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Next generation pollen monitoring and dissemination

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Although pollen allergy is the most frequent allergic disease in countries with a western life style (1), knowing “the enemy” i.e. the current pollen exposure, is still a neglected scientific topic. This is remarkable, as pollen levels predict allergy symptoms in allergic individuals (2). In addition, higher pollen exposure results in more allergic sensitizations (3). Thus, knowing the local pollen count is of relevance for allergic individuals. Instrumental to the measurement of ambient pollen was the

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development of the manual Hirst trap in 1952, a simple and cheap but efficient instrument able to assess airborne pollen. And indeed, pollen is now monitored in almost every country of the world with this instrument (4), with some time series dating back to 1952.

The EAACI conference 2018 in Munich showed that the field of pollen monitoring is now rapidly changing. In Bavaria, Germany (the county of the conference) a network of 8 automatic pollen monitors (robots) was installed this year. Novel is that the network called ePIN (electronic Pollen Information Network) is state owned (www.lgl.bayern.de), circumventing the problem of declining finances many private pollen monitoring networks face. Second, data is delivered to any person online and for free, and third, the speed of delivery of data is within hours instead of days as in the conventional setting.

Pollen data are now available online as soon as the pollen robots report their findings. The next novelty is, that the dissemination of the data is revolutionized too. At the EAACI conference 2018 the worldwide first and only “Pollen Indicator” was unveiled, see figure 1. The purpose of this “Pollen Indicator” is to show in one glance which pollen, and how many are in the air right now. The “Pollen Indicator” does not measure pollen, but instead is linked to a robot that does the job (5). The “Pollen Indicator” makes a light show of the current pollen levels, delivered by the robot. Horizontally at the top, a running screen with bright LEDs shows which pollen is currently displayed. Although thresholds for allergic symptoms due to pollen are still debated and vary with patient and location (6), vertically a color-coded LED-column shows how much allergic symptoms an allergic individual might expect: when the whole “Pollen Indicator” turns red, >100 pollen/m^3 of the displayed pollen are in the air and symptoms are expected to be severe. When pollen is <25 pollen/m^3, a smaller light column glows up green, telling individuals that no symptoms are expected, even for sensitized individuals. A QR-code on the “Pollen Indicator” links to a website (www.zaum-online/pollen) that explains in more detail the ins and outs of what is shown. The “Pollen Indicator” makes pollen visible.

The robot uses image recognition, a field that is changing rapidly and although currently only three automatic pollen monitors are on the market, probably more will follow. The oldest automatic pollen monitors are installed in Japan. In Japan, one pollen type is dominant and of concern: those of the Japanese Cedar (*Cryptomeria japonica*) to which most Japanese are allergic. Thus, reporting Japanese cedar pollen is enough. In other countries this is not sufficient and the information which pollen type is flying is critical. Then only two instruments with completely different working mechanisms are available. The BAA (Bio-Aerosol-Analyzer) is a robotic microscope that, like humans, recognizes pollen by image recognition (5). The second instrument is an “air flow cytometer”, measuring optical parameters of a pollen when it passes through two red and then an UV laser (7). Although the performance of both instruments is not perfect and does not beat the human eye, when running large numbers of samples in a network of pollen monitors the “human eye method” is not without errors too. Simplified, both make similar errors but each of another kind. Importantly, the robots´ major error is “I don´t know this pollen” and seldom wrong classification of a pollen i.e. when a robot classifies, it is mostly right. Improvements will be made in the recognition of pollen with a “bad hair day”, as pollen are not little flying stones, but can be easily deformed by environmental conditions. Deformed pollen is no problem for the human eye, but are a problem for a robot. Due to training, the classification as "unknown pollen" is steadily decreasing.

The novel instruments at the EAACI 2018 conference make clear that the well-established field of pollen monitoring is suddenly rapidly changing, not only in novel and online instrumentation but also in dissemination. If users realize that a new type of data is available online, more users might use this information and probably some of them might be willing to record their symptoms. It is now becoming clear that the relationship of more pollen results in more symptoms might be more complicated than previously thought (6). Perhaps there is a lag time between exposure and symptoms, or some exposures are more severe for allergic individuals than others (8), or other factors like daily pollen peak are more important that daily average concentration etc. Without higher time resolved and reliable systems these questions cannot be addressed. Thus, the new networks are not only an improvement of the old technique, they open new ways of research previously not possible or only possible at very specialized centers at a high cost.

To obtain the local pollen exposure, an interactive map of about 900 pollen monitoring stations worldwide is available (www.zaum-online.de). This information might show that a pollen monitoring site is not close enough. Most officials or politicians do not know how small and fragile their local networks are, and that the government should support their survival. Pollen counts are popular, exemplified by the availability of many pollen apps, and pollen forecasts are among the most popular websites of weather services. If pollen is not properly measured, pollen numbers will be modelled, calculated or just made up by "independent suppliers".

