Scenario

Food-Related Norovirus Outbreak in Southern Germany

Preliminary Events

An above-average number of gastroenteritis cases was registered in Baden-Württemberg, a federal state of Germany located in the southwest of the country. Many children in schools and day-care centres show symptoms including fever, diarrhoea and vomiting.

The responsible authorities (you!) have declared an outbreak and started an investigation. The number of cases and the fact that these appeared at the same time at different locations make a transmission via smear infection unlikely. The children have lunch in their educational institutions (schools, day-care centres) making a transmission via catering possible. Menus have been asked for as well as the methods of food preparation.

Due to information from public health authorities, noroviruses could be found in faecal samples from patients with gastroenteritis. Regarding the onset of the first symptoms and the incubation period of norovirus infections in humans, tracing activities were focused on menus eaten directly before the first symptoms became obvious.

The caterers are working closely together with you and have already sent hastily written menu names by fax. These might have contained viable pathogens because some ingredients had not been heated.

The objective is to find the contaminated food(s) and the pathogen responsible for the outbreak by tracing back the suspicious food items. If the product(s) and lot number(s) were able to be traced, they could be withdrawn from the market, minimising further spread of the pathogen as well as reducing the number of new cases.

Case definition

<u>for an educational institution in Baden-Württemberg affected by a gastroenteritis outbreak:</u>

- The educational institution (school, day-care centre) offers menus from external caterers for all children.
- Catering is provided by an external caterer.
- At least 10% of individuals (children, pupils) have fallen ill between 1. Sep and 7. Sep 2014 and show symptoms like diarrhoea or vomitus.

OR

- At least 10 individuals* (children, pupils) have fallen ill between 1. Sep and 7. Sep 2014 and show symptoms like diarrhoea or vomitus.

* Including educational institutions not fulfilling the 10% criterion but with at least ten diseased individuals considers the fact that especially in grammar schools and secondary modern schools a substantial proportion of pupils does not eat the meals offered at school. This way schools with many pupils but with a small number of pupils affected can be included in the outbreak investigation.

