



Review article

Interruption of cancer screening services due to COVID-19 pandemic: lessons from previous disasters

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ARTICLE INFO

Keywords:

COVID-19

Health services

Early detection of cancer

Cancer screening program

ABSTRACT

Purpose: To review the scientific literature seeking lessons for the COVID-19 era that could be learned from previous health services interruptions that affected the delivery of cancer screening services.

Methods: A systematic search was conducted up to April 17, 2020, with no restrictions on language or dates and resulted in 385 articles. Two researchers independently assessed the list and discussed any disagreements. Once a consensus was achieved for each paper, those selected were included in the review.

Results: Eleven articles were included. Three studies were based in Japan, two in the United States, one in South Korea, one in Denmark, and the remaining four offered a global perspective on interruptions in health services due to natural or human-caused disasters. No articles covered an interruption due to a pandemic. The main themes identified in the reviewed studies were coordination, communication, resource availability and patient follow-up.

Conclusion: Lessons learned applied to the context of COVID-19 are that coordination involving partners across the health sector is essential to optimize resources and resume services, making them more resilient while preparing for future interruptions. Communication with the general population about how COVID-19 has affected cancer screening, measures taken to mitigate it and safely re-establish screening services is recommended. Use of mobile health systems to reach patients who are not accessing services and the application of resource-stratified guidelines are important considerations. More research is needed to explore best strategies for suspending, resuming and sustaining cancer screening programs, and preparedness for future disruptions, adapted to diverse health care systems.

1. Introduction

Screening is a key component of the cancer control continuum, and when effectively implemented, can decrease the burden of breast,

cervical, colorectal and lung cancers (Copeland et al., 2019; von Karsa et al., 2008; Perry et al., 2008). As COVID-19 reached pandemic levels in March 2020 reports of the interruption of regular delivery of cancer screening services, including opportunistic and organized cancer

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<https://doi.org/10.1016/j.pmedr.2021.101399>

Received 26 December 2020; Received in revised form 5 April 2021; Accepted 8 May 2021

Available online 17 May 2021

2211-3355/© 2021 The Authors.

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screening, pilot and research programs, and diagnostic follow-up emerged from around the world (Jazieh et al., 2020; Richards et al., 2020). Several countries took mitigation measures, limiting movement of populations as growing numbers of COVID-19 cases generated pressure on health care systems (Jazieh et al., 2020; Bruinen de Bruin et al., 2020). Efforts to control COVID-19 and reduce mortality became the focus of the public health agenda globally, while diverting attention from cancer prevention and control activities. However, cancer remains an important public health issue, accounting for an estimated 9.6 million deaths worldwide in 2018 (Bray et al., 2018). In addition, early epidemiological evidence suggests that cancer may be an important risk factor for COVID-19-related deaths (Geisslinger et al., 2020; Liang et al., 2020).

To limit the spread of coronavirus through healthcare-associated infections and preserve available resources for the COVID-19 response, political and health authorities and administrators in several countries mandated the interruption of non-emergency medical procedures, including routine cancer screening (Jazieh et al., 2020; Richards et al., 2020; Bruinen de Bruin et al., 2020). In the Netherlands, for instance, national screening programs for breast, cervical and colorectal cancers were suspended on March 16, 2020, and the Netherlands Comprehensive Cancer Organization reported a decrease in cancer diagnosis since the start of the COVID-19 pandemic (Dinmohamed et al., 2020). In the UK, cancer screening services were suspended and urgent 2-week-wait diagnostic referrals saw a decrease of up to 80% since March (Maringe et al., 2020). In Hong Kong, colorectal cancer diagnoses fell by 37% in the weeks after the emergence of COVID-19 and an initial model estimated colorectal cancer upstaging for 6.4% of patients at 6 months (Lui et al., 2019). In the United States, the National Cancer Institute projected almost 10,000 excess deaths from breast and colorectal cancers in the next ten years associated with delays in screening and treatment due to the COVID-19 pandemic (Sharpless, 2020).

By June 2020, as COVID-19 containment restrictions were progressively lifted, countries and regions were in various phases of resuming cancer screening services. Although the unprecedented scale of the current health crisis in recent times makes it difficult to find previous situations that were comparable, there have been occasions when natural and human-caused events, such as hurricanes, armed conflicts, and nuclear catastrophes, led to adverse effects on health systems, including interruption of services. Experiences derived from these events may be valuable to address the past and current interruptions of cancer screening services due to COVID-19 as well as to inform best practices for resuming screening and preparing against future interruptions, if necessary.

The purpose of this study was to systematically search the available scientific literature to look for lessons that could be learned from previous health services interruptions that affected the delivery of cancer screening services. Hopefully, the results will inform the next steps for cancer screening as services resume and to prepare for potential next rounds of service interruption during the COVID-19 pandemic or for future ones.

2. Methods

2.1. Literature search

An electronic search was conducted up to April 17, 2020, with no restrictions on language or dates. The search strategy was developed with assistance from the Library of Medical Sciences, in the Radboud university medical center, and carried out in PubMed, Google Scholar and Embase using the following keywords and their combinations: “disaster”, “mass screening”, “cancer” and “time factors” (referring to terms related to the time of interruption, such as “delay”, “stop”, “discontinue”, “after” or “during”). The keyword “mental health” was used to exclude articles from the search results because screening for mental health problems often occurs following a disaster, to punctually address

issues that arise post-event and not as an ongoing health service, while the current review focuses on the interruption and restart of health services. The full search strategy can be found in Appendix A.

