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COMMENTARY

Authors' response on *Perkins* et al. (2021) "Dead in the water: comment on "Development of an aquatic exposure assessment model for imidacloprid in sewage treatment plant discharges arising from use of veterinary medicinal products"

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Abstract

In 2020, Anthe et al. published a newly developed model to predict imidacloprid surface water concentrations stemming from sewage treatment plant (STP) effluent as a consequence of the use of veterinary medicinal products containing imidacloprid in the UK (Anthe in Environ Sci Eur (2020) 32:147, https://doi.org/10.1186/s12302-020–00424-4). The modelled data indicate that these veterinary medicinal products make only a very small contribution to the levels of Imidacloprid observed in the UK water monitoring programme.

The commentary by Perkins et al. (Perkins in Environ Sci Eur (2021) 33:88, https://doi.org/10.1186/s12302-021-00533-8) questioned the validity and conclusions of the modelling approach. We believe the modelling approach, which considered what we anticipated to be, the major exposure pathways, gives a realistic picture of the chronic emission via STPs to UK rivers.

Keywords: Imidacloprid, Veterinary medicinal product, Surface water, Scenarios, Exposure assessment, United Kingdom

Background

Imidacloprid is an active ingredient included in plant protection, biocidal and veterinary medicinal products (VMPs). Monitoring data collected under the Water Framework Directive between 2016 and 2018 showed detectable and varying levels of Imidacloprid in the UK surface water bodies. Anthe et al. [1] investigated the potential contribution of VMPs by developing a model to predict the emissions from sewage treatment plants from the use of dog and cat spot-on and collar VMPs. Due to the absence of appropriate exposure models for VMPs, the model was built based on the principles of environmental exposure assessment for biocidal products under the biocidal product regulation (BPR). Three emission paths were considered to be the most likely routes for repeated emissions to waterways from the use of spot-on and collar VMPs, i.e. transfer to pet bedding followed by washing, washing/bathing of dogs, and walking dogs in the rain. Realistic worst-case input parameters were deduced from: product characteristics, sales and survey data. In addition, some of the input parameters came

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from data generated in experimental studies; the data from which has been evaluated by veterinary regulatory bodies as part of their approval of the authorisation of these VMPs. The calculated concentrations for each emission pathway did not exceed the ecological thresholds for the most sensitive aquatic invertebrate organisms and were found to be much lower than the UK monitoring data for river water.

A response from the authors to the critique by Perkins et al. [2] is provided below.

Comments

We welcome the views of others and take these seriously in reviewing our own work.

Perkins et al. [2] seem to question the validity of the well-established biocide modelling approach that is set out by the Authorities responsible for regulating biocides in the EU (such as the use of default values) [3]. The model is based on the principles of the environmental risk assessment for Biocidal Products, which provide protection over an extended period (e.g. biocidal insect repellents [5]). The default values accepted and widely used in biocide modelling and in our model are summarised in Table 1.

The model is designed to estimate the average contribution of Imidacloprid arriving in STPs due to its usage as a veterinary parasiticide in the catchment area of the STP. It gives an average concentration in the STP outflow and based on standard dilution factors [3] the subsequent predicted average concentrations of Imidacloprid in the rivers which are connected to the STP are calculated.

Focusing on the spot-on products, this calculated average concentration takes into account the seasonality effect by studying the months when most of the spot-ons are used. The resulting average river concentration for a month of highest use has been compared with the lowest Predicted No Effect Concentration (PNEC) for aquatic chronic exposure in use by the European Commission, as well as the annual average surface water concentrations measured at different locations in the UK. The critique from Perkins et al. [2] stipulating that the model implies Imidacloprid is released from pets into the environment for 24 h only, is incorrect. The calculations are detailed in the section "Materials and Methods—Emission calculations" [1] with an example calculation given by the authors in the Additional File 1 (https://enveurope.springeropen.com/articles/10.1186/s12302-020-00424-4#additional-information). In the model, it is assumed that the applied amount of imidacloprid is available for 4 weeks, which is the period of protection registered on the label of the spot-ons. The average amount of Imidacloprid available per day equals the total amount applied in the month divided by 30. The total amount applied per month is calculated from the month of highest frequency of use, which is August based on survey data, as a fraction of the annual amount of imidacloprid used in the STP catchment area (see Eq. 4 [1]). Again, it is the daily average the model calculated to compare this with the chronic PNECs. There might be days with higher release and some with lower release, but it is reasonable to use the mean for comparison with the long-term chronic benchmark.

Another critique from Perkins et al. concerning unpublished in-house studies is not justified. A summary of the study design, main results and derived input parameter for the three emission scenarios were already provided in the Additional File 1 (https://enveurope.springeropen.com/articles/10.1186/s12302-020-00424-4#additional-information). An overview of the used in-house studies is provided in Table 2.

In the absence of regulatory guidance on the conduct of such studies, they were designed in-house to be realistic. The results were used to derive realistic input parameters for the model. Where appropriate the results of the pet owners' survey have been used to support the derived parameters and a margin of safety has been considered for these input parameters as illustrated above in Table 2.

