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Evaluation of Surveillance and Response Systems of Foodborne diseases and outbreaks at service level in Riyadh city- Saudi Arabia, 2015.

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Abstract

Objective: To assess the capacity of surveillance and response systems of FBDs and FBDOs in Riyadh city at the service level.

Methodology: The cross-sectional Study was conducted at service levels in Riyadh city. The questionnaire of the WHO model for surveillance was modified and filled out.

Results:

Service level: there is no national manual for surveillance and response systems for FBDs or FBDOs. 64 % said that no protocols demonstrating the policy of FBDs or FBDOs. 50 % admitted that there is no surveillance register for FBDs and FBDOs. 42 % need to know the deadline to report. No feedback.

Conclusion: Two surveillance and response systems of FBDs and FBDOs. Core functions still need to be fulfilled. Feedback and reporting are impaired at the service level. There are significant gaps in the Riyadh region's surveillance and response systems of FBDs and FBDOs.

Introduction

Unfortunately, it is common for foodborne illness incidents/outbreaks to go unreported by public health officials and uninvestigated by epidemiologists to pinpoint the source pathogen and food item consumed **[1]**. This is true for the vast majority of the world's population. Countries must urgently build capacity, primarily for physical infrastructure for detection and data collection and then for institutional mechanisms. Even when the pathogen and food item sources are identified in developed countries, a lack of public communication during foodborne outbreaks causes a delay in creating awareness and a loss of trust in public health institutions **[2]**.

Lack of international and institutional cooperation in notification and investigation has serious consequences, including uncountable losses in national or global economies and, more importantly, human lives, as demonstrated by the Escherichia coli O104:H4 outbreak in 2011. It is nearly impossible to provide a snapshot of actual risks to public health in the global food supply chain due to the patchiness of in-place functional surveillance systems globally and the inability of surveillance systems to collect sufficient amounts of raw data.

For example, there is yet to be a fully operational global database for case-specific outbreak investigation reports; publicly available epidemiological and trace-back information is only published by a few public health institutions worldwide. In light of these facts, even the most occupied countries struggle to meet the heavy burden of preventing foodborne illness outbreaks in a globalized food system. New pathogenic strains may continue to emerge as they acquire unique pathogenic characteristics, and transmission routes and vehicles may change unexpectedly **[3]**. Repeated unforeseen food safety incidents (BSE crisis, melamine crisis in milk, microbiological incidents, etc.) in recent decades have reactively led to new legislation or control measures, highlighting the need for developing early detection systems and adopting new control measures **[4]**.

Epidemiological data are required for various reasons, including informing public health authorities about the nature and magnitude of foodborne illnesses and their epidemiology, detecting foodborne disease outbreaks early, and planning, implementing and evaluating food safety programs. As a result, epidemiological surveillance of foodborne diseases is critical to any food safety program **[5]**.

The rationale of the Study:

There have yet to be any previous studies to evaluate the surveillance and response systems of FBDs and FBDOs in Saudi Arabia at the service level in Riyadh, focusing on performance indicators.

We aimed to reveal the gaps in the foodborne outbreak surveillance systems of service levels in Riyadh, Saudi Arabia, to propose solutions to existing problems. For this reason, an in-depth examination of the foodborne disease surveillance systems was undertaken. The surveillance system was assessed in terms of in-place

notification and monitoring systems. Lastly, we highlighted solutions for preventing and handling foodborne illness outbreaks more effectively and efficiently.

Objectives:

General objective: To assess the capacity of surveillance and response systems of FBDs and FBDOs in Riyadh city.

Specific objectives: 1- To utilize the WHO standardized tools to evaluate the current FBDs and FBDOs surveillance and response systems in Riyadh city **[6]**.

2- To identify weaknesses (absence of core and support functions) in surveillance and response systems of FBDs and FBDOs in Riyadh city.

3- To recommend strategies to strengthen the capacity of surveillance and response systems of FBDs and FBDOs in Riyadh city based on the assessment findings.

Methodology:

Study design:

A cross-sectional study.

Study setting:

The study was conducted in Riyadh city. Riyadh is the capital of KSA, with about six million people living in it.

The study was conducted at the service (health facilities) level represented by the four-leading governmental MOH hospitals in Riyadh city; King Saud medical city (KSMC), King Fahd medical city (KFMC), King Salman general hospital, and Aleman general hospital. In each hospital, the emergency department was involved.