2.2. Study selection

The search resulted in 385 articles and two researchers (D.M.P.P., T. C.) independently performed the selection process, initially reviewing the articles based on their title and abstract. A reversed search on the Web of Science, reviewing the reference list from retrieved articles and literature suggested by experts resulted in eleven more articles. Studies had to include either an interruption in health care services or describe an event that affected screening rates and the health of the population, while providing information on how the health system was able to cope with the event and resume operations. Articles were excluded when information about the provision of health care services was insufficient to offer a picture of the experiences encountered in the setting or when there was no possible parallel with the current COVID-19 pandemic. Any disagreements between the two researchers regarding the selected articles were discussed and a consensus on the final selection was achieved. Twenty-four potential articles were identified based on the titles and abstracts: nine articles were retrieved from PubMed and three from Embase; eight were selected using a reversed search on the Web of Science, and a search in Google Scholar; and, another four were found by reviewing the reference list from retrieved articles and literature suggested by experts. After reading the full-text articles, thirteen were excluded based on the criteria previously described. Therefore, eleven studies were included in the literature review.

The selection process of the articles is shown in Figure 1.

2.3. Data extraction

Relevant information was extracted from each included study, including characteristics that identify the setting as a disaster scenario, and the main findings relative to how it affected the organization or delivery of health services and any plans to resume them. Information from the selected studies were thematically analyzed, independently by two researchers (T.C. and D.M.P.P.) with the assistance of a senior cancer screening researcher (M.J.M.B.). Following the method developed by Braun and Clarke (Braun and Clarke, 2006); six stages were adhered to during analysis, i.e., familiarization with the data, coding, developing themes, reviewing themes, defining and naming themes, and final analysis. Consensus was reached through discussion when discrepancies arose. All co-authors recognized the four main thematic categories - coordination, communication, resource availability and patient follow-up - as key for the organization and delivery of cancer screening services.

3. Results

3.1. Study Characteristics

General characteristics of the seven original research studies included in the review are found in Table 1. Three studies were based in Japan (Kodama et al., 2014; Miki et al., 2020; Ozaki et al., 2011); two in the United States (Lobato et al., 2007; Nogueira et al., 2019); one in South Korea (Kang, 2020) and one in Denmark (Larsen et al., 2016). The remaining four studies were reviews that offered a global perspective on interruptions in health services (El Saghir et al., 2018; Gorji et al., 2018; Koscheyev et al., 1997; Martin-Moreno et al., 2012); and their characteristics are described on Table 2.

Eight studies included information about a health services interruption during a natural or human-caused disaster (Kodama et al., 2014; Miki et al., 2020; Ozaki et al., 2011; Lobato et al., 2007; Nogueira et al., 2019; El Saghir et al., 2018; Gorji et al., 2018; Koscheyev et al., 1997). The remaining three studies provided a perspective of events that may

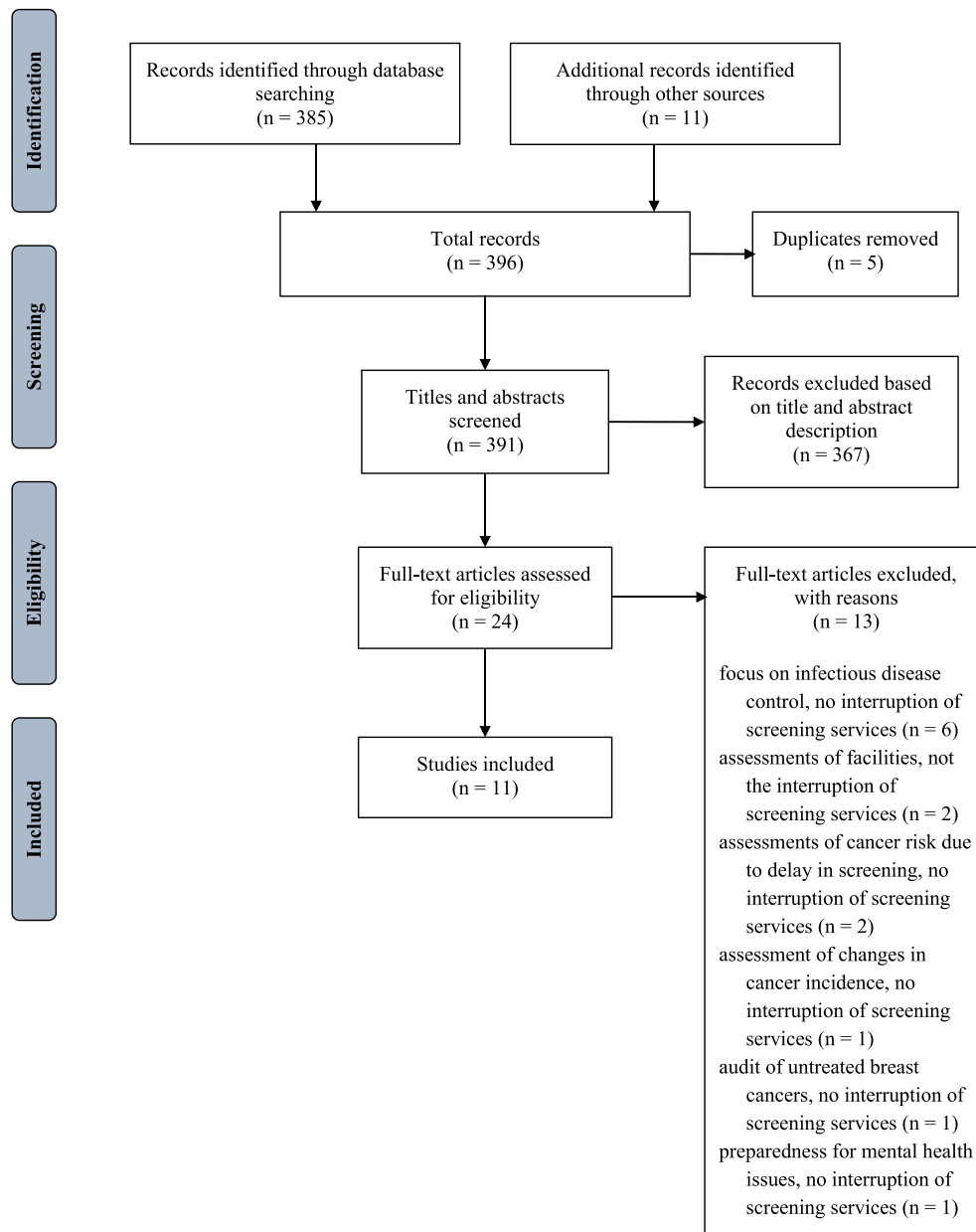


Figure 1. Overview of study inclusion.

