidence regarding the relative efficacy of reusable versus disposable materials at preventing contamination, including gowns and drapes, which were suggested as potential opportunities to replace disposable plastic materials by some participants; for a majority of shorter procedures, at least one study suggests that they remain comparable.<sup>15</sup> A more recent study found that while the thickness of certain types of reusable gowns will significantly change after numerous wash cycles, the overall average thickness, and therefore protective capacity, of reusable gowns far exceeds that of disposable gowns.<sup>30</sup> All participants cited packaging from manufacturers as an area in which plastic is being used excessively, an observation that has support in the literature, as it was demonstrated that the largest portion of plastic on the global market in 2019 was related to packaging.<sup>31</sup> This suggests that focusing on reducing the amount of plastic used in product packaging could make a significant impact on the amount of plastic used by veterinary facilities.

The different views presented under the Drivers of Change category represent contradicting ideas about how change can realistically be implemented. No existing data could be found in the veterinary or medical literature that supports or refutes either the top-down or bottom-up approaches. However, studies from other industries indicate a hybrid top-down-bottom-up approach may be the ideal strategy for achieving environmental outcomes.<sup>32,33</sup> Improving education about plastic waste within the field (as well as among clients) was a common suggestion from most participants. This principle was previously demonstrated by a 2020 study by Kramer et al., which found that veterinarians are cognisant of the threats of climate change but feel ill-equipped to address them due to a lack of sustainability education within the veterinary curriculum.<sup>34</sup> In society more generally, the importance of improving education around plastic waste has been established, as different strategies toward education alter behaviour around plastic usage with varying degrees of success.<sup>35</sup>

In the debate between the 'Use and Recycle' and 'Reduce and Replace' approaches, the best answer may be a middle-ground method in which resources are allocated to improving recycling as well as working to reduce overall plastic usage. This approach is supported by the fact that most interviewees made suggestions that supported both bodies of thought. The aforementioned South African study pertaining to plastic grocery bags also supports this notion, as a lower environmental cost was attributed to a greater number of times a bag is either reused by a consumer or commercially recycled.<sup>23</sup> A similar middle-ground approach may also be applied to the opposing suggestions within 'Drivers of Change' as it will most likely require motivated individuals, large governing bodies and improved education (among clients and veterinary



professionals) to push the veterinary profession toward producing less plastic waste. In a wider context, a hybrid approach should be employed to engage other relevant stakeholders, such as government bodies, manufacturers and distributors, waste and recycling facilities, and other professional organisations. Such movements do exist, such as the Australian Packaging Covenant Organisation's ANZPAC Plastics Pact, which aims to engage its hundreds of member organisations to reduce plastic waste.<sup>36</sup> Only by involving all relevant bodies will true progress be made.

This study had several limitations. The most apparent limitation is that, due to the interview format, subject matter and small participant pool (n = 7), individuals who were passionate about or interested in the topic were the most likely to agree to participate. As a result, the ideas and opinions represented in this dataset may not accurately represent the 'average' Australian veterinarian, as those veterinarians ambivalent toward plastic usage were less likely to participate. However, although the ideas presented here may not be shared by all veterinarians across Australia, they are no less valuable in the discussion of plastic usage within the field. Future studies could mitigate this limitation by including screening questions in the survey regarding participants' level of knowledge on the subject and where this knowledge originated.

Furthermore, only veterinarians were included as participants in the study, so a recommendation for future research would be to include veterinary nurses, practice managers and others associated with the veterinary profession, as they may also provide valuable insight. Larger future studies should extend this to also include affiliated manufacturers, waste contractors, government bodies and other relevant entities, as a holistic approach will be crucial for achieving maximum impact. Although the participant pool was small, all themes and nodes mentioned were repeated across multiple interviews, suggesting data saturation was achieved. Data saturation has been argued to be more significant than sample size in qualitative analysis,<sup>37</sup> so the small participant pool can likely be disregarded as an issue. The second major limitation is that participants did not equally represent all Australian states, as the majority reside in Victoria and New South Wales. Having additional input from all states would have been valuable, as different states approach plastic recycling in different ways, and accessibility to recycling programmes varies significantly between regions and states.<sup>38</sup> As this was a pilot project, equal representation across all states/territories could not be achieved, however, these data could inform further research that aims to include representation across all states/territories. Nevertheless, veterinarians in any given field use plastic for similar purposes regardless of their location, so the data gathered are applicable to Australian veterinarians in every state. This is yet another argument in favour of stakeholder cooperation, as increased unity on a federal scale could result in significant improvements to local recycling programmes in regions with less access.