Study population:

Service level = 50 subjects (ER doctors) distributed as (KSMC = 15, KFMC =15, King Salman hospital = 12, Aleman hospital = 8).

Sample calculation:

The Study covered all populations after applying inclusion and exclusion criteria. No statistical tests were needed to calculate sample size (n) because of the small number available.

Inclusion Criteria:

The investigator interviewed a person who has worked for at least six months and above. Language, gender, and nationality were not barriers in the Study.

Exclusion Criteria:

Anyone working for less than six months was not included because he may have yet received formal training regarding food safety surveillance.

Data collection:

Self-administered questionnaires and observational lists are the techniques to collect data. The principal investigator explained the questions to the participants when needed. The questionnaires were administered in English. The questionnaire and observational list were designed to cover the food-safety program. These tools are based on the Protocol for the Assessment of National Communicable Disease Surveillance and Response Systems, developed by WHO. The WHO recommended the protocol to help the national teams evaluate surveillance and response systems for communicable diseases, including FBDs **[6]**. The WHO designed three levels of generic questionnaires; central, district (intermediate), and health facility (service) levels. The questionnaires and observational lists are modified according to the local setting in the systems used in Saudi Arabia to be suitable for food safety because they are designed for all communicable diseases. Therefore, some elements do not apply to food safety, such as no weekly report on food safety.

The performance indicators and metrics used in the tools suit food safety programs in Saudi Arabia. These indicators are selected based on their importance and feasibility of implementation. They include metrics for epidemiology, laboratory, and environmental health. Metrics are measurements used to estimate performance indicators. For example, if the objective is FBDO detection, one of the performance indicators regarding this objective is the reported cases. Two of the metrics used in this study are completeness, i.e., the percentage of patients with complete data, and timeliness, i.e., time reporting. The health facility level is labelled as a service level to assess food safety in the selected hospitals.

Each tool will focus on the program functions, both core and support functions. The core functions of the surveillance systems are case detection, case registration, case confirmation, reporting, data analysis and interpretation, epidemic preparedness, response and control, and feedback. The supporting functions of the surveillance systems are standards and guidelines, training, supervision, communication facilities, resources, monitoring and evaluation, and coordination **[7]**.

The principal investigator collected the data to ensure reliability and validity.

The research comprised the leading four hospitals in Riyadh city, King Saud medical city, King Fahd medical city, King Salman hospital, and Aleman hospital. The Study covered emergency departments because they are the departments receiving patients with FBD. The hospitals assigned identified times to collect data because they were involved in corona disease. All ER doctors who were available on the day of data collection and agreed to participate were included in the Study.

Pilot study:

At the service level, the questionnaire was emailed to King Fahd central hospital in the Jazan emergency department.

The selection was by convenience according to the feasibility.

The pilot study's purpose was to test the questionnaires and reveal any ambiguities in the study tools. The questionnaires were reviewed and modified according to the finding of the pilot study; for example, the analysis of data and the outbreak investigation are not related to the service level. It was noticed from the pilot study that the major problems were in service level. Regarding notification or reporting of FBDs or FBDOs, no fixed system. It depends on the possibility and the availability of staff at the time. Sometimes physicians and sometimes nurses or other staff report the event. The role of infection control departments is the registration of cases. Some questions could be more understandable (e.g., questions about the standard manual of FBDs), and some could be more applicable (e.g., investigation of FBDOs and analysis). Hence significant changes were made to the service level questionnaire.

Analysis plan:

Epi-Info software (version 3.5.4) from CDC was used for data entry and analysis. The data was analyzed to respond to the objectives of the Study. The frequency of different descriptive variables, such as the availability forms, priority list of FBDs and standard case definition, etc., were estimated to know their percentages to find out the gaps and the opportunities in our surveillance and response systems of FBDs and FBDOs. Analysis was done at the service level; there were different regulations between medical cities and general hospitals, besides the sample size (n) was suitable (50). There are two medical cities (KSMC and KFMC) and two general hospitals (King Salman and Aleman hospitals). This is because KFMC and KSMC are medical cities, i.e., referral or tertiary hospitals, so they may have restrictions on receiving FBD cases. Also, they are following different authorities. This would negatively affect the results of our Study. Therefore, there was a need to know the differences between each indicator among other hospitals.

To test the differences and their significance, we divided the hospitals into two categories:

1- Medical cities category involved KSMC and KFMC.