indirectly disrupt the provision of health services, including a maritime incident (Kang, 2020); a systematic error in screening registration (Larsen et al., 2016); and a financial crisis (Martin-Moreno et al., 2012). No articles covered an interruption in regular health services due to a pandemic. There were no selection criteria for study design resulting in a wide range of study types, including three narrative reviews (El Saghir et al., 2018; Koscheyev et al., 1997; Martin-Moreno et al., 2012); three cohort studies (Ozaki et al., 2011; Nogueira et al., 2019; Larsen et al., 2016); two cross-sectional studies (Lobato et al., 2007; Kang, 2020); one systematic review (Gorji et al., 2018); one trend analysis (Miki et al., 2020); and one case study (Kodama et al., 2014).

The main topics covered in the included studies can be found in Table 3. Considering the medical subjects covered, two articles were focused on cervical cancer (Miki et al., 2020; Larsen et al., 2016); one on breast cancer (Ozaki et al., 2011); and one on lung cancer (Nogueira et al., 2019); while another explored the organization of breast, cervical and colorectal cancer screening in the context of the 2007-2008 global financial crisis (Martin-Moreno et al., 2012). Finally, one study looked at

the impact of a ferry disaster in South Korea on vaccination rates and health screenings (Kang, 2020), including cancer screening, and another on how Hurricane Katrina, in 2005, affected newborn screening in the state of Louisiana, in southern United States (Lobato et al., 2007). Multiple studies looked at the effects of patient delay and lack of access to oncology care (Ozaki et al., 2011; Nogueira et al., 2019; Gorji et al., 2018; Martin-Moreno et al., 2012); including in refugees and similarly displaced populations (El Saghir et al., 2018). The main themes identified from topics covered in the reviewed studies were coordination, communication, resource availability and patient follow-up, and the relevant lessons learned are further detailed below.

3.2. Adequate Coordination Across and Beyond Health Sector

After a disaster, the chaotic environment that often ensues makes it difficult to proceed with regular coordination of the health care activities beyond the immediate response to the event. Therefore, coordination and collaboration across the health care sector, and with other

Table 1
Characteristics of the original research articles included in the literature review.

Author	Study Type	Type of interruption	Type of Disease	Country	Study area and dates	Study population	Data source	Measures	Research objectives
Kang (2020) (Kang, E. Impact of disasters on community medical screening examination and vaccination rates: The case of the Sewol ferry disaster in Ansan, Korea. Disaster Med Public Health Prep., 2020)	Cross sectional study	Sewol Ferry Disaster	Chronic diseases, including cancer	South Korea	Ansan City, 2011 to 2016	5,524 residents of Ansan who participated in the Korean Community Health Survey (KCHS) in 2011–2013 (before the disaster), and 5,502 who participated in the 2014–2016 survey (after the disaster). Control group included all respondents who participated in the KCHS and were living outside of Ansan: 681,404 in 2011–2013 and 680,220 in 2014–2016.	National survey	Health screening examination, cancer screening examination, influenza vaccination	Assess the association of the Sewol Ferry Disaster with health examination, cancer screening rate and vaccination rate.
Kodama et al. (2014) (Kodama et al., 2014)	Case study	Earthquake, tsunami and nuclear power plant disaster	Chronic diseases (including cancer), injury, cold syndrome, trauma	Japan	Minamisoma Municipal General Hospital (MMGH), March 11 and 20, 2011 (within first 10 days of Great East Japan Earthquake).	241 admitted patients (27 cancer patients). 659 patients to the outpatient clinic (44 cancer patients)	Medical and administrative records	Hospital condition, number of inpatients, new admissions, number of discharged patients, death discharges, self-discharges, transfers, mean age, radioactivity levels	Investigate the operation of the Minamisoma Municipal General Hospital within the first 10 days of the Great East Japan Earthquake followed by the Fukushima Daiichi nuclear power plant accident.
Larsen et al. (2016) (Larsen et al., 2016)	Cohort study	Systematic error in screening registration	Cancer	Denmark	Danish National Cervical Cancer Screening Program (DNCCSP). Identification of females unsubscribed from program: October 13, 2013. Patient follow-up data: September 30, 2014. Adjudications in the Danish Patient Compensation Association: April 1, 2016. Media coverage: July 1, 2013 to March 31, 2014	19,106 women unsubscribed from the DNCCSP who did not receive invitations or reminders as recommended by the health authorities	Registry data, compensation claims, media reports	Screening test results, number of adjudications, value of compensation, number of hits in the media	Report an adverse event of women being unsubscribed from an organized cervical cancer screening program and describe the outcomes after re-establishing invitations.
Lobato et al. (2007) (Lobato et al., 2007 Oct)	Cross sectional study	Hurricane	Newborn diseases	United States	Hospitals in the Great New Orleans area, August 15 to September 21, 2005	64 hospitals in the Great New Orleans area	Survey	Number of live births, number of newborn screening specimens, number of missing results	Examine the extent to which newborn screening was disrupted in the immediate period before and after Hurricane Katrina.
			Cancer	Japan			Annual reports		

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Table 1 (continued)