The data collected in this study suggests that many Australian veterinarians are passionate and conscientious about the disposable plastic they use, despite individuals having different opinions on how to address this issue. While any of the suggested approaches would have to overcome major hurdles, it is imperative that action be taken, as environmental plastic contamination will only become an

increasingly dire concern for future generations of veterinarians and their patients. Before changes can be made, further scientific research must be conducted to inform how the veterinary medical field approaches this issue. Specific, quantitative data on the ways in which veterinary clinics use disposable plastic do not exist in the scientific literature, and further research will be required in this area. Other recommended future research includes life cycle analyses of reusable alternatives to disposable plastics within veterinary medicine, investigating ways to improve medical plastic recycling (as has been more extensively researched in human health facilities<sup>39,40</sup>), and exploring ways to integrate sustainability into veterinary education. Now that scientific research has repeatedly demonstrated the negative implications of excessive plastic waste production, it is the responsibility of humankind to act upon that knowledge and confront the problem.

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#### References

- Geyer R, Jambeck JR, Law KL. Production, use, and fate of all plastics ever made. *Sci Adv* 2017;3:e1700782.
- North EJ, Halden RU. Plastics and environmental health: the road ahead. *Rev Environ Health* 2013;28:1–8.
- Pereira S. Plastic perceptions: surveying public opinion of plastic pollution in Rhode Island [Open Access Master's Theses]. 2019.
- United States Environmental Protection Agency. *Database of sources of environmental releases of dioxin-like compounds in the United States*. 2001.
- Bucknall D. Plastics as a materials system in a circular economy. *Philos Trans R Soc A Math Phys Eng Sci* 2020;378:20190268.
- Pickin JRP, Randell P. *Australian National Waste Report 2016*. Department of the Environment and Energy and Blue Environment Pty Ltd, 2017.
- Vasanthakumar M. Reducing veterinary waste: surgical site infection risk and the ecological impact of woven and disposable drapes. *Vet Evid* 2019;4. doi: 10.18849/ve.v4i3.251.
- Lerner B. *Prevention of dioxin formation in medical waste incineration*. Vol. 6. Pittsburgh, PA, Air & Waste Management Assoc, 1997.
- Lee B-K, Ellenbecker MJ, Moure-Eraso R. Analyses of the recycling potential of medical plastic wastes. *Waste Manag* 2002;22:461–470.
- Joseph B, James J, Kalarikkal N et al. Recycling of medical plastics. *Adv Ind Eng Polym Res* 2021;4:199–208.
- Conrardy J, Hillanbrand M, Myers S et al. Reducing medical waste. *AORN J* 2010;91:711–721.
- Ibbotson S, Dettmer T, Kara S et al. Eco-efficiency of disposable and reusable surgical instruments—a scissors case. *Int J Life Cycle Assess* 2013;18: 1137–1148.
- Vozzola E, Overcash M, Griffing E. Environmental considerations in the selection of isolation gowns: a life cycle assessment of reusable and disposable alternatives. *Am J Infect Control* 2018;46:881–886.
- Eckelman M, Mosher M, Gonzalez A et al. Comparative life cycle assessment of disposable and reusable laryngeal mask airways. *Anesth Analg* 2012; 114:1067–1072.
- Kieser DC, Wyatt MC, Beswick A et al. Does the type of surgical drape (disposable versus non-disposable) affect the risk of subsequent surgical site infection? *J Orthop* 2018;15:566–570.