2- General hospitals category involved King Salman and Aleman hospitals.

Three indicators were selected at the service level: a surveillance manual for FBDOs, the protocol of FBDOs, and reporting forms of FBDOs. These indicators are the essential core functions at the service level. They represent the dependent variables (outcomes) because their distributions depend on the health facilities' level.

The investigator concentrated on FBDOs because they are more critical and striking than single FBDs.

The answer options are "yes" and "no" (no answer comprises both no and do not know). In reporting time, "yes" is equal to "immediate," while "no" is equivalent to "do not know and 24 hours". In protocol item, "ministry, directorate, service" options are similar to "yes" while "no and do not know, or unknown source" options are equal to "no."

The frequencies, chi-square, and p-values were calculated for each indicator among the outcomes.

Ethical concerns

1- Ethical approval was taken from the Institutional Review Board (IRB) in the General Directorate of Research and Study in the ministry of health (RS-MOH). The administrative approval was taken from the MOH authorities.

2- The informed consent was explicit and indicated the purpose of the Study and was taken from health authorities and the participants at each level.

3- No incentives or rewards were given to the participants.

4- There are no conflicts of interest.

5- Participants' anonymity and autonomy were respected, and the principal investigator only was responsible for the content, and the participants were not included in the report.

6- The purpose of collecting information is the improvement of surveillance of FBDs through scientific recommendations.

Budget:

The authors did not receive funding from the MOH or any other institution. There is no other external fund.

Results

Service (hospital) level:

Identifiers

The total number of doctors included in the study was 50. This number is after applying inclusion and exclusion criteria. All ER doctors who were available on the day of the study and agreed to participate were included in the study. They are distributed as follows; 30 (60 %) doctors are in medical cities (15 doctors in KSMC, 15 in KFMC), and 20 (40%) doctors are in general hospitals (12 in King Salman hospital, and eight doctors in Aleman hospital).

Indicator; availability of national surveillance manual:

28 subjects (56 %) said that they do not know if there is a national manual for surveillance and response systems of single FBDs, while 22 (44 %) said "no."

27 subjects (54 %) said that they do not know if there is a national manual for surveillance and response systems of FBDOs, while 23 (46 %) said "no." **(Table 1)**

Table 1: Study participants response to availability of national surveillance manual at the service level. (N=50)

Indicator: availability of national surveillance manual	Response	Frequency	Percentage %
Presence of a national manual for surveillance and response systems of single FBDs.	No	22	44
	Do not know	28	56
Total		50	100
Presence of a national manual for surveillance and response systems of FBDOs?	No	23	46
	Do not know	27	54
Total		50	100

Indicator; availability of protocols demonstrating FBDs and/or FBDOs policy either by ministry or directorate or service level:-

18 subjects (36 %) said that there are protocols demonstrating the policy how to deal with single FBDs or FBDOs. Among them; 10 subjects (55.6 %) admitted that, the source of the protocols is MOH, one subject (5.6 %) admitted that, the source is general directorate of health affairs in Riyadh region, four subjects (22.2 %) admitted that, the source is the hospital itself (service level), two subjects (11 %) admitted that, they do not know the source, and only one subject (5.6 %) in KSMC admitted that, there are protocols from MOH and from KSMC.

20 subjects (40 %) said that, there is "no" protocol, while 12 subjects (24 %) said "do not know". **(Table 2)**

Table 2: Study participants response to availability of protocol demonstrating FBDs / FBDOs policy at the service level. (N=50)

Indicator: availability of protocol demonstrating FBDs / FBDOs policy	Response		Frequency	Percentage %
Presence of protocol demonstrating FBDs / FBDOs policy in the service level.	Yes	MOH=10 (55.6%)	18	36
		Directorate=1(5.6%)		
		Service=4 (22.2%)		
		MOH and service =1(5.6%)		
		Unknown source=2(11%)		
	No		20	40
	Do not know		12	24
Total			50	100

Registration indicator:

25 participants (50 %) admitted that there is a surveillance register for foodborne diseases. Among them, one participant (4 %) said that there is a register only for single FBDs, nine participants (36 %) said that there is a register only for FBDOs, and 15 participants (60 %) said that there is a register for both single FBDs and FBDOs.

Nine participants (18 %) admitted that there is "no" surveillance register for foodborne diseases.

