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Risk and crisis communication during the corona pandemic

In a crisis such as the coronavirus pandemic, medical risk communication faces the particular challenges of acting under time pressure with uncertain data. In the case of a novel, highly contagious respiratory pathogen, the responsible actors in politics, science and science communication were confronted with ethically difficult decisions to weigh up. This was particularly true as protection against infection was not only relevant for individual health, but also for collective health through possible transmission (1). Due to concerns about the possible catastrophic effects of an uncontrolled wave of infection, there were repeated deviations from previously established recommendations for risk communication.

>> The communication of health and pandemic risks was carried out by various actors: by politicians in press conferences, talk shows and media reports, by authorities such as the RKI, by scientists and doctors in scientific journalistic articles and by opinions expressed by professional actors and also by laypeople in social media. In this article, we would like to highlight some of the weaknesses of this communication, including possible causes and negative consequences. Media literacy and awareness of the complex problems associated with the pandemic can certainly not be assumed to be the same for all stakeholders.

Our aim is not to use the benefit of hindsight to criticise mistakes that were perhaps not clearly recognisable at the time, but we would like to initiate a discussion process in order to learn for future crises. A public review, as is currently taking place in the UK and has been called for here by the 'Pandemic Review Initiative', among others, could make an important contribution here (Link I). This text is not intended to be a completely objective and comprehensive treatment of risk communication during the pandemic, but rather to highlight some aspects that we consider to be problematic. We invite you to complement our views and, where appropriate, to contrast them with divergent points of view. We see the presentation and harmonisation of complementary perspectives on crisis communication and management as an iterative process that should be continued with further texts.

Communication during the pandemic: chronological order

In order to assess the media environment of pandemic communication in Germany, it is helpful to look at communication by politicians from March 2020 onwards. For example, on 16 March 2020, the French president declared (Link II) 'we are at war' (Link III) with regard to the pandemic that was developing at the time, while German Chancellor Angela Merkel addressed the population on 18 March 2020 in a television address (Link IV) and declared 'it's serious', appealing to people to show solidarity with each other and to strictly adhere to the measures to slow down the rapid spread of the virus.

At the end of March 2020, the Federal Ministry of the Interior issued the so-called 'panic paper' (2). This paper is important for several reasons. Firstly, because the measures outlined there (including 'hammer and dance') and communication strategies ('emphasise worst-case scenarios') were largely adopted in political action and government communication. But also because risk communication in such a situation faces two important but difficult to harmonise objectives: Not to minimise threats, but at the same time to avoid fears and overreactions (3).

In large parts of Europe, a form of communication was also established in the later course of the crisis that in some cases was reminiscent of war rhetoric. Divergent opinions on approaches to measures and communication were barely heard. In addition, there was a gradual shift in the objectives of the coronavirus protection measures away from acute prevention of overloading the healthcare system towards a low-incidence strategy. On 20 April 2020, for example, the German Chancellor forbade 'opening discussion orgies' (Link V), while in May 2020 the then President of the Robert Koch Institute (RKI) let himself be dismissed with the words 'We will have to adhere to these rules for months to come. They must be the standard. They must never be questioned.' quote (link VI). In autumn 2020, politicians discussed (link VII) the possibility of sanctioning violations of Covid measures in private homes and the 'last Christmas with grandparents' was invoked (link VIII). In 2021, the willingness of the population to be vaccinated was the focus of political and media statements. The social disadvantage of unvaccinated people was called for from summer 2021 (link IX), in autumn the 3G/2G and 2G+ rules (link X), which were then also introduced. From November 2021, a discussion (link XI) followed about a general vaccination obligation. In this context, statements by political officials and also the wording and demands in opinion pieces in the major media became increasingly extreme from 2021 at the latest (link XII), to the point of labelling opponents of vaccination as 'enemies of the state' (link XIII). There was further escalation on social media, including dehumanising abuse. To summarise, there was a linguistic escalation in pandemic communication within two years. This also led to the formation of hardened fronts. In extreme cases, some people could hardly be reached by public communication and doubted the existence of the virus, while others called for ever tougher measures with the aim of eradicating the virus (4, 5).