Is such a system worth the costs? This is currently not known. The government calculated that the sum of direct and indirect costs of allergic diseases in Bavaria amounts to €600Mio/year. The automatic network itself costs about €600.000/year. If reliable pollen data would save 0.1% health costs, the system would be cost efficient. In Bavaria, it is believed that this will be the case.

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Authors contribution statement:
JB was responsible for planning, design, manufacturing, installation and writing the manuscript. CSW was responsible for planning, design, realization and writing. JO was responsible for programming the display-software, network design, network building and writing.

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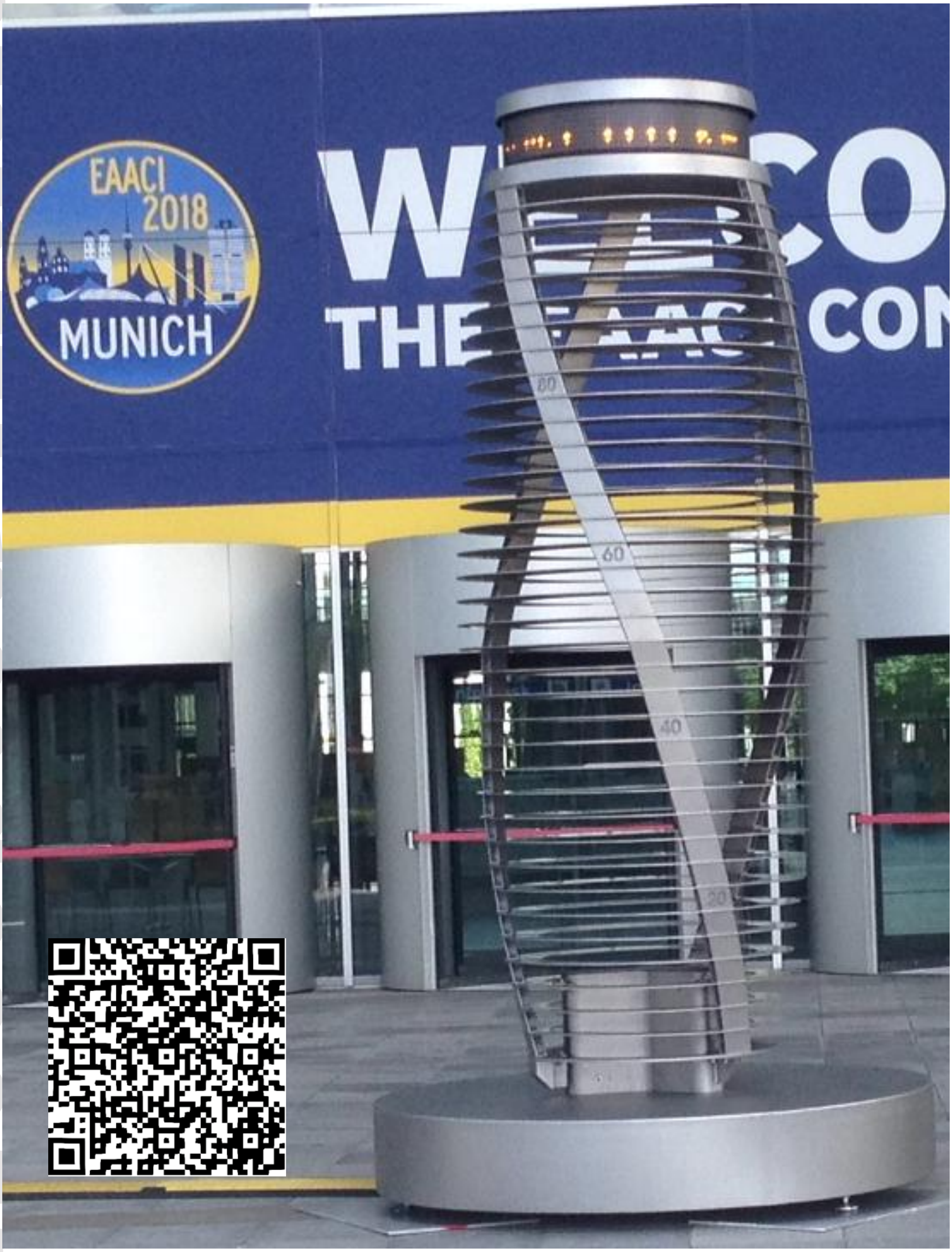
Figure 1. The worldwide first and only pollen indicator showing the current pollen levels with a light show at the EAACI 2018 conference in Munich. The QR-code on the monitor links to a website with more information.

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