16 participants (32 %) admitted: "do not know." **(Table 3)**

Table 3: Study participants response to availability of surveillance register FBDs / FBDOs at the service level. (N=50)

Indicator: availability of surveillance register FBDs / FBDOs	Response		Frequency	Percentage %
Presence of a surveillance register for foodborne diseases.	Yes	FBDs only= 1(4%)	25	50
		FBDOs=9(36%)		
		Both=15(60%)		
	No		9	18
	Do not know		16	32
Total			50	100

Data reporting indicator:

24 doctors (48 %) admitted that there was no shortage in the forms recommended by MOH for FBDOs during the past six months, 23(46 %) admitted "do not know," while three (6 %) admitted "yes" there was a shortage in those forms.

36 doctors (72 %) revealed that emergency room physicians fill the reporting form, two doctors (4 %) admitted that the reporting form is filled by infection control / public health personnel, two doctors (4 %) revealed that the reporting form is filled by others (nurses), and nine doctors (18 %) admitted: "do not know." One doctor (2 %) realized that emergency room physicians and nurses filled out the reporting form.

Three doctors (6 %) admitted that emergency room physicians are sending the reporting form to a higher level (sector, directorate, and MOH), 24 doctors (48 %) admitted that infection control / public health personnel are sending the reporting form, 7 doctors (14 %) admitted that others (nurses) are sending the reporting form, and 13 doctors (26 %) admitted: "do not know."

30 doctors (60 %) admitted they knew to whom they should report FBDs and FBDOs in the hospitals.

No doctor (00 %) admitted that they should report FBDs only, 24 doctors (48 %) admitted that they should say FBDOs only, 22 doctors (44 %) admitted that they should report both FBDs and FBDOs, four doctors (8 %) admitted that, they do not know the events that should be reported. 29 doctors (58 %) admitted that they should say FBDs and FBDOs immediately, six doctors (12 %) admitted that they should report FBDs and FBDOs within 24 hours, and 15 doctors (5%) did not know the deadline to register. **(Table 4)**

Table 4: Study participants response to data reporting at the service level.(N=50)

Indicator: data reporting	Response	Frequency	Percentage %
Presence of deficiency of appropriate surveillance forms recommended by MoH for FBDOs at any time during the last 6 months.	Yes	3	6
	No	24	48
	Do not know	23	46
Total		50	100
Who is filling the reporting form?	Emergency room physician	36	72
	Infection control or public health personnel	2	4
	Others (nurses)	2	4
	Do not know	9	18
	Emergency room physician and nurses	1	2
Total		50	100
Who is sending the report to higher level	Emergency room physician	3	6
	Infection control or public health personnel	24	48
	Others (nurses)	7	14
	Do not know	13	26
	Emergency room physician and nurses	1	2
	Infection control / public health personnel and nurses	2	4
Total		50	100
Do you know whom you should report to?	Yes	30	60
	No	20	40
Total		50	100
The events to report.	FBDOs only	24	48
	Both	22	44
	Do not know	4	8
Total		50	100
The deadlines for reporting of FBDs and FBDOs.	Immediately	29	58
	24-hours only	6	12
	Do not know	15	30
Total		50	100

Feedback indicator:

No one, 0 (0%) of doctors received any feedback from MOH during the last year neither for FBD cases nor for FBDOs.

Indicator: feedback

Supervision and training indicator:

41 doctors (82 %) said that they have never seen regional food safety program coordinator or regional communicable diseases coordinator during the last year, two doctors (4 %) said "yes" and seven doctors (14 %) said "do not know".

49 doctors (98 %) said that they have not been trained in surveillance and response systems of FBDs and FBDOs, while one doctor (2 %) said "yes". **(Table 5)**

Table 5: Study participants response to feedback at the service level. (N=50)

Indicator: supervision and training	Response	Frequency	Percentage %
Food safety program coordinator visits to the	Yes	2	4
service level in the past 6 months.	No	41	82
	Do not know	7	14
Total		50	100
Have you been trained in surveillance and	Yes	1	2
response systems of FBDOs?	No	49	98
Total		50	100

Resources indicator:

5(94 %), Email as reported by 37 subjects (74%), and other means as reported by 12 subjects (24 %). **(Table 6)**

Table 6: Study participants response to supervision and training at the service level. (N=50)

Indicator: resources	Response	Frequency	Percentage %
Does the hospital have communication	Telephone	44	88
resources? ***(Select all possible).***	Fax	47	94
	E.mail	37	74
	Others	2	24

Regarding FBDO definition; among 50 participants, 15 (30%) defined it correctly.

