The establishment and first experiences of a crisis advisory service for water supplies in Norway

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ABSTRACT

Water supply systems, in particular small-scale water supply systems, are vulnerable to adverse events that may jeopardise safe drinking water. The consequences of contamination events or the failure of daily operations may be severe, affecting many people. In Norway, a 24-hour crisis advisory service was established in 2017 to provide advice on national water supplies. Competent and expert advisors from water suppliers throughout the country assist other water suppliers and individuals who may be in need of advice during an adverse event. This paper describes the establishment of this service and experiences from the first three years of its operation. Since the launch of the service, water suppliers across Norway have consulted it approximately one to two times a month for advice, in particular about contamination events and near misses. The outcomes have helped to improve guidance on water hygiene issues at the national level.

Key words | crisis management, drinking water, water contamination

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HIGHLIGHTS

- Prevention of drinking water emergencies.
- Sharing of experience on novel prepardness measures.
- Effective and low-cost solution which is replicable elsewhere.

INTRODUCTION

The delivery of safe drinking water is an important public health issue (Bain *et al.* 2014). When pathogens or harmful chemicals contaminate drinking water, many individuals suffer adverse health effects (Nygard *et al.* 2006; Pitkanen *et al.* 2008; Widerstrom *et al.* 2014). Several serious water emergencies have led to an increased focus on risk management for drinking water systems (Mac Kenzie *et al.* 1994; O'Connor 2002). For more than ten years, the World Health Organization (WHO) has repeatedly advocated water safety plans (WSPs) (World Health Organization 2004). Safe drinking water does not necessarily imply zero risk (Hrudey *et al.* 2006); regardless of multiple hygiene barriers and precautionary actions, there will always be a small remaining risk of waterborne illnesses or diseases (Hrudey & Hurdey 2007). Since unwanted events will inevitably occur, learning from incidents and near misses concerning water supplies is imperative for preventing future events (Hrudey & Hurdey 2014).

Drinking water safety is highly dependent on management decisions at all levels of the water supply sector (Hrudey *et al.* 2006; Rizak & Hrudey 2007). The water

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suppliers must manage multiple perceptions and risks to maintain regulatory compliance and consumer trust (Jalba *et al.* 2014). Small-scale drinking water supplies have been identified as particularly vulnerable to failure to provide a continuous supply of safe drinking water (WHO 2011). They share a range of common managerial, financial and institutional challenges and particularities that make them more vulnerable to inadequate management and operational breakdowns, which may impair the provision of sustainable services (WHO 2016). Residents in the Nordic countries rely widely on small-scale systems serving fewer than 500 people, where performance information generally is lacking for these systems. However, a study implies that non-compliance of faecal indicators occurs more frequently among small-scale drinking water supplies than larger systems (Gunnarsdottir *et al.* 2017).

The safety of small-scale drinking water supplies plays an important role in terms of ensuring public health, worldwide and in Europe, since such small-scale supplies serve a significant number of people (UNICEF 2019); for instance, in Norway, 86% (1,224 of 1,421) of the regulated water supplies serving permanent residents in 2018 served fewer than 5,000 inhabitants (Hyllestad *et al.* 2019). This is similar to the statistics for other countries in the region, for example, France, Austria, Finland and Spain (WHO 2016). Although the true burden of waterborne diseases in the WHO European region, which stretches from Europe to Central Asia and includes a number of low- and middle-income countries, is unknown due to the underreporting or underestimation of water-related diseases (Kulinkina *et al.* 2016), it is believed that they constitute a leading contributor to the global disease burden. Despite the fact that the water supply sector in Norway is of general high technical standard, 28 waterborne outbreaks resulting in 8,060 cases were reported in the period 2003 to 2012, implying that outbreaks occur almost every year (Guzman-Herrador *et al.* 2016). Some of these outbreaks are large, such as the Giardia outbreak in Bergen in 2004 with an estimated 6,000 cases (Nygard *et al.* 2006), the outbreak of campylobacteriosis in Røros in 2007 with an estimated 1,500 cases (Jakopanec *et al.* 2008) and the recent outbreak of campylobacteriosis in Askøy in 2019 with an estimated 2,000 cases (Norwegian Institute of Public Health 2019). In addition, breaches in the supply, such as main breaks, drought and contamination events, are each year notified to the Norwegian Food Safety Authority, and some also reach the media.