Pandemic plans by the authorities

The 'National Pandemic Plan for Germany' (Link XIV) was originally developed by the RKI in 2005 with a focus on a possible influenza pandemic, but was fundamentally revised in 2016/17, the last revision before the coronavirus pandemic. This comprehensive, multi-part elaboration also deals in detail with risk and crisis

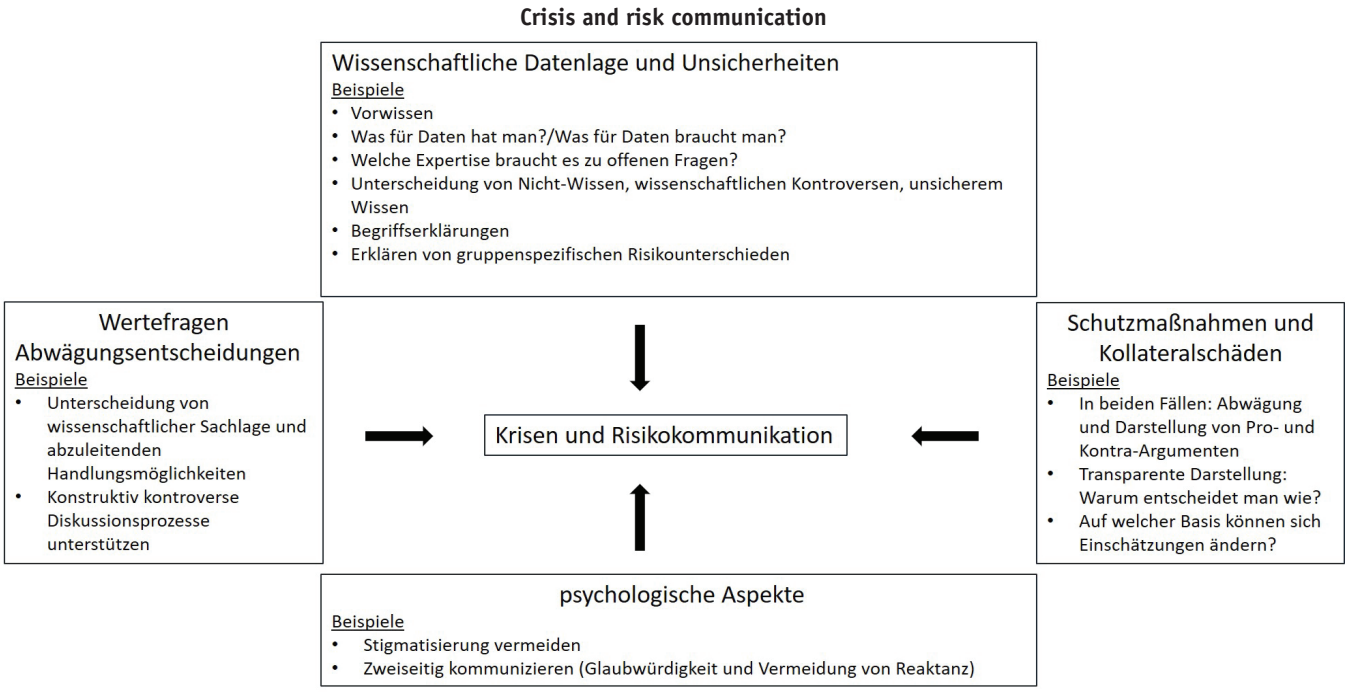


Fig. 1: *Crisis and risk communication. Source: own illustration*

communication. Credibility, trustworthiness, neutrality and transparency of the communicators as well as proactive communication of uncertainties and misjudgements are named as essential basic conditions for successful pandemic communication (see National Pandemic Plan, Scientific Basis (Part II) (2016) page 194, Link XV). In the early phase of the coronavirus pandemic, the recommendations corresponding to the state of knowledge at the time were specified and supplemented in a separate document (link XVI). Pandemic planning included a graduated concept of non-pharmaceutical infection control measures - depending on the stage of the pandemic - as well as continuous epidemiological surveillance of the infection process.

Risk and crisis communication that was much more closely aligned with the above-mentioned basic conditions of the planned pandemic planning could be observed in a direct European comparison, for example in Denmark. Communication in Denmark included regular risk reports (Link XVII), which were similar in content to the RKI weekly reports. However, in contrast to the procedure in Germany, five clearly and comprehensibly defined risk levels (link XVIII) were also defined, according to which different Covid containment measures were gradually taken or withdrawn (link XIX) (6). Accordingly, with a very good vaccination rate and low disease burden, the Covid measures were discontinued for the first time in September 2021 (link XX). During the delta wave, the measures were reintroduced according to the risk levels and then ended again in 2022 when the wave of infection subsided (link XXI).