Author	Study Type	Type of interruption	Type of Disease	Country	Study area and dates	Study population	Data source	Measures	Research objectives
Miki et al. (2020) (Miki et al., 2020)	Trend analysis	Earthquake, tsunami and nuclear power plant disaster			Areas of the Miyagi Prefecture, 2009 to 2016 (April 1 to March 31)	45 areas of the Miyagi Prefecture		Cervical cancer screening rates	Changes in the cervical cancer screening rates before and after the Great East Japan Earthquake in Miyagi Prefecture, Japan.
Nogueira et al. (2019) (Nogueira et al., 2019 Jul 16)	Cohort study	Hurricane	Cancer	United States	U.S. National Cancer Database, 2004 to 2014	1,734 patients undergoing definitive radiotherapy for nonoperatively advanced non-small cell lung cancer (NSCLC) who were exposed to a hurricane disaster. 1,734 matched unexposed patients	Hospital-based registry data, hurricane disaster declarations by the U.S. Federal Emergency Management Agency	Treatment duration, risk of death	Investigate whether hurricane disasters occurring during radiotherapy were associated with poorer survival for patients with non-small cell lung cancer.
Ozaki et al. (2017) (Ozaki et al., 2011)	Cohort study	Earthquake, tsunami and nuclear power plant disaster	Cancer	Japan	MMGH and Watanabe Hospital, in Minamisoma City, January 1, 2005 to March 10, 2016	219 female breast cancer patients (122 pre-disaster patients and 97 post-disaster patients)	Patient records	Delay in first medical consultation	Identify whether there was a post-disaster increase in the risk of experiencing patient delay among breast cancer patients in an area affected by the 2011 Great East Japan Earthquake.

Abbreviations – DNCCSP: Danish National Cervical Cancer Screening Program; MMGH: Minamisoma Municipal General Hospital; KCHS: Korean Community Health Survey; NSCLC: non-small cell lung cancer.

Table 2

Characteristics of the review articles included in the literature review.

Author	Review Type	Type of interruption	Type of Disease	Country	Research objectives
El Saghir et al. (2018) (El Saghir et al., 2018)	Narrative review	Middle East conflicts and global natural disasters	Cancer	Worldwide	Examine the effects of conflicts (focusing on the Middle East) and global natural disasters on cancer patients and those diagnosed with cancer during and in the immediate aftermath of these events.
Gorji et al. (2018) (Gorji et al., 2018)	Systematic review	Natural and human-caused disaster	Cancer	Worldwide	Identify challenges and preparedness measures for cancer patients during and after disasters.
Koscheyev et al. (1997) (Koscheyev et al., 1997)	Narrative review	Natural and human-caused disasters	Disaster-related health problems	Worldwide	Explore the health issues following natural and human-caused disasters that affect the welfare of both the individual and the larger communities.
Martin-Moreno et al. (2012) (Martin-Moreno et al., 2012)	Narrative review	Financial crisis	Cancer	Worldwide	Elucidate the rationale for sustaining and expanding cost-effective, population-based screening services for breast, cervical and colorectal cancers in the context of the 2007-2008 financial crisis.

sectors such as the media and local government authorities, are important factors to ensure the continuity or re-establishment of services ([Lobato et al., 2007](#); [El Saghir et al., 2018](#); [Koscheyev et al., 1997](#)). For example, according to [Lobato et al. \(2007\)](#), only 58.5% of New Orleans area hospitals reported having received the post-Hurricane Katrina advisory regarding resumption of state laboratory services, and this lack of coordination left several hospitals without a clear path forward ([Ozaki et al., 2011](#)). Moreover, [Martin-Moreno et al. \(2016\)](#), looking at the effects of the 2007-2008 global financial crisis, highlighted that lack of coordination and poor design in the implementation of cancer screening can waste considerable financial, material and human resources, pointing to the importance of optimal organization to face an

adverse event ([Martin-Moreno et al., 2012](#)).

[El Saghir et al. \(2018\)](#) noted that low- and middle-income countries often have under-resourced health care systems, and face economic and structural constraints that create coordination challenges and heighten the already difficult situation during and after disasters ([El Saghir et al., 2018](#); [Koscheyev et al., 1997](#)). However, high-resource settings facing a disaster scenario often encounter constraints familiar to low-resource settings. As [Ozaki et al. \(2017\)](#) reported, after the Great East Japan Earthquake, the risk of patients experiencing three or more months delay in cancer care in Minamisoma City reached levels similar to low-resource settings ([Miki et al., 2020](#)). Knowledge sharing and collaboration between different countries are helpful to those with less resilient

Table 3
Key findings organized under the main themes identified in the assessed studies.