In early 2017, a 24-hour advisory service – the National Water Guard (NWG) (in Norwegian: Nasjonal vannvakt) – for water emergencies that could affect water utilities was introduced in Norway to address the challenges of inadequate managerial capability in the water supplies. The primary aim of the NWG is to strengthen emergency preparedness measures in the sector. An expected outcome of the NWG is data collection on events that challenge the organisational capacities of the water supplies in order to shed light on necessary preparedness measures, and ultimately reduce the risk of waterborne illnesses. The objective of this paper is to present the experiences for the first three years of the NWG's operation, with the objective of describing the background and enabling factors relating to the establishment of the NWG, including an analysis of the registered requests for advice to manage adverse events.

METHODS

The methods used to address the objective in this paper are two-fold: methods used to design a crisis advisory service in the Norwegian context, and methods used to present the experience of three years of operation.

Establishment of a crisis advisory service for water supplies

In the establishment of the crisis advisory service for water supplies in Norway, several methods and approaches were used to explore and design a crisis advisory service that would be suitable for the Norwegian context.

In the design phase for the service, the researchers assessed the documented experiences of similar crisis services for water supplies, here, particularly in Sweden. In Sweden, a crisis group (VAKA) addressing emergencies in water supplies was launched in 2004 after experiencing several severe events of flooding in 2001 and 2002 which affected the water supplies. Since the launch, representatives of VAKA have been involved in addressing crisis events in the water supplies, approximately every month, in Sweden. Consultations with key representatives of the

Norwegian Water Association were conducted to determine potential types of advice that might be needed and the expectations of such an emergency service among the water supplies. The Norwegian Water Association collected their input from workshops with representatives from several water suppliers of various sizes. Other official services, such as the Infectious Disease Control Service at the Norwegian Institute of Public Health, were consulted about their experiences of the 24-hour advisory service. Principal discussions regarding enabling factors, roles, responsibilities, and funding were conducted with the Ministry of Health and Care Services, the Norwegian Food Safety Authority, the Norwegian Water Association and the Norwegian Institute of Public Health.

In the launch phase of the advisory service and during the development of procedures, a project group consisting of personnel from the Norwegian Institute of Public Health and the Norwegian Water Association was formed to execute the planned actions. VAKA in Sweden and the Norwegian Poison Center (administered by the Norwegian Institute of Public Health) were consulted about their experiences of procedures, codes of conduct relating to sensitive and detailed information obtained from water suppliers, and practical issues concerning staffing and incentives for the service. Workshops involving unpaid volunteers from water suppliers and personnel from the Norwegian Institute of Public Health were held to discuss issues pertaining to the operation of the service, and to test procedures using tabletop simulations. A two-month pilot period was assigned at the beginning of 2017 to test the service's functions and procedures.

Data collection and analysis

The advisory service logs all requests in a crisis incident management tool (CIM). We used data from 2017 to 2019 to examine the frequency and main topics of the requests.

A request was considered relevant to the service and data synthesis if it was: (1) directed by a leader of a water supplier and/or in collaboration with a municipal doctor, (2) of an acute nature and (3) severe enough to be referred to the leadership in the water supplier. Requests that originated from private individuals, private building owners, lawyers seeking expert opinions, municipal doctors who sought general advice on how to answer water-related questions, and water suppliers that sought advice on general questions regarding non-acute water hygiene in the offshore oil industry were filtered out and excluded from the data set, to ensure that only organisational capacities were monitored.

Data from the CIM log were imported to Excel for data management and analysis.

Ethical considerations

Data from the crisis advisory service did not include individual health data or sensitive personal data; thus, ethical approval for this study was not required.

According to the Norwegian drinking water regulations enforced in 2017 (Lovdata 2018), the water suppliers have an obligation to notify customers and the Norwegian Food Safety Authority about events that may have implications for human health. Most notifications also have to be copied to the municipal medical officer responsible for infectious disease control measures.

