According to the World Health Organization (WHO), mobile health is defined as “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices.” For example, mobile apps (such as MASK-Air, Allergy Monitor, Pollen, and others) have proven useful in the management of patients with allergic rhinitis. These apps can be used in the context of broader clinical decision support systems (CDSS) for enhancing allergy-related decisions and actions with pertinent, organized clinical knowledge and patient information to improve allergy care.

A CDSS targeted to control rhinitis with drugs and other interventions guiding the patient in his/her self- and doctor-driven management is currently being produced and investigated by the MACVIA network. Another one, called @IT-2020, is targeted to support etiologic diagnostics and allergen immunotherapy (AIT) prescriptions for patients with seasonal allergic rhinitis. Intensive investigation is necessary to better define the advantages and limitations of mobile-health technology in allergology and establish guidelines for their proper use in daily practice in the context of a rapidly evolving European regulatory environment.

**KEYWORDS**

allergy diagnostics, clinical decision support, digital health, disease management, mobile health

1 | THE DIGITAL HEALTH TRANSFORMATION

According to the World Health Organization (WHO), mobile health is defined as “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices.” According to the 71st World Health Assembly in Geneva (2018), mobile wireless technologies have the potential to revolutionize the interaction of populations with national health services. They improve quality and coverage of care, increase the access to health information, services, and skills, thus promoting positive changes in health behaviors and preventing the onset of acute and chronic diseases.

The WHO Director General recommended Member States to identify standardized approaches for applying digital health in their health systems and services. Several aspects of traditional health care will be changed by the digital health revolution: (a) The point of care is no longer the clinic or laboratory, but the patient; (b) the approach to care is based rather on the individual patient than on a population of patients with similar disease; (c) the traditional hierarchy between doctor and patient (doctor as an authority) based on prescriptions and orders is replaced by a collaboration based on a partnership (doctor as a guide); (d) the
patients’ data are their own property, not that of any institution; (e) decisions will be based rather on limitless data analysis than on the doctors’ experience only; (f) the doctor is not isolated in an ivory tower, but interacts publicly with the patients via social media; and (g) the costs of care are diminished.2

2 | DIGITAL HEALTH IN ALLERGOLOGY

Digital health may also have a very positive impact on allergic patients. A position paper by the American College of Allergology, Asthma and Immunology (ACAAI) stated that allergic patients, especially those living in rural or remote areas, benefit from telemedicine. Consequently, a better patient-doctor collaboration, easy access, and adherence to allergists’ consultation and prescription become possible.3 However, the document points out the need of improved regulations and certification programs, high attention to data protection, and the development of adequate reimbursement systems.3 Recently, a Task Force of the European Academy of Allergy and Clinical Immunology (EAACI) published a position paper on “Mobile Health & Allergy.”4 The study group examined over 130 allergy-related apps and reported on the role of mHealth technologies in allergic rhinoconjunctivitis and asthma, atopic dermatitis, chronic urticaria as well as food allergies, anaphylaxis, drug, and venom allergies.4

3 | APPS FOR ALLERGIC RHINITIS

Although many apps are dedicated to allergic rhinitis, only few have been used in studies published in peer-reviewed international journals.4 A very large collaborative network focused on rhinitis and its treatment is accumulating evidence through the worldwide use of MASK-Air (MASK stands for Mobile Airways Sentinel Network). This electronic clinical diary assesses nasal, ocular and asthma symptoms, as well as work impairment and global health via visual analogue scales (VAS).5 MASK-Air has already accumulated real-life data from a large number of patients worldwide, whose analysis has led to innovative knowledge on productivity at work, innovative patterns of treatment, and new allergic disease phenotypes.6 Another app, called Allergy.Monitor, is dedicated more specifically to the measurement of symptoms and medication intake of patients and their correlation with local pollen concentrations.7 It has been instrumental to improve disease awareness and adherence to daily therapy with nasal corticosteroids in children with grass pollen allergy.8

4 | CLINICAL DECISION SUPPORT SYSTEMS (CDSS)

According to HIMSS (Healthcare Information and Management Systems Society), a “CDSS is a process for enhancing health-related decisions and actions with pertinent, organized clinical knowledge and patient information to improve health and healthcare delivery.”9 The origins of CDSS date back to the 1960s, an example how this field of medicine has initially developed slowly, and now, in the era of the internet develops much faster.10

A CDSS is generally composed of three elements: A) data; B) algorithms; and C) reporting: (Figure 1).