Cases, aggregated by Educational Institution

Educational Institution	Name	Street	House Number	Postal Code	City	Federal State[1]	Cases	First Symptoms	Laboratory Test Result	Confirmed Cases? (Y/N)-	Lunch by Caterer? (Y/N)	Name of Caterer	Caterer's Principal Office	Establishment Capacity (No. of Children)
School	Primary school 01	Heuweg	1	72417	Jungingen	BW	18	01/09/2014			Y	Y	Caterer 1	Burladingen	146
School	Primary school 02	Lichtensteinweg	1	72393	Burladingen	BW	22	02/09/2014			Y	Y	Caterer 1	Burladingen	173
School	Primary school 04	Stillfriedstraße	1	72379	Hechingen	BW	27	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	187
School	Primary school 05	Steinbeisstraße	1	72501	Gammertingen	BW	12	01/09/2014			Y	Y	Caterer 1	Burladingen	83
School	Primary school 06	Sonnenhalde	1	72532	Gomadingen	BW	22	03/09/2014			Y	Y	Caterer 2	Engstingen	109
School	Primary school 07	Stuttgarter Straße	1	72574	Bad Urach	BW	18	04/09/2014			Y	Y	Caterer 2	Engstingen	108
School	Primary school 08	Emil-Mörsch-Weg	1	72555	Metzingen	BW	31	03/09/2014			Y	Y	Caterer 2	Engstingen	128
School	Secondary modern school 01	Brunnenstraße	1	72417	Jungingen	BW	20	01/09/2014			Y	Y	Caterer 1	Burladingen	181
School	Secondary modern school 02	Gammertinger Straße	1	72379	Hechingen	BW	15	02/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	106
School	Secondary modern school 03	Europastraße	1	72501	Gammertingen	BW	28	02/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	175
School	Secondary modern school 04	Siemensstraße	1	72818	Trochtelfingen	BW	24	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	166
School	Secondary modern school 05	Auf dem Graben	1	72574	Bad Urach	BW	12	03/09/2014			Y	Y	Caterer 2	Engstingen	103
School	Secondary modern school 06	Orffweg	1	72555	Metzingen	BW	17	03/09/2014			Y	Y	Caterer 2	Engstingen	116
Day-care centre	Day-care centre 01	Weilbachstraße	1	72417	Jungingen	BW	25	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	149
Day-care centre	Day-care centre 03	Panoramastraße	1	72393	Burladingen	BW	31	02/09/2014			Y	Y	Caterer 1	Burladingen	180
Day-care centre	Day-care centre 04	Tübinger Straße	1	72379	Hechingen	BW	19	01/09/2014			Y	Y	Caterer 1	Burladingen	191
Day-care centre	Day-care centre 05	Friedrich-Wolf-Weg	1	72379	Hechingen	BW	16	01/09/2014			Y	Y	Caterer 1	Burladingen	96
Day-care centre	Day-care centre 06	Eichertstraße	1	72501	Gammertingen	BW	24	01/09/2014			Y	Y	Caterer 1	Burladingen	146
Day-care centre	Day-care centre 07	Kapelleschweg	1	72818	Trochtelfingen	BW	24	01/09/2014			Y	Y	Caterer 1	Burladingen	168
Day-care centre	Day-care centre 08	Sperberweg 28	1	72829	Engstingen	BW	24	03/09/2014			Y	Y	Caterer 2	Engstingen	145
Day-care centre	Day-care centre 09	Bannholz	1	72532	Gomadingen	BW	18	04/09/2014			Y	Y	Caterer 2	Engstingen	140
Day-care centre	Day-care centre 10	Eichbergstraße	1	72813	Sankt Johann	BW	32	03/09/2014			Y	Y	Caterer 2	Engstingen	122
Day-care centre	Day-care centre 11	Schillerstraße	1	72574	Bad Urach	BW	24	04/09/2014			Y	Y	Caterer 2	Engstingen	115
Day-care centre	Day-care centre 12	Im Altweck	1	72585	Riederich	BW	10	03/09/2014			Y	Y	Caterer 2	Engstingen	67
Day-care centre	Day-care centre 13	Bachstraße	1	72585	Riederich	BW	31	03/09/2014			Y	Y	Caterer 2	Engstingen	124
Day-care centre	Day-care centre 14	Wangstraße	1	72813	Sankt Johann	BW	36	03/09/2014			Y	Y	Caterer 2	Engstingen	132
School	Grammar school 01	Gammertinger Straße	1	72379	Hechingen	BW	18	01/09/2014	Norovirus	Y	Y	Caterer 1	Burladingen	110
School	Grammar school 02	Hechinger Straße	1	72501	Gammertingen	BW	19	02/09/2014			Y	Y	Caterer 1	Burladingen	110
School	Grammar school 03	Schillerstraße	1	72818	Trochtelfingen	BW	18	01/09/2014			Y	Y	Caterer 1	Burladingen	152
School	Grammar school 04	Stuttgarter Straße	1	72574	Bad Urach	BW	33	04/09/2014			Y	Y	Caterer 2	Engstingen	176
School	Grammar school 05	Im Millert	1	72555	Metzingen	BW	11	03/09/2014			Y	Y	Caterer 2	Engstingen	92

1)   BW – Baden-Württemberg

Technical Note

The following example scenario is structured as a table with the following columns: D<small>ATE</small> and S<small>TORY</small> both depict the events of the fictitious outbreak. To investigate the outbreak certain T<small>ASKS</small> need to be done. How this can be achieved with FoodChain-Lab is explained in the column W<small>HAT TO DO IN</small> F<small>OOD</small>C<small>HAIN</small>-L<small>AB</small>. Options in KNIME and FoodChain-Lab are numbered in square brackets (e.g. [T15]) and can also be found in the screenshots (see *FCL Workshop Gastroenteritis Screenshots.pdf*). Data to be imported via Excel files can be found in the column F<small>ILES</small>.