Possible causes of crisis and risk communication in need of improvement

Science and science communication under time pressure

Another key task that could have provided greater certainty in pandemic planning and communication with regard to important parameters such as transmission dynamics and age group-specific infection prevalence, and which was much more successful in other countries (especially the UK), was the rapid and constantly updated generation of representative epidemiological data on infection dynamics, disease severity, mortality and population-wide immunity (through vaccination and infection). The Heinsberg study (7) was heavily criticised for, among other things, the early communication of the local infection fatality rate (IFR), which was not easily transferable to the whole of Germany before longer follow-up data was available. Despite such errors, it was one of the most relevant epidemiological publications from Germany, as it was one of the first studies to closely examine the question of transmission routes of infection, which was open and very important at the beginning of the pandemic, using the example of the Covid outbreak in Heinsberg. No large, Germany-wide representative cohort study was subsequently set up over the entire course of the pandemic. The NAKO Health Study (Link XXII), which began recruiting people right at the start of the pandemic, would have provided an existing organisational framework that could possibly have been used to a greater extent. Although local studies, such as the Hamburg City Health Study, were expanded with regard to the investigation of Covid-related secondary diseases (8), at national level there was usually a communicative equation of reporting incidence obtained by means of different test regimes and (uncollected) representative disease incidence, which repeatedly led to ambiguities and fallacies with regard to high prevalence settings, transmission risks, disease severity and mortality.

Between March 2020 and November 2021, a total of ten ad hoc statements were published by the Leopoldina as part of scientific policy advice. These statements were extensively criticised (9). A central point of criticism is that the Leopoldina itself has issued

guidelines for its own statements since 2014 and also for ad hoc statements in cases of 'urgent need for action', which it did not fulfil in its publications on the Covid pandemic. In particular, the ad hoc statements also included normative values, which were not communicated transparently. Only in the foreword to the complete publication of the seven statements, which was published in 12/2020, is there a reference to this. There it was stated that health protection was the non-negotiable goal of all measures during the pandemic (9). However, such normative values cannot be regarded as set by science or political bodies, but are usually the result of social negotiation processes.

Follow the science

With the adoption of the slogan 'follow the science' from the climate movement and formulations such as 'the science', what constitutes scientific discourse and knowledge gain, especially in a highly dynamic new situation with many unknowns, was lost in public perception: an iterative approach to a topic or hypothesis through the publication and discussion of small-scale, sometimes contradictory results with permanent questioning and verification of the robustness of the original hypothesis. The path to be 'followed' in this picture would therefore not be a path, but at least a corridor of understanding of varying width within which the scientific discourse should move. The labelling of positions that at times questioned dominant viewpoints in this discourse as 'PLURV' (pseudo-experts, logical fallacies, unfulfillable expectations, cherry-picking and conspiracy theories) or ad hominem attacks against people who participate in this discourse as 'pseudo-experts' (episode 82 - (link XXIII) of the coronavirus update, SPIEGEL interview with Christian Drosten (link XXIV) from 22 January 2021) can be seen as an example of this.01.2021) may themselves constitute an inadmissible abbreviation in such a situation. This is particularly true as current perceptions and apparent majority positions can sometimes be different in retrospect, as currently shown, for example, by the results of a survey of scientists regarding lockdowns and their collateral damage (link XXV) in the UK.

Science makes mistakes

The exaggeration of the process of gaining scientific knowledge into an unquestionable path that must be followed is particularly problematic because this process is inevitably full of systematic and unsystematic errors. Long before the pandemic, there was already a crisis regarding the reproducibility of research results - especially in the biomedical sciences - which has received increased attention since the mid-2000s, partly due to a much-noticed essay by John Ioannidis (10). One interesting aspect mentioned in this article is that the more a particular topic is at the centre of general attention, the more likely it is that the results will be wrong. This may be largely due to the strong competition between different research groups and the resulting pressure to publish results as quickly as possible before another research group beats you to it. In neuroscience, for example, after the spread of fMRI technology, a striking number of papers emerged that found unexpectedly high correlations between personality traits and brain activity patterns in view of the inherent variability of the technology and the characteristics analysed (11).