Author	Themes			
	Coordination issues	Communication issues	Resource availability issues	Patient outcomes and follow-up issues
El Saghir et al. (2018) (El Saghir et al., 2018)	Most natural disasters occur in low-income countries with vulnerable health care systems, where a coordinated response is less likely to occur because of economic and structural constraints. Recommended the adoption of the Sendai Framework for Disaster Risk Reduction (Martin-Moreno et al., 2012) as a preparedness measure to strengthen the resilience of communities and countries.	Public awareness and information about how, where, and when to seek medical attention should be made more available to refugees in asylum countries. This could be achieved by improving communication between the health care system and the refugees through publicity and awareness campaigns.	At the end of 2017, in Syria, 45% of public hospitals were reported damaged, with 15% fully damaged and 30% partially damaged. Forty-nine percent were reported fully functioning, 25% of hospitals were reported partially functioning, and 26% were reported non-functioning. Only 23% of functional public hospitals in Syria provided cancer treatment services. Settings receiving displaced populations should consider applying resource-stratified guidelines to manage cancer patients, following the principle of doing the best possible with the resources available.	Only 46% of patients with cancer in Syria completed radiotherapy treatment without interruption, and 55% of them completed systemic therapy/chemotherapy without interruption.
Gorji et al. (2018) (Gorji et al., 2018)	Mobile clinics may help overcome barriers to treatment access in a disaster.	Communication infrastructures may be completely collapsed following a disaster, impacting interactions between providers, providers and their patients, and provider agencies and governmental agencies.		When assessing challenges of cancer patients, it is important to consider the diverse cancer types as disaster will affect them differently.
Kang (2020) (Kang, E. Impact of disasters on community medical screening examination and vaccination rates: The case of the Sewol ferry disaster in Ansan, Korea. Disaster Med Public Health Prep., 2020)				In 2014–2016 period, after the Sewol Ferry disaster, those who did not live in Ansan (where the ferry disaster took place) received more health screening, more cancer screening, and more vaccination than residents in Ansan. People living in the same area as disaster victims tended to receive fewer health services, even if they did not directly experience the disaster.
Kodama et al. (2014) (Kodama et al., 2014)	MMGH had a disaster plan in place. MMGH did not receive any information on Fukushima Daiichi nuclear power plant accident from the public administration office of the central government until March 18.	All communication devices including telephone, cell phones, and internet access were not available between March 11 and March 15. Lack of adequate communication led to worse response planning and increased anxiety among patients and medical staff.	70% of hospital employees chose to evacuate, mostly due to concern about their families and work responsibilities. Shortages happened faster than expected leading to treatment cessation. Delivery of supplies resumed 5 days after the earthquake. Lack of human and material resources, and information after the nuclear accident made it difficult to maintain the health care provider system.	Drug and meal administration to patients were shortened as medicine, food and water supplies were halted.
Koscheyev et al. (1997) (Koscheyev et al., 1997)	Disaster response is extremely demanding when followed by destruction of the social infrastructure, chaotic situation, inadequate medical supplies and lack of coordination between the various emergency, medical and scientific groups. Three disaster stages are identified: acute (one hour to several weeks), mid-term (months to years), long-term (years to decades). Importance of developing an integrated, multi-agency, inter-organizational structure to enhance the effectiveness of local emergency management directors and need for careful organization and communication among all levels of the chain of command. Having expert and competent personnel in charge of the response under	Following the Chernobyl nuclear accident, many government officials made decisions with long-term implications that were not optimal from a public health perspective after spending only one or two days at the scene. Contradictory orders given by different officials led to serious mistakes in data gathering and analyses.	Availability of physicians and other health care providers for rapid mobilization is often inadequate due to poor planning, insufficient numbers or the sheer magnitude of the disaster.	Patient triage can be disrupted by simple mistakes, communication difficulties, transportation problems or incorrect information, on top of high levels of fatigue and stress experienced by health care providers. Population health effects (physical and mental) following the acute emergency period of disasters require closer attention and accurate measurements are needed. However, the immediate research goals to protect the health of the population may be different from the long-term ones, which may lose momentum. Immediate health impact is difficult to be assessed during an acute disaster situation, due to issues such as poor information gathering, poor communication and coordination, and problems of field diagnosis.

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Table 3 (continued)

Author	Themes			
	Coordination issues	Communication issues	Resource availability issues	Patient outcomes and follow-up issues
Larsen et al. (2016) (Larsen et al., 2016)	the framework of the incident command system ^b is recommended in a disaster scenario. Coordinated, comprehensive mobile systems to monitor the health of hard-to-reach populations are recommended in disaster planning.	Prior to women's unsubscription becoming public in October 2013, only 25 cervical cancer-related items were retrieved from media sources mostly regarding human papillomavirus vaccination. In the six months following the event, 698 items covered the risk of similar events in other programs, patient compensation, and a new law to override the ten-year statute of limitation to the claims.		Among the 10,094 women within screening age who were unsubscribed from the DNCCSP, 3,804 (37.7%) had been opportunistically tested within 3 years (23- to 49-year olds) or 5 years (50- to 64-year olds) despite receiving no invitation. Of 4,783 women within screening age who were re-invited to the DNCCSP, 2,660 (55.6%) received cytology tests within 1 year and 26 (1%) high grade squamous intraepithelial lesions were detected. Among the 8,868 females older than 64 years, a total of 1,124 (12.7%) females received HPV tests, and over 90% of the tests were hrHPV negative. The Danish Patient Compensation Association processed 85 complaints from females diagnosed with cervical cancer, leading to 19 females compensated with a total of €693,000.
Lobato et al. (2007) (Lobato et al., 2007 Oct)	On August 29, 2005, the landfall of Hurricane Katrina in New Orleans led to the closure of the Louisiana Office of Public Health and its laboratories, causing the interruption of newborn screening services and diagnostic follow-up. Only 31 (58.5%) of the 53 reporting hospital laboratories stated that they had received the post-Hurricane Katrina advisory regarding resumption of state laboratory services. From 5958 specimens submitted from hospitals after the hurricane, 1207 (20.3%) screening results had not been received or could not be considered valid due to improper storage or delayed shipment.		Staff were evacuated and many could not return for weeks and months, eventually leading to over 70% of newborn screening laboratory staff to resign. Of the 53 hospitals that responded to the full survey, a few reported disruptions in laboratory processing (18.9%), labor and delivery (5.7%), and both (11.3%). Delays in the postal service led to an increase in the number of specimens rejected as a result of being over 14 days old (4% compared to ~0.1% rejection prior to the hurricane).	
Martin-Moreno et al. (2012) (Martin-Moreno et al., 2012)	Poorly designed and coordinated screening wastes considerable financial, material and human resources, so during an economic crisis, it is important to focus on aspects that contribute to optimal organization and implementation of cancer screening. Aspects essential to quality and effectiveness also include financing sustainability; identification, information and invitation of the target population; linkages within the healthcare system (including primary care and oncology); human resource training; laboratory and equipment infrastructure; technical quality;			Adequate and timely diagnosis and treatment, as well as awareness-raising are aspects needed to establish organized screening.