- The data may come not only from the patient, but also from the environment the patient is exposed to and the community he/she is living in. The patient’s data include information from his/her past and current clinical history, results of investigations and examinations prescribed by the doctor, and data acquired through monitoring of his symptoms and medication (clinical diary).
- The algorithms are, in most simple terms, mathematical formula (simple or complex) using the data and generating reports, suggesting diagnostic interpretations, or therapeutic decisions. These algorithms can be rigid or flexible and can be anchored in

Figure 1 General concepts of a clinical decision support system. Three elements compose a CDSS: (a) data—from the patient and also from the environment (to which the patient is exposed and from the community in which he is living); (b) algorithm—mathematical formulas (simple or complex) that take the data and generating reports; and (c) reports—can be delivered as a written report, a suggestion of further diagnostic examinations, a therapeutic plan to the operator (ie, the doctor) as a suggestion to be considered for his/her actual diagnostic or therapeutic decision. [Colour figure can be viewed at wileyonlinelibrary.com]
or based on clinical guidelines. Flexible algorithms can be modu-

lated or fine-tuned by the operator (ie, the doctor) who can adjust

thresholds, decision cut-points, and lists of the parameters to be

taken into consideration, according to his/her own experience.

Fine-tuning can be applied to the local patient population or to

individual patients.

- The reporting system can appear as a written report, a suggestion

of further diagnostic examinations, or a therapeutic plan and is
directed to the operator (ie, the doctor) as a suggestion to be con-
sidered for the actual diagnostic or therapeutic decision.

A CDSS can also incorporate a reiteration process, consisting in

further monitoring of the patient, for example, once the therapy has
been started to register the patient’s response to treatment. A new
application of algorithms enables further reporting.10

5 | CDSS FOR ALLERGIC RHINITIS

A CDSS for rhinitis, including allergic rhinitis, has been produced by
the MACVIA network and is the object of active investigation.11 This
CDSS is targeted to control rhinitis with drugs and other interven-
tions and guide the patient in his/her self- and doctor-driven man-
agement.11 Another CDSS, called @IT-2020 (Figure 2), is exclusively
dedicated to seasonal allergic rhinitis and to the prescription of aller-
gen immunotherapy. @IT-2020 is based on the collection of clinical

history, pollen calendar information, determination of allergic sen-
sitization with allergen-extracts, component-resolved diagnostics,
and clinical monitoring through an electronic diary. Algorithms are
based on international guidelines including ARIA, GINA, and EAACI

guidelines for SPT, molecular IgE assays, and pollen season defini-
tions. This CDSS system guides the doctor through the different
steps of the diagnostic workup and, on the basis of the electronic
clinical diary and pollen counts, provides evidence on the frequency
and intensity of the patient’s allergic symptoms during the season
of those pollens, whose genuine IgE sensitization has been proven
by component-resolved diagnostics. Each element of this CDSS is
being validated, and the CDSS itself is tested in a large international
project called @IT-2020 currently in progress in seven Southern
European countries.

6 | PERSPECTIVES AND CONCLUSIONS

Overall, the role of doctors, in particular allergists, and their inter-
action with their patients, will be progressively altered with the in-
creasing use of digital opportunities in order to improve patient care.
WHO, ACAAI, EAACI, and other relevant international organizations
have recognized the advent of the mHealth era in medicine and aller-
gology. This novel area requires regulation and intensive investiga-
tion to better define the advantages and limitations of mobile health
technology in allergy and establish guidelines for their proper use in
daily allergy practice.

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CONFLICT OF INTEREST

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FIGURE 2  @IT-2020 is a CDSS system based on several steps in
a diagnostic workup: collection of clinical history, pollen calendar
information, determination of allergic sensitization with allergen-
extracts, component-resolved diagnostics, and clinical monitoring
through an electronic diary. Algorithms used in each of these steps
are based on international guidelines including ARIA, GINA, and
EAACI guidelines for SPT, molecular IgE assays, and pollen season
definitions. The CDSS is flexible and customizable as the different
steps can be used in various combinations and sequences and the
thresholds for decisions adapted to the doctor’s targets and the
local epidemiological and environmental conditions [Colour figure
can be viewed at wileyonlinelibrary.com]
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