Such events were few in number and could easily be traced back to specific water suppliers; hence, we simplified the descriptions of the events to avoid identification of the organisations and maintain credibility and trust in the advisory service.

RESULTS

Background for the establishment of the crisis advisory service

The inability of water suppliers in Norway to manage water emergencies, particularly for small-scale systems, has raised concerns. There are approximately 1,500 geographically widespread individual water supply systems, both public and privately owned, regulated and inspected by the Norwegian Food Safety Authority in Norway (Hyllestad *et al.* 2019). Many water supplies are managed by small organisations with limited training and competence. Reports on interruptions in the water supply caused by breakdowns in the distribution systems, and audits of the water distribution systems themselves, revealed non-compliances at 81% of the inspected waterworks (Norwegian Food Safety Authority

2013). All of the registered water suppliers in Norway must have an emergency preparedness plan, which is mandatory according to the Norwegian drinking water regulations enforced in 2017 (Lovdata 2018); however, a recent national audit revealed that two-thirds of the water suppliers did not conduct exercises, creating uncertainty with respect to the water suppliers' capacity to deliver safe drinking water during major events (Norwegian Food Safety Authority 2017). Against this backdrop, a decision to explore the opportunities and prerequisites for establishing a crisis advisory service for water supplies was made in 2016, following a discussion about the drinking water sector in Norway that had been ongoing since the middle of 2000.

Expectations and need for advice: outcome of interviews with water suppliers

Based on input from the Norwegian Water Association which was collected in workshops with a group of water suppliers, the feedback and expectations differed between the large and small water suppliers. We expected that the large water suppliers would have the competence to manage operational breakdowns; however, they would expect advice on concerns such as outbreak investigations and the outcomes of microbiological analyses on which they would not necessarily be up to date. Experience revealed that advice in these areas was not fully provided by the municipal doctor. For the smaller water suppliers, there was a need for advice on troubleshooting breakdowns in daily operations and the distribution network. Both groups, however, expressed the advantage of having 24-hour advice available if needed.

Purpose of the advisory service

The Norwegian NWG service is a 24-hour service for suppliers that need advice and support during events that can affect the water supply and have health consequences for the population. The idea behind the NWG was to use existing expertise in the drinking water sector and public health agencies to support other water suppliers in severe situations when needed. It was expected that the advice would enable water suppliers to implement appropriate measures in the early stages of a crisis, when drinking water safety was under siege. In the introductory phase, the crisis advisory service was named the National Water Guard (translated from Norwegian) after input from the people volunteering to the crisis service.

Enabling factors

A prerequisite for the NWG was that it should rely on the existing structure to avoid extra costs relating to compensation for service provision for personnel. The participation of unpaid, experienced personnel from other water suppliers was one of the most important factors in the establishment of the NWG. To ensure 24-hour a day operations, the responsibility for running the service is shared by experienced personnel from various water suppliers that provide unpaid volunteers, and employees at the Norwegian Institute of Public Health who contribute as a part of their daily work routines. The network has remained stable since its formation, consisting of eight regular volunteers, who meet regularly to conduct preparedness training, discuss matters of common interest, and facilitate team building under the aegis of the Norwegian Institute of Public Health. Another prerequisite was to establish the NWG within existing public health structures in Norway, via the Norwegian Institute of Public Health, which comprises personnel with epidemiology, microbiology, toxicology and water hygiene expertise, with additional 24-hour health advice services provided by the Norwegian Poison Center and a duty officer on call for infectious disease control.

Although the discussions regarding establishment of a crisis advisory service had been ongoing since the middle of 2000 in Norway, it was only when developing the national goals for water and sanitation under the auspices of WHO/UNECE's Protocol on Water and Health (Norwegian Food Safety Authority 2014) that the establishment of such a service became a political commitment. When the scope of the advisory service had been defined and the costs estimated, the Ministry of Health and Care Services provided funding to launch the NWG. The funding was intended to cover a dedicated position to the crisis advice service and expenditure for meetings, travel and technical tools, such as computer software.