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Table 3 (continued)

Author	Themes			
	Coordination issues	Communication issues	Resource availability issues	Patient outcomes and follow-up issues
Miki et al. (2020) (Miki et al., 2020)	<p>risk communication; monitoring of results among many others that must work together coherently.</p> <p>After the Great East Japan Earthquake (11 March 2011), cervical cancer screening was resumed in April, 2011. However, in coastal areas restarting screening was delayed from July to December, 2011. In the Miyagi Prefecture, cervical cancer screening was performed in the mobile van or the hospital, with the van covering areas severely affected by the disaster.</p>	<p>There were areas where screening rates recovered in the 5 years following the disaster, and others that did not. It was not clear from the study what accounted for these differences, although communication is suggested as an important factor.</p>		<p>After the Great East Japan Earthquake, cervical cancer screening rates markedly decreased in the 4 coastal areas affected by tsunami and covered by mobile van: Ogatsu (−5.2%), Onagawa (−7.0%), Karakuwa (−4.8%), and Shizugawa (−4.1%).</p>
Nogueira et al. (2019) (Nogueira et al., 2019 Jul 16)				<p>Patients with locally advanced NSCLC exposed to a hurricane disaster had longer radiation treatment durations and significantly worse overall survival than matched unexposed patients. The adjusted relative risk for death increased with the length of the disaster declaration.</p> <p>There was no significant difference in the proportions of patients presenting with a lump between pre- and post-disaster patients. However, there was a significantly higher proportion of hormone receptor-positive breast cancer after the disaster, compared with the pre-disaster period. When comparing the overall post-disaster population with the pre-disaster baseline, there was a significant increase in the age-adjusted risk ratio for both total patient delay and excessive patient delay, and this trend continued for five years after the disaster. In the post-disaster period, none of access- and disaster-related factors and sociodemographic factors were significantly associated with experiencing total patient delay, however a significant association was observed with having a family history of any cancer. Although the proportion of those with total patient delay was 18.0% pre-disaster, similar to other settings in high-income countries, it reached 29.9% post-disaster, a level comparable to low- and middle-income countries. Furthermore, 18.6% of all post-disaster patients experienced excessive patient delay, compared to 4.1% pre-disaster. Only 22.2% of post-disaster patients with excessive patient delay lived with their children compared to 53.2% of those without excessive patient delay, which may point to lack of social support as an important factor.</p>
Ozaki et al. (2017) (Ozaki et al., 2011)	<p>MMGH and Watanabe Hospital in Minamisoma City stopped outpatient services immediately after the disaster (11 March 2011), and restarted services in June 2011. Breast cancer care was re-established at MMGH on August 2011. Minamisoma City has continuously provided mammography screening to residents throughout the post-disaster period. Alternative mechanisms, rather than changes in healthcare access (since measures did not differ significantly pre- and post-disaster), may have contributed to patient delay among post-disaster breast cancer patients.</p>			

Abbreviations – DNCCSP: Danish National Cervical Cancer Screening Program; MMGH: Minamisoma Municipal General Hospital; NSCLC: non-small cell lung cancer.

health systems and there are common lessons to be learned regarding optimization of resources and health personnel in the disaster response (El Saghir et al., 2018).

One common framework that El Saghir et al. (2018) recommend is the Sendai Framework for Disaster Risk Reduction (The United Nations Office for Disaster Risk Reduction, 2015), adopted by the United Nations, to address vulnerabilities and increase the resilience of health care systems, especially in settings where economic and structural constraints are greater (El Saghir et al., 2018). The authors suggest that general guidelines from the Sendai Framework could be applied to cancer care in disaster scenarios, such as providing information to patients and caregivers, ensuring continuity of care, identifying vulnerable patients and expanding international collaboration and global partnership. In addition, Koscheyev et al. (1997) point to the importance of ensuring that highly trained and certified personnel are in charge of the response, to be implemented under a coordination framework such as the incident command system (ICS) (Koscheyev et al., 1997). The ICS structures the disaster response into five functional sectors - command, operations, logistics, planning and finance - and encompasses core concepts that facilitate a coordinated approach such as a unified command, use of common terminology and integrated communications. Studies suggest that these frameworks could facilitate the development of an integrated, multi-agency, inter-organizational coordinated structure to enhance the effectiveness of the response (El Saghir et al., 2018; Koscheyev et al., 1997).

Finally, some studies found that new coordinated strategies, such as the quick implementation of mobile health clinics and similar mobile systems are useful to monitor the health of hard-to-reach populations and overcome barriers to accessing health services during and post-disaster (Miki et al., 2020; Gorji et al., 2018; Koscheyev et al., 1997).

3.3. Open Communication within the Health System and with the Public

Studies showed that there are two aspects of communication to be considered in the event of an interruption of health services. From an infrastructure perspective, natural or human-caused disasters may damage the local communications infrastructure and bring down telephone, TV, radio stations or the internet (Kodama et al., 2014). For example, Kodama et al. (2014) reported that communication devices such as landlines, mobile phones, and internet access were not available for four days at the Minamisoma Municipal General Hospital (MMGH) after the Great East Japan Earthquake hit (Kodama et al., 2014).

The second aspect is to ensure good communication among health providers, and between health providers, government authorities and the general public, providing the status of health system and the response. Several studies recommended this as a way to enhance the disaster response and avoid mistakes in triaging patients, while ensuring continuity of care (El Saghir et al., 2018; Gorji et al., 2018; Koscheyev et al., 1997). El Saghir et al. (2018) pointed out to the need of raising public awareness and providing information about how, where, and when to seek health services after the event (El Saghir et al., 2018). On the other hand, looking again at the MMGH example, the hospital received information about the Fukushima Daiichi nuclear power plant accident from the public administration office a week after the event (Kodama et al., 2014). Kodama et al. (2014) reported that this lack of adequate communication led to worse response planning and increased anxiety among patients and medical staff (Kodama et al., 2014).

Finally, health services interruption increases the interest of media and the general public in the event. For example, Larsen et al. (2016) noted that in Denmark, after it became public that women had been mistakenly unsubscribed from the cervical cancer screening program, the number of lay press articles about cervical cancer screening increased over 27 times (Larsen et al., 2016). Initially, these articles described the adverse event. Then, in the following months, they focused on the risk of similar adverse events in other screening programs and the compensation of women who were affected.