Problems arose here, among other things, due to the analysis of very large data sets with an unchanged sample size in the search for increasingly subtle effects. Many research groups did not make the necessary corrections for multiple testing. One study that clearly demonstrated the absurdity of the results produced in this way was the work by Bennet et al. (12), which has become known as the 'dead salmon study'. In an fMRI study, the authors showed that, without statistical corrections, significant response signals could be derived from the display of emotion-inducing images, even in a ready-to-cook salmon. During the pandemic, scientific teams worldwide - including many who had never previously worked on viruses, infection epidemiology or similar issues - began working on SARS-CoV-2 from 2020 onwards and the number of publications increased massively in a very short time.

By 02/2024, over 195,000 publications on SARS-CoV-2 had been indexed on pubmed (link XXVI). Already in the course of 2020, there were voices warning of a blatant lack of quality in the published papers related to the Covid pandemic (13). There were also contributions that made concrete proposals for better procedures to ensure quality standards, including at preprint level (14). Early on, it was criticised that even peer review procedures did not always reliably improve the quality of publications (15). As a result, papers that were initially published prominently had to be retracted (e.g. on the evolution of the Omicron variant (16) or on hydroxychloroquine (17). The Retraction-Watch website currently lists 403 retracted Covid papers (link XXVII) and a further 18 papers where there are serious objections to the published results. There are currently doubts (link XVIII) about the statistical methods and thus about the statements of the study that identified the seafood market in Wuhan as the epicentre of the Covid pandemic (18).

There is also clear criticism of the content of a number of well-known publications from Germany that have been publicised in the media and published at a high level. One example is the modelling work of the MPI for Dynamical Systems, which used a so-called SIR model to estimate a temporal relationship between turning points in the incidence of infection and Covid containment measures (19). Various scientists have expressed doubts (links XXIX, XXX) about the validity of the model used, leading the authors of one of the reviews to conclude that 'the dates of the turning points, as stated in the article, were not produced by the model, but arise from the preconceived assumptions'. Other publications, which also came to different conclusions regarding the influence of the measures on changes in the incidence of infection, failed to gain acceptance in the public perception (20, 21).

John Ioannidis, who became known above all for pointing out the increasing shortcomings and problems of the scientific production process, also made methodological errors in scientific studies during the Covid-19 pandemic (22). These are all examples where the authors of the papers are not suspected of having deliberately falsified or embellished results, but personal expectations and a lack of critical distance, which can influence study planning and evaluation, are human and also play a role in scientific work.

In contrast to the article by the MIP for Dynamic Systems, which seemed to confirm the effectiveness of the federal government's packages of measures by means of modelling, the studies by John

Ioannidis questioned, among other things, whether parameters relating to the danger (infection mortality) of SARS-CoV-2 had possibly been overestimated. While the criticism of the assumptions of the modelling study by the MPI for Dynamic Systems hardly found its way into the public debate, in the case of Ioannidis there was harsh public criticism, which also included personal attacks (Scientists who express different views on Covid-19 should be heard, not demonised) (Link XXXI).

Communicating and distinguishing between misinformation, disinformation, simplification, ignorance, uncertainty and simple mistakes had become increasingly difficult in a highly politically heated atmosphere. Furthermore, the perceived urgency of the situation to make new knowledge available quickly led in some cases to a lowering of scientific quality standards for studies compared to pre-pandemic norms (23). The fact that high-ranking journals such as Science did not offer the opportunity to submit peer-reviewed technical comments for Covid-19 articles during the pandemic as a qualified response from the scientific community to contentious issues also did not help to objectify the debate. Unresolved internal scientific questions could thus become the breeding ground for political controversies.

Scientific communication that, in a situation characterised by great uncertainty, provides strong certainties with regard to general dangers and necessary countermeasures and allows fewer critical voices to have their say can also obscure the view of existing gaps in knowledge. It can give the impression that it is not necessary to obtain additional information. One example of this may be the long persistence of justifying pandemic measures with error-prone modelling scenarios (24) without obtaining data, such as on the proportion of antibody-based immunity in the population, which could have improved the validity of the models. A communication problem (Link XXX-XII) in the context of modelling studies was also the often unclear separation between assumptions made in advance that were incorporated into the model (such as the degree of effectiveness of wearing masks in everyday life) and the model's subsequent results with regard to the effect of the measures on the incidence of infection (25).