Roles and responsibilities

In Norway, an important principle in crisis management is that those closest to the crisis are the most suitable people to deal with the situation ('the subsidiarity principle') (The Norwegian Government (Regjeringen) 2019). The subsidiarity principle has also been a guiding premise for the establishment of the NWG. The personnel associated with the NWG do not directly manage and control the incident; thus, the established roles and responsibilities for the emergency services in Norway have not changed.

Technical assistance and tools

The technical tool used to manage the incoming requests for advice is a web-based CIM application, accessible from a PC or mobile, and the programme is used to record enquiries and to maintain communication about an enquiry while it is in progress. In addition, the programme is used to extract statistics and produce reports about the enquiries. The water supplier may contact the crisis advisory service by calling one number that is operational 24 hours a day. The day is divided between the Norwegian Institute of Public Health and the group of volunteers from the water suppliers, with the Institute covering normal office hours and the volunteer group serving after office hours and during weekends. The assistance mainly consists of providing telephone support, but the members are prepared to assist at the event in person locally if necessary.

Registered requests submitted to the advisory service from 2017 to 2019

In the period 2017–2019, 50 (41%) of 122 requests were considered relevant to the NWG. The requests were referred to other organisations or, if considered to be non-acute requests, managed by the Norwegian Institute of Health as general public health advice. Fourteen of the 50 requests came to the service outside office work hours. All the requests were managed using telephone support only, except one that was managed by several telephone calls and mail counselling. Most callers were from small to medium water suppliers (serving less than 5,000 inhabitants).

The number of requests per year were 10 (2017), 22 (2018) and 18 (2019), respectively, with no clear trend (Figure 1), but the summer months produced the greatest number of requests.

Questions relating to possible microbiological contamination made up 72% of the requests (Table 1).

Usually, the callers sought advice on proper measures to take, such as whether to issue a boil water advisory or not, or whether to flush the pipe distribution system or use emergency chlorination. There were specific questions about the issuing of a boil water advisory, based on the findings of a coliform bacteria test, which did not detect *E. coli* in the water samples (Table 2). The reason for the request was uncertainty about the health consequences if the number of coliform bacteria was high and the significance of measuring coliform bacteria in the absence of clear action points for this parameter. Typical requests for advice regarding chemical spills concerned the risk to human health due to the possible consumption of the pollutants by residents.

The requests categorised as 'operational' were diverse. One common theme was failure of, or concerns relating to, the water treatment process. One request was of a more precautionary nature: due to an extremely warm period in early summer 2018, there was a shortage of the carbon dioxide needed for the coagulation process. This request came from the Norwegian Food Safety Authority on behalf of several water suppliers.

DISCUSSION

Based on ongoing discussions and the expressed need for a 24-hour crisis advisory service for water supplies in Norway, the NWG was established in 2017. After its launch, the NWG received 50 relevant requests in its first three years of operation (2017–2019). All requests except one, mainly coming from small water suppliers, resulted in one-time support with no follow-up action. Almost three-quarters of the requests concerned microbial contamination.

Timeliness and added value of the Norwegian crisis advisory service

On average, one to two requests per month were considered relevant to the NWG. However, it is not the