The observational list of the service level:

There is neither an observed national manual for surveillance and response systems for FBDs nor for FBDOs. There is no clear definition of FBDO. No protocol for FBDs or FBDOs policy was observed in ER departments. The updated MOH forms are not present, but the hospitals have their own forms. There are manual registers for FBDs and FBDOs in infection control departments. In ER, the register (a manual register) was seen in KFMC and King Salman hospital (KSH).

The analysis demonstrated that; the national manual for surveillance and response systems of FBDOs is not available neither in medical cities nor in general hospitals. 16 (32 %) of participants said "yes" there are protocols demonstrating the policy how to deal with FBDOs, while 34 (68 %) said "no".

The protocols presented more in medical cities 10 (62.5 %) than in general hospitals 6 (37.5 %). Chi-square is 0.06, and p value is 0.8.

29 (58 %) of participants said "yes" there is an immediate reporting of FBDOs, while 21 (42 %) said "no".

This immediate reporting presented more in medical cities 16 (55.2 %) than in general hospitals 13 (44.8 %). Chi-square is 0.657, and p value is 0.4. **(Table 7)**

Table 7: Evaluation of surveillance and response systems of FBDs and FBDOs in Riyadh city, 2015, analysis at the service level.

	protocols of policy of FBDOs (+)*	protocols of policy of FBDOs (-)	Total	x^2	*P value*
General hospitals	6 (37.5%)	14 (41.2%)	20 (40%)	0.06	0.8
Medical cities	10 (62.5%)	20 (58.8%)	30 (60%)		
Total	16 (32%)	34 (68%)	50 (100%)		
	Reporting time of FBDOs (+)**	**Reporting time of FBDOs (-)**	**Total**	X^2	*P value*
General hospitals	13 (44.8%)	7 (33.3%)	20 (40%)	0.657	0.4
Medical cities	16 (55.2%)	14 (66.7%)	30 (60%)		
Total	29 (58%)	21 (42%)	50 (100%)		

*Positive means protocol is there.

**Positive means immediate (correct) reporting time.

Table 8: Study participants response to core and support functions indicators at the service level. (N=50)

Indicators: case detection	Response	Frequency	Percentage %
Presence of a national manual for surveillance and response systems of single FBDs.	No, Do not know	50	100
Presence of a national manual for surveillance and response systems of FBDOs?	No, Do not know	50	100
Indicator: FBDO preparedness and response			
Presence of protocol demonstrating FBDs / FBDOs policy in the service level.	Yes	18	36
	No, Do not know	32	64
Indicator: registration			
Presence of a surveillance register for foodborne diseases.	Yes	25	50
	No, Do not know	25	50
Indicator: data reporting			
Presence of deficiency of appropriate surveillance forms recommended by MoH for FBDs and FBDOs at any time during the last 6 months.	Yes	3	6
	No, Do not know	47	94
The events to report.	FBDOs only	24	48
	Both	22	44
	Do not know	4	8
The deadlines for reporting of FBDs and FBDOs.	Immediately	29	58
	24-hours	6	12
	Do not know	15	30
Indicator: supervision and training*			
Food safety program coordinator visits to the service level in the past 6 months.	Yes	2	4
	No, Do not know	48	96
Have you been trained in surveillance and response systems of FBDOs?	Yes	1	2
	No, Do not know	49	98

* Support function does not core function

The main and specific objectives are fulfilled. Full assessment of the functional capacity of surveillance and response systems of FBDs and FBDOs in Riyadh city is achieved.

Discussion

The food safety program developed its manuals demonstrating FBDO investigation. These manuals are produced and distributed with the permission of MOH.

The striking gaps are in the service level, the front station to encounter FBDs, scattered cases, or outbreaks. All hospitals and all doctors do not know about these manuals and have never seen them. No one said there is a national manual for surveillance and response systems for FBDs or FBDOs. The investigator did not observe any manual for FBDs or FBDOs at any hospital he visited. Only 36 % of doctors in ER admitted the availability of protocols demonstrating FBDs and FBDOs policy. This represents trouble for the doctors in ER, particularly new ones. It is clear from the exclusion criteria (less than six months) that the turnover is high among ER doctors. This lack of protocol can damage the reporting mechanism about single FBDs and FBDOs because new doctors need the orientation to deal with such diseases. Half of the participants (50 %) admitted that there is no surveillance register for foodborne illnesses either for single FBDs or FBDOs or for both. The investigator observed manual logs for FBDs and FBDOs in infection control departments. In ER, a manual register was seen in KFMC and King Salman hospital. This result shows that 50% of FBDs or FBDOs need to be registered, so there is no documentation for them, i.e., half of the cases need to be included. The knowledge about foodborne diseases could be better.