Risk communication, interventions and collateral damage

In communication by politicians and authorities, abbreviations and simplifications of complex relationships were frequently observed. Attempts were made to achieve desired behaviour through a strong emphasis on the risks of infection and transmission in combination with a relativisation of possible collateral damage and moral judgements. The focus was less on providing information on individual risk, such as a differentiated view of the age-specific risk of a severe course of the disease or the different transmission risks depending on the setting (care situation, indoor, outdoor). This becomes clear, for example, in the presentation (Link XXIII) of scientific work in social media by Federal Health Minister Karl Lauterbach. Examples include his repeated statements (link XXXIV) that the Covid vaccination is 'more or less free of side effects' (Anne Will programme, 13 February 2022, link XXXV) or on Long Covid (Twitter/X, link XXXVI), in which a relative risk reduction was presented as an absolute risk of illness. However, in the attempt to proclaim messages that were as simple and meaningful as possible - such as reports about a 'pandemic of the unvaccinated' - the methodological inadequacies of the calculations quickly became apparent (link XXXVII).

Scientific journalism was challenged during the pandemic as rarely before. Not only was it necessary to present medical and scientific content in an understandable form for a broad audience, but it was also expected to categorise health risks. In addition, the question of how to deal with and take into account different points of view on individual topics arose time and again. It is understandable that these requirements could often not be fully or only partially met. Nevertheless, various communication patterns can be identified that have been repeated and will be analysed in more detail here:

Age-specific Covid risks were rarely categorised in comparison to other risks (such as accidents in children or the consequences of mental illness). However, it would have been important to communicate different strategies for risk reduction and the possible effects of infection and infection avoidance strategies in a balanced way, especially later on in the pandemic. If a one-sided communication strategy at this point instead leads to a shift in perception with regard to the benefits and collateral damage of protective measures, this can have consequences for their appropriate individual and collective balancing.

One example of this would be respecting children's rights to education, participation, support and care. There were detailed proposals on this early on in the pandemic that set out ways to safely implement school openings (26). These contributions received little attention in the broad public debate in Germany at the time and to some extent still do today. Today, there is evidence of clear psychological and social consequences of the long closures of daycare centres, schools and clubs and the restrictions on contact with peers. Study results indicate, among other things, an increase in the proportion of children with mental illnesses and a higher number of illnesses associated with a lack of exercise, such as obesity (27, 28, 29). There are also indications of possible long-term consequences in terms of the acquisition of skills and the deepening of social inequalities as a result of school closures (30).

A mismatch in communication and perception of the age-associated Covid risk may also mean that groups that would have needed increased protection were underserved on the one hand and suffered from inadequate measures on the other. The group of residents of residential care facilities should be mentioned in particular. On the one hand, the implementation of effective PCR rapid test strategies or the accelerated improvement of staffing and spatial-structural conditions in long-term care were hardly a topic in the media in this setting - unlike in schools, for example. Such measures could have contributed to a reduction in the burden of infection and possibly to the maintenance of certain joint activities and daily structures. Corresponding advice and recommendations from nursing science were hardly taken into account (31). On the other hand, during the pandemic, there was prolonged and very strict isolation of care home residents in hospitals and nursing homes, which was often continued even when the viral load was barely detectable after infection and therefore had little relevan-

ce in terms of protecting third parties. Visiting restrictions (Link XXXVIII) also continued even after the majority of residents had already been vaccinated. This caused damage to the mental health of many residents due to social deprivation (32, 33, 34).

Illnesses, whether of a somatic or more psychological nature, also have psychosocial effects that can play a role in the perception and processing of the illness (35). In some studies, the incidence of post-Covid may have been overestimated, partly due to severe limitations such as biased sample selection, lack of inclusion of control groups or inclusion of controls that were poorly matched to the infection group (36). However, such studies also had a strong influence on media communication on post-Covid. In terms of a nocebo effect, there is a risk of a functional shift of symptoms (37). A register study from Norway collected data on over 200,000 mild Covid infections between July 2020 and January 2022. Over the long observation period, it was also possible to record the effects of virus variants that occurred later. The study puts the incidence of post-Covid symptoms that persist for more than three months after infection at around 0.4% (38). The strength of the Norwegian study lies above all in the fact that the infections could presumably be recorded almost completely during the study period. Weaknesses lie in the fact that the consequences of the infection were recorded via the utilisation of medical assistance/services (which can lead to the under-recording of symptoms in people who make less use of such services) and in the fact that infections may not have been reported by the GPs (although this was required by law) or the consequences of infections were not always coded correctly.