Perkins et al. dismiss, without any validation, other potential sources of imidacloprid found in UK rivers [2]. We believe that most of the arguments in the Perkins et al. commentary relates to exposure pathways without a consideration of their plausibility, relevance or significance. However, we acknowledge that amongst the criticism there is one which is fair and warrants further work: consideration of two additional potential pathways of imidacloprid into water. The build of the model was the first time this has ever been done for veterinary medicines and it is not surprising that enhancements can be

Table 1 Default values used according to the BPR

Parameter	Nomenclature	Value	References
Number of households connected to the same STP	N_{houses}	4000	[4]
Effluent discharge rate for a STP	$EFFLUENT_{STP}$	2,000,000 L/d	[3]
Dilution factor from the STP effluent into the adjacent receiving river water	DILUTION	10	[3]

Table 2 In-house studies used to derive input data for modelling by Anthe et al. [1]

Type of study	Study design	Results	Derived input parameter
Stroking tests for spot-ons	16–20 dogs treated according to the registered label. Four samples taken between 10 min and 24 h post-application by stroking the dogs with highly absorbent cotton gloves	< 10% of the active substance applied was measured on day 1 (worst case)	Considering an adequate margin of safety abrasion to resting places was estimated 20% $F_{abr} = 0.2$ is used in Scenario 1 "Washing of pet bedding"
Stroking tests for collars	8 dogs and 8 cats were treated with a collar. The animals were stroked with absorbent cotton gloves on 11 days within a period of 1 to 238 days after applying the collars. The calculated amount of each interval was summed up to cover the 8-month period. Assuming stroking 4 times per day the results were multiplied by 4	< 0.6% of the total active substance content was available for abrasion during the 8-month treatment period	An amount of 1% is used for the calculations ($F_{abr} = 0.01$) in Scenario 1 "Washing of pet bedding"
Washing and vacuuming of cat bedding	2 groups of six cats, 6 h post treatment, received in their cage a piece of cloth-covered plywood which was left in the cage for 4 consecutive days. The cloth was then cut in half. One piece was analysed immediately, remaining pieces of cloth from group 1 were machine washed and those of group 2 were vacuumed. Then extraction and analysis of the imidacloprid present was performed	Imidacloprid concentration measured in the cloths were: - < LOQ after washing - Decreased by 50% after vacuuming	A fraction released due to washing was set to $F_{washing}$ of 0.5 taken also into account the pet owners survey that showed vacuuming is done normally in between each washing (relevant for Scenario 1 "Washing of pet bedding"). Therefore, by the time of washing a proportion of the active substance is no longer available for release [1]
Immersion test with collars	Study 1: Eight collars for large dogs were immersed in plastic tubes filled with 180 L water for a period of 5 min Study 2: Eight dogs were treated with a collar. 83 and 90 days after treatment each dog was immersed in tepid water for a period of 5 min. The dog's head was wetted three times during the immersion procedure	Imidacloprid concentration measured in water samples were below the LOQ (5 µg/L) Less than 0.9% of the collar inventory was detected in water whether or not dogs wore the collar during immersion. The fraction of Imidacloprid released in these tests was estimated at 1.64% (90th percentile)	The fraction of imidacloprid released from treated pelt due to rain was set to 2% for collars and the input parameters F_{rain} 0.02 is used in the scenario 3 "Walking dogs in rain" Based on the immersion tests with the collars and a safety factor > 10 taking into consideration the frequency of shampooing (Table S6 in Additional File 1), an average fraction $F_{washing}$ of 0.2 was calculated for the scenario 2 "Washing/bathing of dogs" (see Eq. 12 and Table 1 [1])

considered. Before the commentary was published, we had already examined other potential exposure pathways and identified two additional major ones; hand washing after pet stroking and washing of clothes. We completed modelling of these pathways using the same calculation approach as described in the publication by Anthe et al. However, these results have not been published yet.

Conclusions

We are still convinced that the model gives reliable information on the most likely imidacloprid emissions from UK sewage treatment plants resulting from spot-ons and collars used for pets.

Further evidence is needed to establish the main contributors to detection of imidacloprid at certain points in UK waters. Modelling is one important source of evidence.

Abbreviations

BPR: Biocidal products regulation; EQS: Environmental Quality Standard; EU: European Union; STP: Sewage treatment plant; UK: United Kingdom; VMP: Veterinary medicinal product.

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Authors' contributions

All authors reviewed the manuscript before submission. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

J. Achtenhagen works as consultant for Bayer Animal Health GmbH.

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References

1. Anthe M et al (2020) Development of an aquatic exposure assessment model for imidacloprid in sewage treatment plant discharges arising from use of veterinary medicinal products. Environ Sci Eur 32:147. https://doi.org/10.1186/s12302-020-00424-4
2. Perkins R et al (2021) Dead in water: comment on "Development of an aquatic exposure assessment model for imidacloprid in sewage treatment plant discharges arising from use of veterinary medicinal products." Environ Sci Eur 33:88. https://doi.org/10.1186/s12302-021-00533-8
3. ECHA (European Chemicals Agency) (2017) Guidance on biocidal products regulation: volume IV environment—assessment and evaluation (Parts B+C). European Chemicals Agency, Helsinki
4. OECD (Organisation for Economic Cooperation and Development) (2014) Insecticides, acaricides and products to control other arthropods for household and professional uses. Series on emission scenario documents, No. 18. OECD Publishing, Paris. https://doi.org/10.1787/9789264221123-en
5. ECHA (European Chemicals Agency) (2015) Emission scenario document for product type 19—repellents and attractants. European Chemicals Agency, Helsinki

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