Surveillance's consistency and sensitivity criteria regarding FBDO definition are impaired at the service level, although the definition is consistent and sensitive at central and regional levels. Only 30 % of the service level defined FBDO correctly. Hence at least 70 % of FBDOs are not reported. Some who know FBDO may not know that they should say it. This is very clear from the data reporting indicator results.

No doctor admitted that they should report single FBDs only, about half (48 %) admitted that they should say FBDOs only, and less than a half (44 %) admitted that they should report both FBDs and FBDOs. Reporting channels and mechanisms of foodborne diseases are different between hospitals. 72 % of doctors admitted that emergency room physicians fill out the reporting form. This is going with the regulations. 28 % said that others fill out the reporting form (e.g., nurses). This can be understood. ER departments are challenging departments. They treat complex cases and need more time to fill out reporting forms. Therefore, they ask other staff to fill them, such as the infection control unit staff. Forms availability was admitted only by about half (48 %) of doctors. The forms differed from the recommended forms by MOH, as seen by the investigator, but the hospitals have developed them. This may mean the completeness of MOH (standard) reporting forms may be harmed. When there is a

single FBD or FBDO, about half (52 %) of doctors must be aware of these forms and will not report these events.

About half (48 %) of doctors admitted that infection control / public health personnel are sending the reporting form to a higher level. 14 % admitted that others (nurses) are sending the reporting form. This is going with regulation and practicality. As mentioned, ER doctors are so busy and mostly need to figure out who and how to report.

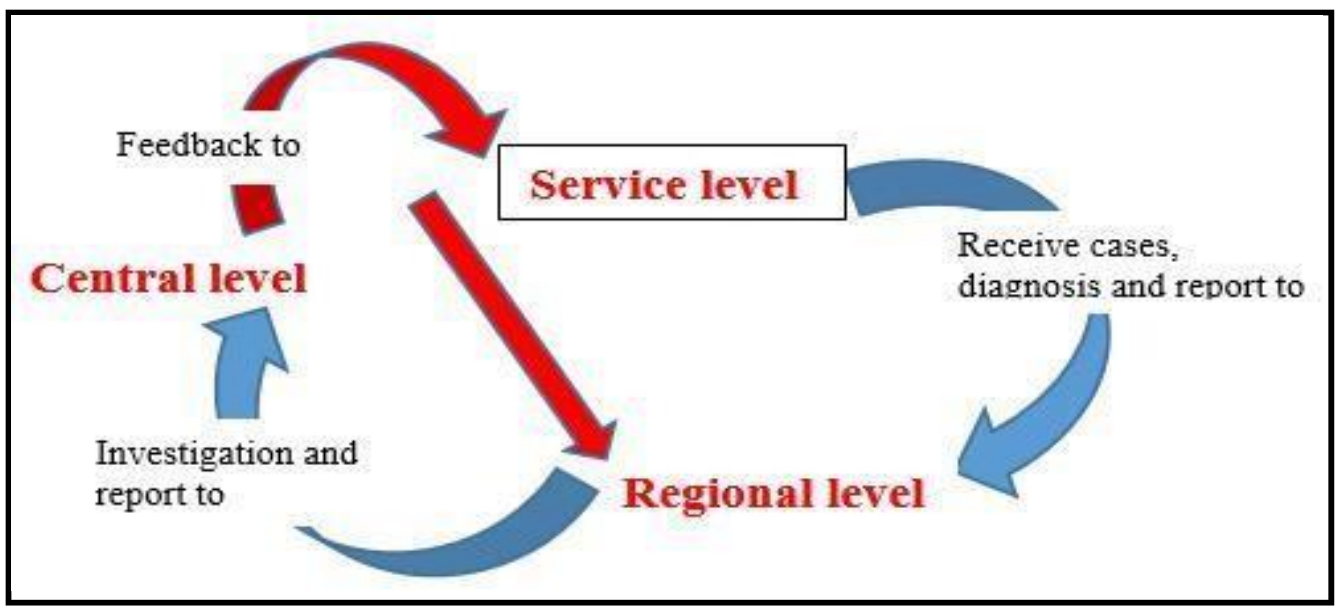
Difficult situations in ER can invite the authorities to think again about simplifying the reporting forms and methods. 20 doctors (40 %) admitted that they do not know to whom they should report FBDs and FBDOs in the hospitals. In addition, 42 % of doctors admitted that they should wait to notify FBDOs, and all of them said they should not report FBDs within 48 hours. Immediate reporting is the correct answer for FBDOs, and 48 hours for FBDs. This means that, in the case of FBDOs, if they know what they should report and how to say it, there is a delay in reporting which may harm the investigation process. Cases can be discharged before being seen by the coordinator, and there is a deficiency in the registry, as shown above, so the coordinator cannot trace them. This indicates to significant underreporting of FBDs or FBDOs. Also, the timeliness criterion of surveillance must be fulfilled at the service level.