3.4. Address Resource Availability through Preparedness and Optimization

Disasters may lead to loss of infrastructure and human resources, causing a disruption in the regular provision of health services. In Syria, where armed conflict started in 2011, 15,000 doctors were reported as having left the country by 2015, while 45% of public hospitals were reported damaged, with 15% fully damaged and 30% partially damaged by the end of 2017 (El Saghir et al., 2018). At MMGH, after the Great East Japan Earthquake, 70% of hospital employees eventually evacuated from the disaster area due to personal concerns. In addition, the lack of adequate resources in terms of food, water and medical supplies soon translated into poorer health services as drug and meal administration to patients were shortened due to lack of medicines and supplies (Kodama et al., 2014). In the United States, Hurricane Katrina severely disrupted laboratory and postal services in New Orleans. Lobato et al. (2007) reported that within the month after landfall, 20.3% of newborn screening results from the affected area were not received or considered valid due to improper storage or delayed shipment, and rejection of inadequate specimens increased by 3,900% (Lobato et al., 2007).

Studies highlighted preparedness as an important element to overcome the sudden loss of resources, and to plan for the continuity or re-establishment of health services (El Saghir et al., 2018; Gorji et al., 2018; Koscheyev et al., 1997; Martin-Moreno et al., 2012). Gorji et al. (2018) suggested that disaster response training and education for health providers and the public is needed to deal with the new scenario (Gorji et al., 2018). Moreover, El Saghir et al. (2018) pointed to the needs of procedural and structural changes to mitigate resource constraints, recommending that health care providers consider applying resource-stratified guidelines to manage cancer patients, following the principle of doing the best possible with the resources available (El Saghir et al., 2018).

3.5. Ensure Patient Follow-up Beyond the Re-establishment of Services

Patients waiting for a diagnostic or treatment follow-up may experience delays during and after a disaster because the health system becomes focused on providing acute care as part of the response. In the United States, Nogueira et al. (2019) found that lung cancer patients affected by a hurricane disaster had 20 more days of radiation treatment on average and were 19% more likely to die of lung cancer compared to those who were not affected (Nogueira et al., 2019).

Ozaki et al. (2017) highlighted that the effects of discontinued services on patient follow-up could last long after the disaster, pointing to the importance of strengthening efforts to reach the affected population (Ozaki et al., 2011). The authors found that after the Great East Japan Earthquake, the population in Minamisoma City had a 66% greater risk of experiencing delays of three months or longer in patient care, and 349% greater risk of experiencing delays of 12 months or longer, compared to the pre-disaster population (Ozaki et al., 2011). Minamisoma City continued to provide mammography services throughout the post-disaster period and full oncology services were also re-established after three months. However, simply ensuring the re-establishment of services was not sufficient to decrease the risk of experiencing delays in cancer care. The increased risk persisted for five years after the earthquake, and the authors did not observe any association with factors related to access to cancer care (distance from hospital, referral, etc.) or to the disaster itself (resident of an evacuation zone), and suggested that experiencing psychosocial distress and lack of social support may have played a role in the delays (Ozaki et al., 2011).

Moreover, disasters have an impact on decisions to engage with the health system even when the population is not directly affected by the event. For example, the Sewol ferry disaster generated a public trauma in the city of Ansan, South Korea, as 304 passengers died, including 250 students and 11 teachers from a local high school (Kang, 2020). Ansan residents were not physically affected by the event and the tragedy did

not result in a disruption to the provision of health services. However, Kang et al. (2020) reported that, in the 3-year period after the event, people not living in Ansan were 1.41 times more likely to receive cancer screening than those who lived there; no differences were observed in the previous 3-year period (Kang, 2020).

4. Discussion

This literature review included 11 articles describing interruptions of health services around the world, with examples about preparedness and management of natural and human-caused disasters. We identified main themes around health services coordination, communication, resource availability and patient follow-up, examining principles and strategies relevant to the context of the COVID-19 pandemic. The COVID-19 emergency presents characteristics similar to previous experiences in disaster management, including interruption of health services, weak communication between health care providers and patients and lack of human resources, inadequate infrastructure or lack of supplies immediately after the outbreak and in many cases extending over several months, and the population not seeking health care services once they restarted. Therefore, the application of these principles and strategies could guide cancer screening practitioners on how to deal with this continuing public health crisis and prepare for future pandemics.

Coordination beyond the delivery of cancer screening itself, involving partners across the health sector, is essential to optimize resources and resume services, making them more resilient while preparing for future interruptions. For example, in the Netherlands, since the COVID-19 emergency response led to the reallocation of many cancer screening practitioners, the re-establishment of cancer screening services required coordination with other areas of the health system to bring back enough staff while ensuring the continuity of the emergency response, (Dinmohamed et al., 2020). In addition, a safe environment for health professionals and the general public is needed for the delivery of cancer screening as the pandemic continues (Jazieh et al., 2020; Richards et al., 2020; Bruinen de Bruin et al., 2020); which requires the coordinated implementation of adequate personal protective equipment and extra sanitation measures, and the assessment of participants for symptoms. These system adaptations call for coordination to ensure that the novel strategies and policies are properly implemented and that there are adequate staff and resources without compromising the response to the COVID-19 pandemic, or future ones.

Open communication and coordination among health care providers, health authorities and the public are essential to ensure that all parties understand the needs, challenges and changes generated by this COVID-19 scenario. Furthermore, we highlight the importance of clear communication with the general population, which can be aided through media, public campaigns, community leaders and organizations, about how COVID-19 has affected cancer screening, and the measures taken to mitigate these effects and re-establish the screening services in a safe manner. Such communication efforts may contribute to restoring participation in cancer screening once the programs restart (Miki et al., 2020; Larsen et al., 2016; Gorji et al., 2018); although the true effectiveness of communication strategies still needs to be tested. Considering the global impact of COVID-19, which led to the interruption of cancer screening in several countries, communication and knowledge exchange at the international level is essential for cancer screening practitioners to share experiences and other resources, learning from each other as they resume screening services and prepare for future disruptions.