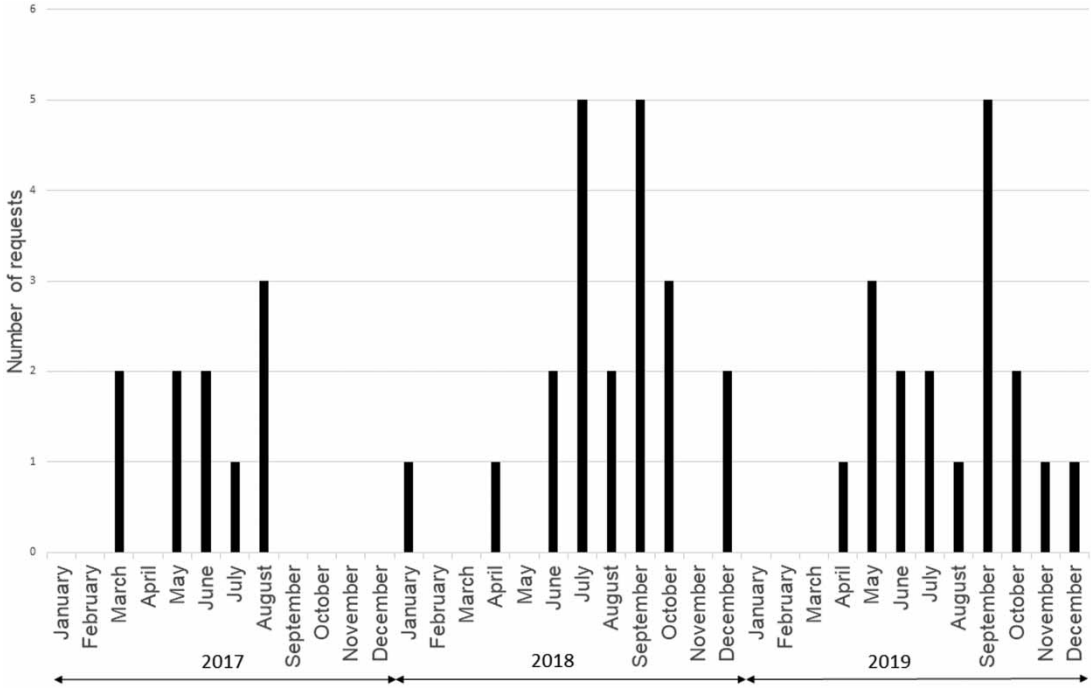

Figure 1 | Requests per month submitted to the Norwegian crisis advice service for water supplies, in the period 2017–2019.

Table 1 | The main topics of the requests submitted to the Norwegian crisis advice service for water supplies 2017–2019 ($N = 50$)

Topic	Number (%)	Main topic of the request (with the number of such requests)
Microbiological	36 (72)	Detection of faecal indicator bacteria[a] in routine samples (27) Suspected contamination (due to pipe break) (4) Suspected contamination due to increased number of consultations at a doctor's office (2) Problems with cyanobacteria (1) Problems with mould in reservoirs (1) Provision to a dentist of a water-boiling advisory (1)
Chemical	6 (12)	Spill of petroleum products near a water source (3) Spill of pesticides after a fire in a storage shed (1) Spill of sodium hydroxide (1) Suspected chemical pollution in a reservoir after sabotage (1)
Operational	8 (16)	Unusual taste and smell of the drinking water (2) Failure of the UV-radiation process (2) Failure of the pH adjustment (1) Sub-optimal coagulation process (1) Precautionary mobilisation due to shortage of carbon dioxide needed for water treatment (1) Shift to emergency water source (1)

[a]*Escherichia. coli,* coliform bacteria, heterotrophic plate count, intestinal enterococci, or *Clostridium perfringens* according to standard methods for analysing faecal indicator bacteria (Lovdata 2018).

number of requests that determined the usefulness of the NWG, but rather whether the water supplier received advice that was both timely and useful in the given situation. Since most of these requests came from small to medium organisations, it may indicate that the large water suppliers were able to manage serious problems

Table 2 | Examples of requests for advice and the advice given by the Norwegian crisis advisory service for water suppliers

