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1 **3R Blackboard: a platform for animal and organ sharing**

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18 **Running head:** Reducing Laboratory Animal Use

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25 **Abstract**

26 Since the embedding of the principles of the 3Rs (Replacement, Reduction, and Refinement) in national  
27 and international regulations on the use of animals, scientists are challenged to find ways to reduce the  
28 number of animals in their research. Here, we present a digital platform, called '3R Backboard', linked  
29 to a laboratory animal management system, which facilitates sharing of surplus biological materials from  
30 animals (e.g. tissues, organs and cells) to other research teams. Based on information provided, such  
31 as genotype, age and sex, other animal workers were able to indicate their interest in collecting specific  
32 tissues and to communicate with the person providing the animals. A short pilot study of this approach  
33 conducted in a limited academic environment presented strong evidence of its effectiveness and  
34 resulted in a notable reduction of the number of mice used. In addition, the use of 3R Blackboard led to  
35 resource saving, knowledge exchange and even establishment of new collaboration.

36 **Keywords:** Reduction; organ/animal sharing; 3Rs principle; animal welfare; software

37 Biomedical research relies on animal experimentation usually conducted in central animal facilities that  
38 handle thousands of animals. The European Parliament and the Council of the European Union  
39 prescribed the EU Directive 2010/63 as a framework for conducting scientific experiments with animals<sup>1</sup>  
40 making strict compliance with the 3Rs principle (Replacement, Reduction and Refinement) mandatory<sup>2</sup>.  
41 In addition, the regulation in place requires thorough tracking of individual animals, data capture and  
42 scientific data management. Recently, diverse freely available non-commercial programs and  
43 commercially distributed management systems were developed<sup>3,4</sup> to allow accurate data integration and  
44 management accordingly to specific requirements of the institution. Most of these systems are designed  
45 to increase workflow efficiency, data security and animal welfare<sup>5</sup>, but do not allow efficient sharing of  
46 information to promote a reduction in animal numbers. Here we demonstrate the value of 'animal  
47 sharing' and report the implementation of a new feature in the tick@lab animal management software  
48 that allows reduction of the number of laboratory animals by sharing surplus animals, organs and  
49 tissues.

50 A recent report revealed that about 10 million animals were used per year for experimental and other  
51 scientific purposes in the 28 EU Member States during 2015-2017<sup>6</sup>. Mice are the most common species  
52 used in regulated procedures (61%) and are mainly sacrificed for organ harvesting only.

53 Accordingly to "reduction" principle of 3Rs<sup>2</sup>, the total number of animals used in experimental settings  
54 can be minimized by performing more than one procedure on an animal. This strategy is permitted only  
55 under specific conditions related to the actual severity level of the previous procedure. Consequently,  
56 animal reuse contributed only to a 2% decrease of the total number of animals used for scientific or  
57 translational purposes in 2017<sup>6</sup>. Reduction can also be achieved by improved information collection and  
58 experimental techniques, as well as appropriate statistical analysis.

59 Alternatively, sharing data and resources, such as surplus animals and tissues, can contribute to  
60 reduction. In particular, surplus animals are commonly generated in laboratories, where single sex or a  
61 specific age of animals is preferentially used for experimentation. Similarly, the generation and  
62 maintenance of new genetically modified strains creates an excess of animals with undesired genetic  
63 background. Based on volunteered data from 3 UK Home Office licensed projects in Cardiff University,  
64 School of Medicine, we calculated that approximately 80% of mice fall into this category. Unfortunately,  
65 generation of these animals (Surplus 1) cannot be prevented. Another group of poorly used animals  
66 (Surplus 2) consist of those destined for tissue collection without procedure, or culled for harvest of a

67 single organ at the end of an experiment, while the rest of the sacrificed animal is disposed of. When  
68 shared, these sacrificed animals can offer a rich source of biological materials (e.g. organs, tissues,  
69 cells) for other researchers. Therefore, meaningful use of Surplus 1 and further exploitation of Surplus  
70 2 can significantly contribute to the reduction of the absolute number of animals used for scientific  
71 purposes.

72 The RWTH University Aachen (Germany) and Cardiff University (UK) use tick@lab (A-Tune Software  
73 AG, Darmstadt, Germany) to ensure protocol compliance and proper reporting of all animal  
74 experimentation. In the basic version of the program, the menu already offers the transfer of animals  
75 that are not required (Surplus 1) from the experimental stock between different licensed projects, if the  
76 legal requirements (e.g. signed transfer agreement, animal application for specific strains) are met.