To "click" means to click with the left mouse button, to "right-click" means to click with the right mouse button and to "double-click" means to click twice quickly with the left mouse button.

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES

08 Sep 2014	Members of the outbreak investigation team have visited all educational institutions. They found out more about the caterers of the educational institutions and which menus they delivered and have entered the data into the Start Tracing templates for FoodChain-Lab.
	
	Your colleague from the analysis team imported the data into FoodChain-Lab and prepared a KNIME workflow to analyse the data.
	
	However, because your colleague is going on holidays, the workflow has been passed on to you so you can take over.
		Import the KNIME workflow and the database backup.	**Open KNIME**
			• Double click on the KNIME icon on your desktop or the knime.exe in the KNIME folder
			
			Import the KNIME workflow
			• Right-click on **LOCAL [K3]** in the KNIME Explorer on the left side and choose **Import KNIME Workflow**.
			• In the Import dialog that appears, select **Select file** and click the **Browse** button to the right of it.
			   • A dialogue appears, select the zipped workflow indicated in the FILES column. You find it in the folder **Norovirus Scenario**. Click **Open**.
			• Click **Finish**.
			• Double click on the imported workflow in the KNIME Explorer on the left side
			
			Import the database backup
			   • Choose **Food-Lab → Open DB Gui… [K2]** in the menu to open the internal FoodChain-Lab database. If it is the first time you open the database, a window "Internal database created" will open. **Click OK**.
			• In the database window
			   • Click the **Database recovery [DB10]** icon (blue and white striped circle)
			   • A dialogue opens. Choose the database file indicated in the FILES column. Click **Open**.
			   • A windows pops up saying "…Really install data backup?" → click **Yes** and also click **OK** in the next pop-up window.
			• Close the database window.
				Workflow:
				Gastroenteritis outbreak.knwf
				
				Database:
				DB_Backup.tar.gz

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
08 Sep 2014		Have a look at the graph in the Tracing View.	**Inspect the delivery network with the Tracing View node** • Open the Tracing View **[K11]**. To do so, you can either double-click on the node or right click on the node and select "Configure". • Position the mouse arrow in the white space, press the left mouse button and move the mouse into a direction to **drag the whole network** into the preferred position. • You can also **rearrange single stations** by drag&drop. • To **select single stations or deliveries** click on them. To **select several stations or deliveries at once**, press "Shift" and draw a rectangle around them or press "Shift" while clicking on station after station. To deselect click in the white space. • Double-click on a station or a delivery to view its **properties**. Close the properties window with **OK** or Cancel. • **Zooming** is possible by clicking the "+" or "-" buttons **[T9]** or by turning the mouse wheel. • If you zoom out far enough you will be able to see two clusters.	
08 Sep 2014	Caterers 1 and 2 delivered lunches to schools and day-care centres. In all educational institutions several children had symptoms of gastroenteritis.	Customise the graph in the Tracing View: Set "Weight" = 1 for all schools and day-care centres to indicate that disease cases were registered there. Additionally, rearrange the network.	**Set the weight of a station** • Open context menu via right-click in the white space of the **Tracing View**, then choose **Set Selected Stations [T7]**: • **Property [T3]** = Type of business • **Value [T4]** = Educational institution (choose in the drop-down menu) → OK. Selected stations are now highlighted in blue. • Afterwards right-click → station selection → show properties → set all weight → 1 → OK → OK. • To deselect the selected stations or deliveries click somewhere into the empty space in the Tracing View window. • By double-clicking on an educational institution you will see the new weight 1 in the first row. Stations with a weight > 0 are coloured in red and indicate that a pathogen was detected (here: ill children in schools or day-care centres). **Rearrange the graph** • If the graph is not well arranged, open the context menu with a right-click and choose a layout from **Apply Layout [T5]**, for example Fruchterman-Reingold. **Save the changes** • Click **OK [T14]** to save the current view status of the Tracing View node and to close the node. To save all changes of the workflow permanently you need to press the **save button in KNIME [K1]**.	