There needs to be feedback regarding FBDs or FBDOs in any capacity control or management.

All the results discussed above correspond with the supervision and training indicators. This indicator is significant indicator because it is training, supervising, and orienting the hospital staff about foodborne diseases. As said, turnover is high, and the regulations are changeable. 96 % have not seen a regional food safety coordinator or regional communicable diseases coordinator, and 98 % have yet to be trained. However, 50 % of participants at the regional level admitted that the regional level, which is responsible for the service level, did visits to the service level in the past six months, and they have trained the staff in surveillance and response systems of foodborne diseases. This opposite information can be explained either by inaccurate answers of one party, or the team in the service level who participated in the study was not available at the time of the coordinator visit. On the other hand, service level admission can go with the other half of regional level staff, i.e., 50 % admitted with no holidays or training for service level during the past six months.

The investigator notices a point; KSMC and KFMC are directly under the ministry's authority, not the general directorate of health affairs as King Salman and Al-eman hospitals. This means that the coordinators at the regional level need permission to supervise and train KSMC and KFMC staff. Also, these two hospitals do not report FBDs and FBDOs at the regional level. KSMC and KFMC represent 50 % of the study population and 60 % of the service level. How does communication between the regional level and KSMC and KFMC take place? I could not find an answer to this point.

Communication resources in all hospitals are available without any difficulties. As shown above, the circle of surveillance and response systems of FBDs and FBDOs is a complete circle.



If there is any defect in one part will affect the whole circle. For instance, there are significant gaps in reporting system of FBD or FBDO (underreporting and no timeliness). The level initially responsible for the reporting is the service level. Hence, the iceberg phenomenon is markedly evident in the service level.

By looking at the service level results and recognizing the significance of this level because it is the first place patients enter, it is clear that there is a failure or drop in the surveillance and response systems of FBDs and FBDOs in Riyadh city, 2015.

From the discussion, it is clear that the study results answered the research question that the surveillance and response systems of FBDs and FBDOs in Riyadh city are functioning but need to be in a proper way. The two main types of FBD surveillance are there but dispersal. Laboratory-based (pathogen-specific) surveillance is there but reported to the communicable diseases directorate in the region and in MOH, not to the food safety program, and no coordination with the food safety program at regional and central levels to search if there is a link between scattered cases. Therefore, many FBDOs can be missed because only individual cases are reported, and no connection can be achieved between them.

Complaint system surveillance is the only surveillance system of FBDs in the food safety program in MOH and the directorate. This system works exclusively on FBDOs but not on single cases of FBDs.

Although at the regional level. There is a regulation that the service level must report even single issues of FBDs based on the complaints, not on the laboratory confirmation, to the coordinator of the food safety program, who will collect them in a folder (similar to a logbook) to find out if there is any link between the cases (e.g., common food source) to discover hidden FBDOs. The latter method is not applied at the main level, so more likely only used in Riyadh. The food safety program does not inform the communicable diseases directorate about FBDOs caused by salmonella. Even at the regional level, the coordinators of communicable diseases and food safety are sitting next to one another, but they have yet to learn about the cases received by their neighbors. That means the infectious diseases coordinator is notified about laboratory-confirmed cases (scattered cases) of typhoid and paratyphoid fever (enteric fevers), salmonellosis, shigellosis, amoebiasis, and hepatitis A & E but does not inform the food safety coordinator about them as said before these cases may have represented hidden outbreaks which need investigation. Scattered points and even laboratory-confirmed outbreaks are reported to the communicable diseases coordinator according to the regulations **[8]**.