	Caller	Event	Question(s) asked	Brief summary of the advice provided by the National Water Guard
Example 1	Representative of a medium-sized water supply	Leakage on the distribution system was repaired and flushed, however, the control samples tested positive for intestinal enterococci (no *E. coli*)	Should they issue a boil water advisory?	Advice to issue a boil water advisory, in conjunction with the municipal doctor, was given until negative results for the tests were obtained
Example 2	Representative of a small water supply	Spill of 2–300 litres of petroleum after a truck fell into a river that was used as a raw water source for the water supply to the municipality	What could they do to limit the spillage, which could affect the wells in the water supply system?	Inspect the river on the same side as the wells, consider suctioning visible petroleum spills, assign a person to test for the smell/taste of petroleum at the intake, and consider closing the supply in case of the smell/taste of petroleum. If so, notify the customers and use a reserve water source
Example 3	Representative of a small water supply	Shortage of water resulting in the use of a reserve water source, which included pumping water from an undocumented water source (without water testing) to the intake of the existing water supply	Was there any risk from using this 'unknown' water source, even if they treated the water?	Since the quality of the water source was not documented, there was a risk that the existing treatment would not have the capacity to act as an adequate hygiene barrier for this particular reserve water source; therefore, a boil water advisory should be issued until water testing had been conducted
Example 4	Representative of a large water supply	A landslide had cut the main supply pipe to the water treatment plant, resulting in a water-boiling advisory affecting 15,000 inhabitants. A series of water sample tests revealed coliform bacteria, but not *E. coli* and intestinal enterococci	Since they did not detect faecal indicators such as *E. coli* and intestinal enterococci, could they rescind the boil water advisory?	This event was of a rather serious character and it was assumed that the detected coliform bacteria resulted from the event. Despite no faecal indicators being detected, it was reasonable to assume that the drinking water had been affected by the event and that the situation remained unstable. In this situation, it might be advisable to take precautionary measures and await further information before rescinding the boil water advisory

themselves, or that severe situations occurred relatively rarely for them.

The value of the advice given for each of the requests submitted to the NWG was a challenge to evaluate. The purpose of the NWG is to contribute in situations that the water suppliers experience difficulty in managing. In response to some of their requests, the water suppliers found support in merely seeking a second opinion regarding their already-planned actions, which may have facilitated timely action. It was difficult to evaluate the added value of preventive measures for water suppliers; however, the societal costs relating to severe outbreaks of waterborne diseases are high (Halonen *et al.* 2012; Larsson *et al.* 2014), so the benefits of early action, even regarding less severe events, should not be underestimated.

An important function of the NWG is to be available 24 hours a day to ensure immediate action and prevent developments that could have major consequences. Most of the requests to the crisis advisory service came during daytime in the assessed period; however, 14 requests after normal working hours demonstrated the need for round-the-clock availability. Due to the low number of requests, it was not possible to evaluate the timeliness of the advisory service overall; however, in one of the cases, relating to the spillage of petroleum into a river serving as a raw water source for a municipal water supply, the timeliness was clearly demonstrated: since the event occurred during the evening, contact with the crisis advisory service was made and the situation was managed during the night. By the following morning, the situation was under control and the case could then be closed, with the conclusion that any harm to the water supply had been avoided (Table 2).

Reaching the target audience: The water suppliers

The rather low rate of contact from what is considered to be the target group of the NWG (41% of all initial contacts) indicated that either awareness of the purpose of the service remains unclear among the water suppliers and/or that the public misunderstands who the target audience for the service is. This may be explained by the fact that the NWG is still a new facility within the context of the Norwegian water sector, despite its three years of operation. Continuous efforts to raise awareness of the NWG will therefore be important. However, occasional telephone contact from private individuals will be inevitable, since information about the service and the phone number are available online to create easy access to information about water supplies.

Introducing a new actor for the management of crises

The uncertainty of roles and responsibilities during an emergency is likely to interfere with an effective response (Hrudey & Hrudey 2014). A concern in the early discussions regarding the NWG was whether such a service would interfere with established roles and responsibilities according to the 'subsidiarity principle' in Norway. When managing a request from a water supplier, the experienced volunteers of the NWG do not, with few exceptions, have first-hand knowledge of the water supplier seeking advice. The advice must then be based on information provided by telephone about the incident and the water supplier's capabilities, meaning that the advisor will experience limitations. Nevertheless, a detailed description of the situation, and in some cases, maps and other additional information, contributed to effective and targeted counselling. This underlines the importance of the water supplier (the 'event owner') contacting NWG, rather than other actors, outside the crisis management arena, that do not have current information to hand. Telephone counselling, as the NWG delivers their advice at present, requires the water supplier to understand and describe its problem relatively accurately, which may improve the supplier's own crisis management ability.