Catering Menus on Outbreak Days
(First Forwarding by Kitchens)

Caterer 1

Menu 1 on 1st September 2014

Pasta with ground beef and tomato sauce

Vanilla pudding with strawberries

Menu 2 on 3rd September 2014

Potato soup with bread

Fruit yoghurt

Caterer 2
3/9/14

Menu 1

Semolina pudding with strawberry compote

Menu 2

Turkey goulash with rice

Fruit quark

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
09 Sep 2014	Data on meals from two caterers is in our dataset so far. We know which caterer provided menus to which day-care centre or school. Now, we need to know the ingredients of the menus and who supplied these to the caterers.	Generate an Excel document to collect the menu ingredients and suppliers. The generated files concerning the caterers can be completed either by local food inspectors or by the caterers themselves.	**Generate backward tracing templates** • Open the DB GUI • Click on the icon **Generate backward tracing templates - for a specific type of business (or all) [DB3]**. • Choose for which business types templates should be generated (default = all) **[DB7]**. To find knowledge gaps it is best to keep all boxes ticked. Click **OK**. • You are asked for an output folder for the templates. Choose or create a folder and click **Save**. A message will be displayed as soon as the templates have been created in the chosen folder. Click **OK**.	
09 Sep 2014	Send the generated backward tracing templates to the caterers to have them filled.			
09 Sep 2014	While you are tracing the food chain, interviews are conducted: Children from schools and day-care centres are asked which menus they have eaten on the days of disease onset.			
10 Sep 2014	A day later the caterers send the filled backward tracing templates of the menus including food component suppliers.	Import the completed backward tracing templates.	**Import backward tracing templates** • Click the button **Table import [DB1]** (folder icon) in the upper-left corner of the DB GUI. • A dialogue opens. Choose the files indicated in the FILES column. You can find the files in the **folder "Backward tracing templates_Caterers"**. To select several files press Ctrl on the keyboard while selecting them with the mouse. To select all files press Ctrl+A. Click on **Open** to import the caterer information into the database. • A window pops up saying "Import successful!" → click **OK**.	StationBacktrace_request_Caterer 1_complete.xlsx StationBacktrace_request_Caterer 2_complete.xlsx

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES

10 Sep 2014	Mistakes can always slip in – be it a table created by human beings or the automatically generated export from a business database. You want to be sure and this is why you check all the data collected in the database.	A similarity search is recommended after importing data into the database. Investigate for faulty addresses or duplicate entries. Correct the mistakes.	**Similarity search in the FoodChain-Lab database**
			• After the data import click the button **Similarity Search [DB2]** (eye icon) in the database window. Tick **Station [DB8]**, and keep the default settings (90), meaning that names or addresses which are at least 90% similar are going to be displayed. Click **OK**.
			• Please have in mind that the algorithm searches for small differences. These do not need to be mistakes, but may also be desired differences between two similar data sets.
			• Go through the search results by clicking **>** or **<** in the lower left corner.
			  • If you find duplicate entries, **merge** them as follows: drag the incorrect data row onto the correct data row.
			  • If you find search results that are unique (desired differences), click "All stations are unique" or just switch to the next result.
			  • With the **Undo** button you can undo changes if you accidentally merged rows.
			• Click **OK** to save the changes and to close the search result window (or click Cancel if you do not want to save the changes).
			• Repeat the procedure for Product, Lot and Delivery **[DB8]**.
			• Close the database window.	

10 Sep 2014	Obviously, several component suppliers delivered products / ingredients to both caterers. Which of these may have been contaminated with the pathogen? Noroviruses could be detected in some cases (see page 4), but not yet in food items. Noroviruses are known to stay intact in poorly heated or non-heated foods. As the virus was ingested via salad, berries, raw vegetables and also bivalve molluscs in past outbreaks, these foods are of special interest when screening the ingredients lists.	Visualise the delivered foods in the Tracing View. Are there any foods which were sent to both caterers? In these food items the supplier might have delivered the agent as well. For an easier tracing of foods label the arrows with the food name.	• Right-click on the Supply Chain Reader **[K10]** and **Reset [K12]** and **execute [K5]** this node. This step is necessary whenever the database has been updated (import of new data, changes during similarity search). • Open the Tracing View by double-clicking the node. • If you cannot read the ingredient names, rearrange the stations manually or open the context menu with a right-click and choose an automated layout from **Apply Layout [T5]**.	