Changing meanings of established terms, polarisation and half-truths

Reinterpretations and reframing of already established terms could be observed at all levels of communication. A prominent example of this is the use of the epidemiological term 'infection', which actually describes the proportion of people who have already had or are currently experiencing an infection.

Considerable communicative damage may have been caused by the abbreviation and reinterpretation of the term 'prevention paradox'. This term was first coined in the 1980s and originally described the difficulty in defining the right target group for prevention measures. Using coronary heart disease as an example, this means that although a specific prevention programme for high-risk individuals (e.g. smokers with obesity and high blood pressure) reduces the risk of a heart attack for this group relatively significantly, the absolute number of heart attacks can often be reduced if a population-wide prevention approach is chosen. Although the individual risk reduction per person is smaller in this case, the total number of heart attacks prevented over a large number of people is greater.

Furthermore, the term prevention paradox describes the observation that population-wide prevention measures primarily reach health-conscious people with a low risk of disease, while the actual risk population is often more difficult to motivate. This played a significant role during the pandemic, as people with low socioeconomic status were more likely to be affected by severe disease and higher mortality, but had a lower vaccination rate (39, 40, 41). A Swedish study showed that pre-booked vaccination invitations in groups that consider their individual risk to be low can generate much more even vaccination coverage (42), i.e. how to deal with this aspect of the prevention paradox.

Over the past 40 years, the concept of the prevention paradox has been expanded to include other facets, such as the observation that when successful vaccination campaigns for infectious diseases increasingly suppress the disease, only the rare side effects and adverse effects of vaccination 'remain'.

During the pandemic, the meanings described above were pushed into the background. Instead, the term was used as a logical fallacy (link XXXIX) to justify coronavirus containment measures retrospectively, even if the effects of these measures were not actually certain or clearly demonstrable. It was often used, for example, to support predictions and forecasting models and to arm them against criticism, even if predicted worst-case scenarios, which had been used to justify the introduction of the measures, did not materialise in the end. These simplifications were used repeatedly in the NDR podcast 'Coronavirus Update', for example in episode 45 (link XL) and in episode 82 (link XLI) by the interviewers.

The strong positioning with which scientific work and scientists were presented differently in the major media is also striking. The reporting on Christian Drosten and Hendrik Streeck as well as on Streeck's 'Heinsberg Study' (43) and the 'Viral Load Study' (44, 45, 46) from Drosten's institute are examples of this. An article in the media magazine 'Übermedien' (link XLII) already discussed and criticised the polarising reporting, some of which disregarded journalistic standards, in detail in May 2020. Nevertheless, the patterns in reporting and the (medially exacerbated) fronts persisted.

The reception of two position papers, the Great Barrington Declaration (link XLIII) of 4 October 2020, which proposed a policy of 'controlled transmission' and focused protection of at-risk groups, and the response, the John Snow Memorandum (link XLIV) of 14 October 2020, which called for a low-incidence strategy (47), was stylised into a question of attitude both in science journalism and in the further discussion on social media. In terms of content, both statements provided sufficient grounds for criticism; many of the demands made by the authors of the Great Barrington Declaration appeared to make little sense shortly before the market authorisation of Covid vaccines (48), and 'focused protection' remained a proposal that had not been worked out in concrete terms. However, the same applied to the argumentation in the John Snow Memorandum, in which immunologically rather implausible speculations, such as the complete absence oflong-term protective immunity due to a Covid infection, were put forward. However, the media mainly attacked the Great Barrington Declaration and drew links to climate change deniers and 'extreme right-wing economic ideology' (SZ, FR, Faktencheck 'Volksverpetzer', (Link XLVII)). The difficulty of the content of position papers in the Covid-19 discourse - which of course also applies to this one, not without a certain irony - was addressedearly on in the academic literature (49). Equally critical is the attempt to measure the 'correctness' and significance of scientific statements in position papers by the number of public supporters, as this may depend less on their quality than, for example, on their presence and perception in social media such as X/Twitter (50).