In dealing with issues of resource availability and patient follow-up, the ongoing COVID-19 pandemic and consequent restrictions put in place worldwide to safeguard the health of the general population present several challenges to cancer screening. For instance, there is a considerable backlog because non-urgent services, including cancer screening, were postponed due to COVID-19 (Jazieh et al., 2020; Richards et al., 2020; Song et al., 2020). Establishing criteria to

prioritize participants is an important part of how programs plan and coordinate the re-establishment of cancer screening services. These delays will not be easy to solve, and may not be solved at all (Song et al., 2020); especially in settings where health care resources were already scarce. Moreover, contact with screening participants becomes more difficult due to the risk of infection, while laboratories are often busy testing COVID-19 samples instead of processing cancer screening samples. From the participant perspective, previous experiences have shown that even after health services are re-established, it may be long before the general population starts accessing them again even when logistical or socio-demographic barriers are absent (Ozaki et al., 2011; El Saghir et al., 2018; Gorji et al., 2018). In the ongoing COVID-19 pandemic, fear of infection when going for a regular screening or diagnostic visit may contribute to lower participation rates in the years to come. Here, the use of mobile health systems to reach patients who are not accessing services presents an opportunity (Miki et al., 2020; Gorji et al., 2018; Koscheyev et al., 1997).

Finally, as high- and low-resource settings face the common challenge of COVID-19, there are important lessons to be learned from one another, such as optimization of resources for restarting services while ensuring quality and effectiveness of cancer screening (DeBoer et al., 2020). El Saghir et al. (2018) recommended the application of resource-stratified guidelines to ensure basic health care delivery for refugees and in other disaster scenarios. This follows the principle of doing the best with the resources available, which is in line with more recent recommendations from the American Society of Clinical Oncology regarding allocation of resources during the COVID-19 pandemic (Marron et al., 2020). In addition, inequalities in cancer screening within and across settings should be monitored as underserved populations become more vulnerable due to health and socio-economic consequences of COVID-19 (DeBoer et al., 2020).

The global scale of the challenges faced during the ongoing COVID-19 pandemic highlight the relevance of lessons learned from disaster medicine, such as adequate coordination, open communication, preparedness and optimization to ensure resource availability and patient follow-up beyond the re-establishment of services, which are universal and transferrable across disaster types but often ignored beyond the localized occurrence. Established frameworks for disaster preparedness and emergency response such as the ICS or the Sendai Framework for Disaster Risk Reduction (The United Nations Office for Disaster Risk Reduction, 2015) provide an important roadmap in preventing unnecessary mistakes in the future (El Saghir et al., 2018; Koscheyev et al., 1997) as their implementation addresses coordination, communication and resource allocation issues that affected cancer screening services in the COVID-19 scenario. For example, the Sendai framework proposes strategies to provide information for patients and caregivers, ensure continuity of care, identify vulnerable patients, and strengthen the resilience of the health care infrastructure while “building back better” (El Saghir et al., 2018; The United Nations Office for Disaster Risk Reduction, 2015).

One of the limitations of this study is that information about resuming services was limited. There was not enough evidence to determine best practices in resuming cancer screening, which was one of the aims of this study. Furthermore, the focus of our search strategy was on screening, avoiding the inclusion of terms such as ‘epidemic’ and ‘pandemic’ because the scope was the disaster literature in general. This may have resulted in missing studies that describe other health services interruptions (e.g., outpatient visits, immunizations, services related to malaria, tuberculosis or HIV, etc.) related to epidemics and other disasters, especially in low- and middle-income countries, such as the Ebola outbreak of 2013-2016 in West Africa (Wilhelm and HELLERINGER, 2019). However, our search strategy captured 6 studies related to epidemics, which were excluded due to their focus on infection control and not the interruption of cancer screening services. Finally, grey literature was not included and there may be several strategies and practices being tested while facing the current COVID-19 crisis that were not included in

our study. However, the information acquired from the published literature on the interruption and re-establishment of health services described in this study provides important lessons for cancer screening practitioners worldwide.

It is important to note that several groups, such as the COVID-19 and Cancer Global Modelling Consortium (<https://ccgmc.org/>), continue to assess the effects of COVID-19 on the cancer care continuum. In addition, the International Cancer Screening Network (ICSN) (Vogel et al., 2019; Broeders and Elfström, 2020) has recently performed a survey to understand the immediate effects of COVID-19 on cancer screening worldwide and plan for the best ways forward. It is essential to coordinate these international efforts and establish open channels of communication across these different groups where relevant information could be shared. (Broeders and Elfström, 2020) Moreover, we encourage researchers to further assess best practices in preparing for and responding to the interruption of cancer screening services in the context of a disaster, and how to resume these services. A recent systematic review conducted by Riera and colleagues (Riera et al., 2021) on COVID-19 disruption to cancer care did not find any studies that addressed the interruption of the diagnostic process or population-based, organized cancer screening programs, indicating that there is a dearth of information even within the present crisis.

5. Conclusion

Coordination and communication while assessing available resources and best strategies to follow-up and monitor patients are essential elements in maintaining and restoring health care services during and after a disaster. Even though the findings gathered in this study are not surprising, they elucidate the importance of applying these fundamental elements of health services in times of crisis. These lessons are crucial in the context of the ongoing COVID-19 pandemic, and future ones, and should be taken into account as cancer screening practitioners re-establish services worldwide and prepare for the next disruption. Furthermore, the international community should work together to exchange information and expertise with the aim of identifying and testing best strategies to resume and sustain cancer screening programs, appropriately adapted to the diverse health care systems. The unprecedented scale of the ongoing pandemic requires a coordinated international effort. By reporting and sharing experiences of how cancer screening is resumed, we can apply lessons learned in other settings and strengthen the response while identifying and preventing potential pitfalls going forward.

Funding

This project has been funded in part with federal funds from the National Cancer Institute, National Institutes of Health, under Contract No. HHSN261200800001E75N910D00024, Task Order No. 75N91019F00129 (D.M.P.P.) and under Grant No. UM1CA221940 (J.S.H., A.K.) and UM1CA222035 (A.K.). The content of this publication does not necessarily reflect the views or policies of the Department of Health and Human Services, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

The authors would like to acknowledge the invaluable assistance from Ms. Alice Tillema, librarian at Radboud university medical center.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.pmedr.2021.101399>.

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