16. Bellchambers J, Harris JM, Cullinan P et al. A prospective study of wound infection in coronary artery surgery. *Eur J Cardiothorac Surg* 1999;15:45–50.
17. Showalter BM, Crantford JC, Russell GB et al. The effect of reusable versus disposable draping material on infection rates in implant-based breast reconstruction: a prospective randomized trial. *Ann Plast Surg* 2014;72:S165–S169.
18. Grimmond T, Reiner S. Impact on carbon footprint: a life cycle assessment of disposable versus reusable sharps containers in a large US hospital. *Waste Manag Res* 2012;30:639–642.
19. Mace GM, Hudson EJ. Attitudes toward sustainability and extinction. *Conserv Biol* 1999;13:242–246.
20. Koytcheva MK, Sauerwein LK, Webb TL et al. A systematic review of environmental sustainability in veterinary practice. *Top Companion Anim Med* 2021;44:100550.
21. Braun V, Clarke V. Using thematic analysis in psychology. *Qual Res Psychol* 2006;3:77–101.
22. EPA. *Waste hierarchy*. Available at: <https://www.epa.nsw.gov.au/your-environment/recycling-and-reuse/warr-strategy/the-waste-hierarchy>. 2017.
23. Russo V, Stafford W, Nahman A. Comparing grocery carrier bags in South Africa from an environmental and socio-economic perspective. *Waste Research Development and Innovation Roadmap Research Report*. Department of Science and Innovation: Pretoria, South Africa. 2020.
24. Bai R, Hakim L, Harrison I et al. Development of a new classification and colour code for medical waste segregation. In: Oprison S, Zaharim A, Eslamian S, Jian, MS, Aiub CAF, Azami, A, editors. *Wseas LLC, Athens, Greece*. 2012: 242–246.
25. Truss RW, O'Donnell FJH. Plastics recycling: an Australian overview. *Macromol Symp* 1998;135:345–358.
26. REDcycle What to REDcycle. Available at: <https://redcycle.net.au/what-to-redcycle/>.
27. Pickin J. *Australian Standard for Waste and Resource Recovery Data and Reporting*. Department of Agriculture, Water and the Environment. 2021.
28. Joe Pickin CW, Kyle O'Farrell, Piya Nyunt, Sally Donovan *Australian National Waste Report 2020*. Department of Agriculture, Water and the Environment; Blue Environment Pty Ltd. 2020.
29. Chen S-C, Liao W-H, Hsieh M-W et al. Influence of recycled ABS added to virgin polymers on the physical, mechanical properties and molding characteristics. *Polym-Plast Technol Eng* 2011;50:306–311.
30. McQuerry M, Easter E, Cao A. Disposable versus reusable medical gowns: a performance comparison. *Am J Infect Control* 2021;49:563–570.
31. Mazhandu ZS, Muzenda E, Mamvura TA et al. Integrated and consolidated review of plastic waste Management and bio-based biodegradable plastics: challenges and opportunities. *Sustainability* 2020;12:57.
32. Jaccard M, Murphy R, Rivers N. Energy–environment policy modeling of endogenous technological change with personal vehicles: combining top-down and bottom-up methods. *Ecol Econ* 2004;51:31–46.
33. Oltean-Dumbrava C, Watts GR, Miah AHS. “Top-Down-bottom-up” methodology as a common approach to defining bespoke sets of sustainability assessment criteria for the built environment. *J Manag Eng* 2014;30:19–31.
34. Kramer CG, McCaw KA, Zarestky J et al. Veterinarians in a changing global climate: educational disconnect and a path forward. *Front Vet Sci* 2020;7:613620.
35. Chow C-F, So W-MW, Cheung T-Y et al. Plastic waste problem and education for plastic waste management. In: Kong SC, Wong TL, Yang M, Chow CF, Tse KH, editors. *Emerging practices in scholarship of learning and teaching in a digital era*. Springer Singapore, Singapore, 2017;125–140.
36. ANZPAC *Plastics pact*. Available at: <https://apco.org.au/anzpac-plastics-pact>. 2022.
37. Dworkin SL. Sample size policy for qualitative studies using in-depth interviews. *Arch Sex Behav* 2012;41:1319–1320.
38. Kourabas S. An Australian National Plastics “plan”: one plan to rule them all? *Aust Environ Rev* 2021;36:26–32.
39. Wyssusek KH, Keys MT, van Zundert AAJ. Operating room greening initiatives – the old, the new, and the way forward: a narrative review. *Waste Manag Res* 2018;37:3–19.
40. Kane GM, Bakker CA, Balkenende AR. Towards design strategies for circular medical products. *Resour Conserv Recycl* 2018;135:38–47.

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