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES

10 Sep 2014	In the delivery network you can see that some of the ingredients were delivered to both caterers. In addition, from caterers 1 and 2 you learn that vanilla pudding, fruit quark and frozen strawberries had not been heated during the preparation of the meals.	Test the hypothesis that one of the ingredients is contaminated to get an idea what impact this could have on stations of the food chain. To do so, set these products "observed" one after another and have a look at the forward and backward trace. Please keep in mind that despite affirmation the menus might not have been heated enough to kill noroviruses. In this case additional suppliers and products might be the source of the pathogen.
		
		Questions:
		• Concerning ingredients and supply relationships, which of the suppliers could have delivered products contaminated with noroviruses?
		• Is there a product or an ingredient from which the forward trace (orange) leads to most or even all outbreak cases (red)?
		• What are your next steps? Tracing? Sampling?
		• In which company would you take samples first if you had too few outbreak investigators to take samples in all suspicious companies?
			Mark deliveries "observed"
			• Right-click → set selected deliveries **[T13]**:
			  • Property = Name
			  • Value = e.g. "Pepper" (select in drop-down menu or start typing and choose from the suggestions)
			  • OK
			• Afterwards, right-click → delivery selection → show properties → set all observed = true → OK →OK
			• You could also define "Observed" by double-clicking on an arrow and activating "Observed" in the properties window.
			• For comparison, repeat this procedure with the other suspicious products. Before observing another product click "Reset Observed" **[T1]** and OK in the following pop-up window. Then mark the next product as described above.
			• Close the Tracing View with **OK**.	

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
11 Sep 2014	You have the strong suspicion that *Frozen Fruit Sales*, the company which produced bags of frozen strawberries, might be the key to the gastroenteritis outbreak. Both caterers received frozen strawberries with the same lot number. You examine the whole company, take samples and ask for the supplying strawberry farms. Also, the other recipients of the strawberries are of interest. In the evening, the samples are sent to the laboratory.	Export a <u>backward</u> tracing template for *Frozen Fruit Sales* to collect information on the suppliers of this company.	**Generate backward and forward tracing templates** Open the DB GUI • Click on the icon *Generate backward tracing templates - for a specific station* **[DB4]**. • In order to find *Frozen Fruit Sales* in the new window *Select Station*, you can either start typing "frozen" into the search box at the top or you can scroll through the list. It can be sorted by clicking on the column headline. • Export a template for *Frozen Fruit Sales* by clicking the *Select* button at the beginning of the row. Then choose or create a folder and click **Save**, then **OK**.	
		Export a <u>forward</u> tracing template for *Frozen Fruit Sales* to collect information on the customers of this company.	In the DB GUI • Deselect *Generate only the missing data* **[DB5]**. Because there is already information on *Frozen Fruit Sales* in the database, no forward tracing template would be generated without deselecting this option. • Click on the icon *Generate forward tracing templates - for a specific station* **[DB6]** and export a template for *Frozen Fruit Sales*.	
11 Sep 2014	You send the generated backward and forward tracing templates to Frozen Fruit Sales to have them filled. The company should note all its suppliers (the strawberry farms) and also which of its products (e.g. frozen strawberries) were received by which customer (caterers). The same day, the company provides you with the desired information.	Import the completed backward and forward tracing templates.	**Import backward and forward tracing templates** In the DB GUI • Import the completed backward and forward tracing templates for *Frozen Fruit Sales*. You can find the file in the **folder "BackwardForward tracing templates_Frozen Fruit Sales"**	Stationbacktrace_request_Frozen Fruit Sales_complete.xlsx StationFwdtrace_request_Frozen Fruit Sales_complete.xlsx
		Look at the updated delivery network and decide on further investigation steps.	To do in KNIME • **Reset** and **execute** the Supply Chain Reader to get the imported data into the workflow. • Open the Tracing View and have a look at the tracing network. If necessary, rearrange the stations. • Close the Tracing View with OK.	