Conclusion

In view of the acute threat situation, there are expectations on the scientific community not to publicly express dissent in order not to expose the population to ambiguity when complying with behavioural measures and recommendations. In the long term, however, this not only contradicts and hinders science in its core task of gaining knowledge, but can also be detrimental in terms of confidence-building communication. There are many indications from the scientific literature that communicating uncertainty and ignorance leads to information sources being attributed greater integrity (51). For example, in one study, scientists and politi-

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cians were attributed more expertise when they presented both the evidence for and against a particular issue (52). A non-bipartite presentation of the benefits and risks of certain measures can encourage prejudice and polarisation of communication. For example, one study (53) showed that during the pandemic, Covid-vaccinated people developed strong negative prejudices towards non-vaccinated people, even more so than the other way round.

From our point of view, one important question in the aftermath of the pandemic remains: How could these differences in the communication of risks from the virus and from intervention, as well as the corresponding studies used to justify or scrutinise interventions, come about?

A major fear during this time was that people would not take the virus seriously enough and might believe trivialisers or even deniers. As a result, it was conceivable that some people would then no longer adhere to protective measures that they perhaps did not consider relevant for themselves on an individual level, even though they could endanger others through their function as possible carriers of an infection.

The fact that SARS-CoV-2 was a very dangerous virus, especially for older people, and that long-term chronic consequences of an infection (post-Covid) cannot be ruled out in rare cases, even in children, is true. However, it is equally true that it will always be difficult to answer the question of how effective the prescription of measures that restrict freedom may have been in contrast to mere recommendations or supportive offers (such as the promotion of social gatherings outdoors), partly due to the lack of regional randomised intervention studies on the measures.

In the end, many studies of poor quality or with an inadequate data basis do not result in reliable knowledge, as is often suggested by the provision of figures, but uncertainty remains. In some cases, figures can even convey a kind of pseudo-objectivity. Many unanswered empirical questions will not be able to be answered conclusively in retrospect. Both sides, those in favour of tough measures and those who are more sceptical about these approaches, will find scientific literature to support their point of view. Ultimately, however, this does not solve the problem or the need to engage in a social dialogue about the different values or fears that may ultimately have been behind the respective preferences and how the sometimes strongly moralising, stigmatising and relentless debate about them came about. We believe that this form of debate was not helpful in solving the various problems. In retrospect, it may also be more important to give people who felt that their views were not seen a voice again and to enter into a dialogue with them.

Finally, we would like to reiterate the importance of differentia-

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ting between political, value-led and scientific communication. As a disruptive event, the Covid-19 pandemic has led to disputes and political discussions in many countries about the right course and an appropriate response. The scientific community was also faced with a particular challenge. In some cases, there was an expectation that scientists would make direct recommendations regarding the necessary measures, and parts of the scientific community also considered this to be necessary. David Spiegelhalter, Winton Pro-

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fessor for the Public Understanding of Risk at the University of Cambridge, has formulated this:

'Scientific expertise, from whatever discipline, can provide an assessment of some of the potential harms and benefits of alternative actions, but unless the solution is absolutely obvious, no conclusion can be drawn from it about what people should do' (54).

Science can identify alternative courses of action and possibly name their advantages and disadvantages. However, making decisions on courses of action is the domain of democratically elected political decision-makers, who have to weigh up different social interests, values and goals. In this context, mixing science with strong political activism can disrupt democratic deliberation and integration processes and also lead to a loss of trust. Scientists also have political opinions and can publicise these as citizens of societies. However, where possible, they should separate their roles as experts and citizens in communication and make them transparent. <<

Author's declaration

The authors declare that there are no conflicts of interest.

Acknowledgements

We would like to thank Bernhard Müller, Ingrid Mühlhauser, Gabriele Meyer, Johannes Pantel, Matthias Schrappe and Dirk Schuricht for helpful feedback, comments and discussions on this article.

Citation

Schöps, C., Padberg, I.: Risk and crisis communication during the corona pandemic', in: „Monitor Versorgungsforschung“ (MVF 03/24), S. 59–68. http://doi.org/10.24945/MVF.03.24.1866-0533.2600

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