Information used to give guidance and facilitate precautionary actions

Based on the assessed requests, it was difficult to spot trends, since the request topics varied greatly and were rarely repeated. Microbiological questions can be expected to recur, as they are of obvious health significance and the value of guidance (zero occurrence of *E. coli*) is attested by the Norwegian drinking water regulations enforced in 2017 (Lovdata 2018). However, regarding microbiological contamination, one recurring type of request related to uncertainty about positive test results for coliform bacteria and, based on this, the desirability of issuing a water-boiling advisory (despite no *E. coli* being detected in the water samples). In Norway, no official guidance exists regarding the presence of coliform bacteria and potential remedial actions, such as boiling water; however, an assessment of the situation to determine possible health consequences is vital. Guidance on safe levels of coliform bacteria does, however, exist in Denmark (Ministry of Environment & Food of Denmark – Natur Agency (Naturstyrelsen) 2013) and Sweden (Swedish Food Agency (Livsmedelsverket) 2017), where specific levels of coliform bacteria are indicated to necessitate a boil water advisory (along with an assessment of the situation) as a precautionary measure. The information obtained from the NWG supports the development of similar national guidance for Norway, to make the evaluation of test results and the planning of action easier or to provide

guidance for both water supplies and the municipal doctors for questions linked to infectious disease control.

Limitations of the data

Our results are only valid for the requests recorded by the NWG and should not be generalised to all water supply-related events. According to the Norwegian drinking water regulations, failure to meet drinking water quality standards and breaches of significance must be reported to the Norwegian Food Safety Authority (Lovdata 2018). This implies that there may have been several adverse events relating to water suppliers during the period assessed, but advice on how to manage the situation was not sought from the NWG, either due to lack of awareness or the event requiring no assistance to manage.

In some cases, it was difficult to classify the events we examined as microbiological, chemical or operational; for example, an operational failure of disinfection would ultimately result in a suspected microbiological contamination and it was debatable whether this request should be classified as a microbiological contamination event or/and an operational failure event. Similarly, accounts of a water treatment failure resulting in excess sodium hydroxide could be classified as an operational failure or a chemical spill event. The results may therefore be prone to classification bias that could affect the aggregated data over time, thus leading to a failure to provide accurate information when a breakdown of the water supply system occurs. A more nuanced manner of classifying requests could prevent this classification bias over time. A means of spotting trends more accurately or identifying common issues among the water suppliers would provide useful information to enhance their preparedness; however, a descriptive synthesis of data would, to a large degree, be heterogeneous and not suitable for detailed assessment.

Assessing whether incidents were severe enough to be considered relevant to the NWG was another challenge for the screening of the requests. Among the approximately 1,500 individual water supply systems in Norway, estimations of an acute situation will vary depending on the experience and competence of the organisation. An event that may be considered routine for a large water supplier could be a challenging event for a small water supplier, but this did not imply that the advice given was of less value than in complicated situations. By contrast, it may confirm that competence, or access to information, is limited and more challenging for small water suppliers.

Recommendations to the Norwegian crisis service on the way forward

Based on the three years of experience, it is recommended to continue to promote the existence and usefulness of the NWG among the water suppliers in Norway to ensure awareness and most possible use, in case of events and to avoid consequences of near misses. Future improvements should also include a more accurate synthesis of data on events, to inform national guidance and capacity building in the drinking water sector from experience from local events. A more in-depth evaluation should also be conducted to inform future decisions related to the development of the NWG.

CONCLUSION

Water supply systems are vulnerable to a number of adverse events that may have health consequences. In Norway, the NWG for water suppliers has, since it was launched in 2017, been approached for advice in different situations by various water suppliers, mainly by managers of small-scale water supply systems. The personnel operating water supplies in Norway have benefited from the NWG when evaluating situations and prioritising timely and effective actions. The NWG is one example of how expertise can be used effectively across water suppliers nationally to prevent the consequences of unwanted water supply events in countries like Norway, where the water supply sector comprises many small water suppliers. The requests elicit information that is useful for improving guidance on water hygiene questions at the national level.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

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