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
12 Sep 2014	According to the information from *Frozen Fruit Sales*, Caterer 3 received the same frozen strawberry lot as Caterers 1 and 2. You ask Caterer 3 to which addresses lunches were delivered.	Generate a forward tracing template, send it to Caterer 3 and have it filled.	**Generate and import forward tracing template** In the DB GUI • Click on the icon *Generate forward tracing templates - for a specific station* **[DB6]** and export a template for Caterer 3. • Select an output folder for the templates.	
		Import the completed delivery list from Caterer 3 and have a look at the trace.	In the DB GUI • Import the completed forward tracing data sheet into the database. You can find the file in the **folder "Forward tracing template_Caterer3".** • Close the database window	StationFwdtrace_request_Caterer 3_complete.xlsx
		Look at the updated delivery network and check the trace of the frozen strawberries.	To do in KNIME • **Reset** and **execute** the Supply Chain Reader to get the imported data into the workflow. • Open the Tracing View. If the frozen strawberries have not been marked "observed", yet, do so now (see above).	
12 Sep 2014	According to the trace, the two additional educational institutions should have reported gastroenteritis cases. However, two quick phone calls later you know that nobody is ill. You interview Caterer 3 again and learn that the fruits were processed to strawberry purée and boiled. By boiling the strawberry purée Caterer 3 has obviously inactivated the included noroviruses and prevented the spread of the disease.	Change the network status so that educational institutions connected to Caterer 3 are not predicted to have gastroenteritis cases.	**Telling FoodChain-Lab that a pathogen is inactivated in a station** • Double-click the station "Caterer 3". • Activate the checkbox **Kill Contamination [T15]** and click OK in the properties window.	

DATE	STORY	TASKS	WHAT TO DO IN FOODCHAIN-LAB	FILES
12 Sep 2014	You would like to share your results with other colleagues who do not have FoodChain-Lab installed.	Export your analysis results to make them available in the more intuitive and easily accessible FCL web app.	**Export results from FoodChain-Lab desktop app** • In the upper left corner of the opened Tracing View click on the tab "JSON" and then on "Export Settings". Select or create a folder and give a name for the JSON file. Click **Save**. To switch back to your analysis click on the "Options" tab. • Now, you are able to provide the JSON file to your colleagues e.g. by sending them an email with the exported JSON file as attachment. • Close the Tracing View with **OK** and save the KNIME workflow **[K1]**. **Bonus task:** Import the JSON file into the FCL web app and try out this version of FoodChain-Lab.	
13 Sep 2014	From the interviews with children you learn that the majority of cases have eaten menu 1 from Caterer 1 or menu 1 from Caterer 2. Both menus contained frozen strawberries, so the current assumption that these fruits might be contaminated is backed. Menu ingredients are tested for noroviruses. In the kitchen of Caterer 1 noroviruses could be detected in a closed bag of frozen strawberries with the Lot No. 108. Caterer 2 used the same lot, but unfortunately, he could not provide a retained sample. Frozen strawberries sampled at *Frozen Fruit Sales* showed a contamination in one sample, but the signal was very weak and could not be confirmed in a repeated test run. However, it is essential to prevent additional disease cases. Evidence is strongest for frozen strawberries with Lot No. 108. The supplier is asked to withdraw this lot from the market.			

Final Remark

It remains unclear how the frozen strawberry lot became contaminated. One suggestion is, that an ill staff member and poor hygiene in the company *Frozen Fruit Sales* might be the reason. Another one might be that one of the three strawberry farmers has delivered contaminated fruits and that during the washing procedure in *Frozen Fruit Sales* the noroviruses were spread onto all strawberries.

Disclaimer

This scenario was inspired by the Norovirus outbreak in Germany in 2012. However, all stations and deliveries are fictitious. If there is by chance any similarity to existing food businesses, this was not intended.