77 We have now extended this function by adding a platform termed “3R Blackboard”, in which research  
78 teams can announce the availability of excess biological materials (tissues, organs, cells). In this  
79 application, the provider lists important details about the animal (e.g. strain, sex, age, treatment) and  
80 their contact information (Figure 1a). Animal workers from other groups can then specify their interest  
81 in collecting tissues and communicate with the person providing the animals.

82 Development of this function follows a successful pilot study involving 10 participants with active UK  
83 licenses from 2 research groups based at Cardiff University. Licensees were requested to offer mice  
84 from Surplus 2 that have not undergone any prior treatment accordingly to guidelines explained above.  
85 Over a period of 19 months, we recorded 46 entries with an average of 5.57 mice per entry and a total  
86 of 256 mice. Nearly half of the mice that were made available (47.8%) were then shared by two to six  
87 licensees including the individual providing the animals. The majority of tissue collections (total of 17)  
88 were performed by 2 licensees (Figure 1b and c). In total, 97 mice out of 256 offered (37.9%) were  
89 shared for extraction of tissues, including bone marrow, peritoneal lavage, brain, and others (e.g. blood,  
90 kidney, peritoneal membrane, skin, spleen, thymus). Bone marrow was the predominantly collected  
91 tissue reflecting the research need of laboratories involved in this study. Most importantly, utilization of  
92 this sharing approach saved 140 mice (97 multi-used mice x 1.45 average number of extra users per  
93 mouse) and reduced animal costs. Accordingly to local animal facility charges, 140 mice bred to age of  
94 8 weeks have a full economic costing approaching £4000, depending on husbandry and environmental  
95 controls, but in simplified terms this represents a cost saving of approximately 35% that matches the

96 reduction in animal use. We anticipate that these and other benefits will be greatly amplified after  
97 implementation of the offer platform on the institute scale and inclusion of remaining animals from  
98 Surplus 2.

99 Notably, working with materials of these sacrificed animals is generally not subject to additional special  
100 regulations and does not require supplementary approval by an institutional animal care and use  
101 committee. However, it should be noted that in some cases when sacrificed animals are subject to  
102 legally binding Material Transfer Agreements (MTA) that involve intellectual property, the dissemination  
103 of materials is potentially limited or even prohibited. The researchers should report the health and  
104 genetic status of the animals used and follow all standard institutional procedures to prevent cross-  
105 contamination of facilities, where appropriate.

106 We provide strong evidence that exchange of surplus biological materials in combination with improved  
107 workflow (Figure 2) fulfills the legal compliance to reduce the number of animals used in research.  
108 Moreover, such strategies offer the opportunity to scientists to generate additional data, harmonize their  
109 protocols and to establish and manage joint collaborative projects and publications. The 3R Blackboard  
110 approach can be easily implemented at other locations as a simple software update.

111 The application of the 3Rs principle is a central component in animal experimentation that has already  
112 improved animal welfare and benefited science in many aspects. However, the best way to improve  
113 general animal welfare is to reduce their usage. We show that implementation of an 'offer platform',  
114 such as 3R Blackboard, in laboratory animal management systems offers an effective approach to meet  
115 this objective.

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122 **Conflicts of Interest:** A.S. is CEO and E.E. is working as a veterinarian at the a-tune software AG  
123 Company. All other authors declare no conflict of interest.

124 **Data availability statement:** All data is included in this paper.

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150 **Figure legends**

151 **Figure 1. The principle and effectiveness of 3R Blackboard.** (a) Tick@lab 3R Blackboard platform;

152 (b) Total number of untreated Surplus 2 mice offered and used by multiple licensees over duration of

153 the pilot study; (c) Number of time licensees made any number of mice available (number of mice offers)  
154 versus the total number of licensees collecting tissue from at least one mouse on that occasion.

155 **Figure 2. Overview of animal surplus handling in tick@lab.** Animal surplus (Surplus 1) from excess  
156 stock is offered to other research teams. Similarly, surplus organs, tissues and cells (Surplus 2) shifted  
157 to offer platform (e.g., 3R Blackboard) from sacrificed animals are shared with other animal workers.  
158 Generated with Smart Servier Medical Art (<https://smart.servier.com/>).