On the other hand, the food safety coordinator does not inform communicable disease coordinators about FBDOs caused by organisms that must be reported to the infectious diseases directorate. The consequence of this dichotomy is the misleading biostatistics of these agents. Indeed, these biostatistics represent the tip of the iceberg. But the iceberg phenomenon here is at the central level, which is a severe issue because the ministry of health should communicate with international agencies about these cases and the situation in the country.

As mentioned, there is an iceberg phenomenon in the service level due to underreporting process and the need for timeliness.

Timely reporting is a significant measure of the performance of public health surveillance systems. It is known that the timeliness depends on the disease's nature (e.g., rapid onset and brief course), the purpose of use of the data, and the public health system level. Timelines lag even in developed countries with high public health system levels, like the USA **[9]**.

Due to the presence of two arms dealing with FBDs, reporting duplication can happen when service level reporting laboratory-based FBDOs for one of the agents in the list of communicable diseases to the coordinator of infectious diseases in the region.

Meanwhile, food safety programs in the region can be reported about the same outbreak but from ER, i.e., complaint-based reporting. This duplication can disturb the work but not affect the biostatistics because only the communicable diseases coordinator report to the ministry and thence to international agencies. At the same time, the food safety program has statistics that will not be sent to international agencies.

The service level could be better. Many indicators need much work. Supervision and training, protocols, feedback, and reporting processes at the service level need urgent intervention from regional or even central levels. Tremendous efforts are required to solve the dichotomy between single FBDs and FBDOs managements. All FBDOs reported to the region last year were investigated. The main level confirms this. Feedbacks play a crucial role in improving the practice. They are essential in maintaining a spirit of collaboration among the public health and medical communities, improving reporting to the surveillance system **[10]**.

Syndromic surveillance of FBDs has no role in Saudi Arabia at any level.

No formal surveillance system is not applicable in Saudi Arabia.

Statistical analysis at the service level did not show any significant differences in the selected indicators (surveillance manual for FBDOs, policy protocol to deal with FBDOs, and reporting time) between medical cities or general hospitals (x2 and p-value results are not significant). So the level of health facility did not affect the study's results.

The results could not reject the research hypothesis that the surveillance and response systems of FBDs and FBDOs in Riyadh city are ineffective, not sensitive, inconsistent, and not timely. There are significant defects in core and support functions at service levels. **(Table 10)**

Limitations:

Need help finding all doctors in the assigned time of data collection. The presence of coronavirus in days of the study. The problematic situation in ER during data collection.

External validity is low because the study results cannot be generalized to private hospitals, non-MOH governmental, and other regions. After all, the study was conducted in the Riyadh region and only in MOH hospitals, although areas follow the same system from the ministry of health.

I need help in comparing my study with other studies.

Conclusion:

1- Underreporting was markedly apparent, along with no timely reporting. Standards and guidelines, such as clear policies or protocols, were absent. This necessitates the presence of a standard protocol for FBDs and FBDOs, besides a clear FBDO definition, to ensure consistency and sensitivity.

2- No registers for FBDs or FBDOs at the service level.

3- Feedback (dissemination) is impaired completely.

4- Supervision, training, monitoring and evaluation, and coordination were impaired totally.

5- The communication facilities were excellent.

Therefore:

The core functions of surveillance and response systems of FBDs and FBDOs still needed to be fulfilled.

The supporting functions of the surveillance and response systems for FBDs and FBDOs needed to do more than what is expected in KSA. These indicators and others indicate significant gaps in the surveillance and response systems of FBDs and FBDOs in Saudi Arabia (mid-level) must be filled as soon as possible.

Recommendations:

1- Intensified training and supervision by regional coordinators (food safety program and communicable diseases directorate) to the service levels. This should include hospitals not under the authority of the directorate (e.g., KFMC) after developing discipline regulating this issue. Minutes and schedules must be documented for each training and supervision.

2- Computerized policy and protocols from the ministry of health to all facilities at the service level demonstrating how to deal with FBDs and FBDOs and clear FBDO definitions to ensure consistency and sensitivity. This can enhance reporting process (completeness and timeliness) and solve the turnover problem among physicians. Manual protocols are not suitable because many protocols are there.

3- Developing a bulletin regarding foodborne diseases must improve the feedback process.

4- Reporting forms and processes must be unified by the ministry and be very simple to fill and complete.

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