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# *Video Observation and Data Coding Methods* to Assess Food Handling Practices at Food Service

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## SUMMARY

Eating at foodservice has been identified as a risk factor for foodborne illness. The World Health Organization (WHO) has identified four food handler-related factors that contribute to foodborne illness: improper cooking procedures; temperature abuse during storage; lack of hygiene and sanitation by food handlers; cross-contamination between raw and fresh ready-to-eat foods. Evaluation of food handler behaviors, important for risk assessment calculations and for the effectiveness of training strategies, has historically been limited to self-reported data, inspection and participatory observation. This article describes the framework of a video observation methodology, novel to food service situations, used to capture and code food handler practices for analysis. Through the piloting of this technique in a working foodservice establishment, a number of lessons were learned, including best equipment to use, equipment location and configuration, as well as pitfalls in coding practices. Finding and working with partner organizations and navigating institutional ethics review is also discussed.

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## INTRODUCTION

Between 17% and 30% of individuals become ill from foodborne illnesses annually in the U.S. *(37, 40, 47, 56, 61).* The WHO has identified five food handler-linked factors that contribute to foodborne illness: improper cooking procedures; temperature abuse during storage; lack of hygiene and sanitation by food handlers; cross-contamination between raw and fresh ready-to-eat foods; and acquiring food from unsafe sources *(62).* While risks to food safety exist from farm to fork, eating meals prepared in foodservice establishments is identified as a major factor for acquiring foodborne disease in North America *(29, 32).* Although reliable data are difficult to acquire, up to 70% of foodborne illnesses are linked to meals prepared outside of the home *(34, 35, 45, 58).* Foodborne illness outbreaks linked to foodservice have resulted in lawsuits in the U.S., costing industry an estimated $80 million since 1993, with workers being the source of over 800 outbreaks *(24, 27, 39).* Nearly 60% of food handler-related outbreaks were due to two specific pathogens often linked to poor personal hygiene practices, human norovirus and Salmonella serovars, with more illnesses being linked to asymptomatic carriers than to those who were ill *(24, 59).*

Studies using qualitative data derived from focus groups, surveys or inspection reports show that food handlers do not always employ safe practices, practice proper hygiene or use risk reduction tools, such as thermometers or handwashing tools *(10, 22, 49, 54).* Self-reported data are, however, wrought with problems of reliability. In a study of factors leading to food handler behavior in foodservice, Clayton and colleagues found that while food handlers may report the intent to perform safe food handling practices, actions are not always realized *(10).*

Data derived from inspection also have limitations, as it has been shown that restaurant inspection is not predictive of foodborne illness outbreaks and does not provide information on daily food safety actions of staff *(11, 30).* A further limitation of utilizing inspection data is that the results rely on observational and risk judgment of the inspector *(13).* Although evaluations of interventions are deemed to be necessary to demonstrate impact, many have used inspection results or knowledge to test food handler actions, with inconsistent results *(16, 17, 43, 54).*

Food handlers' food safety practices may provide a better indicator of outbreak predictability and intervention evaluation than inspection reports or other indicators. Missing from the literature is a reliable, valid and consistent method to capture the food safety practices of food handlers in a multi-user foodservice kitchen or food preparation area, a necessary step to evaluate whether a food handler-targeted intervention is effective. It is difficult to assess where gaps lie within food handling food safety in the absence of a valid and reliable method to capture, assess and catalogue baseline practices and intervention effects.

Researchers have suggested that the only reliable measure of effectiveness of intervention material is through the observation of food preparation practices *(1, 51, 53).* In a review of 87 consumer food-handling studies, Redmond and Griffith *(13)* found that only 15% employed observation methodology of any kind *(65).* As observation can capture actual behavior in context, data obtained through this methodology often yields valid and reliable information upon which further interventions can be developed and risk assessments calculated *(1, 19).*

Few observational studies have examined how consumers store, prepare, and consume food in the home. The studies that utilized direct observation of consumer food handling found that although many consumers commit errors during preparation, they self-report different actions *(1, 12, 28, 33, 53).*

Most studies of food safety actions within a foodservice have relied on participant checklists *(46)* or standardized inspection reports *(18, 31, 44).* A small number of studies have employed direct observation of practices of food handlers within a foodservice environment *(7, 9, 38, 48, 54).* Good food safety practices at foodservice are largely based on behavior as opposed to systems or microbiology, as most outbreaks can be attributed to poor handling or bad decision-making *(21).*

### Framework for video observation techniques in foodservice

In their review of consumer food handling methods, Redmond and Griffith *(51)* reported that primarily two types of observation have been conducted in food safety studies: participatory (where an observer is present in an environment) and non-participant (where practices are captured and reviewed later). There is a paucity of published observation studies associated with non-participant observation of foodservice food safety practices. Of the observation studies within a foodservice setting, all have employed participatory observation *(7, 9, 38, 54).* Participatory observation, while an improvement over inspection data or self-reported behaviors, has limitations in that observers must make quick coding decisions, observe in a fast-paced setting, and observe, record and code multiple tasks by multiple observed participants occurring at the same time, and in that observation may influence the actions of participants.

The observation site can also impact measurable actions. Observed food handlers may augment or adjust their practices based on location — food safety practices in a model kitchen, with an unfamiliar set-up, may be different from what is observed in a food handler's work environment. In an evaluation of consumer food safety observation methods, Redmond *(50)* showed no overall difference in food safety practices in a natural versus controlled environment.

Redmond and Griffith *(51)* also suggest that biases in observation methodologies need to be overcome to establish reliability and validity. The two most prominent biases in observation methodology are observer bias and the impact of observing on practices *(51).* Observer bias, where the observer's perceptions can influence which practices are and are not recorded, is considered the greatest threat to reliability when observational techniques are used *(3, 51).* In the observation methodology literature, much discussion has centered on the impact of the measurement tool, or observer, on the actions of study participants, an effect known as the Hawthorne Effect, wherein the participant changes behavior because of awareness of being observed *(8, 14, 15, 53, 55, 57).* To overcome the Hawthorne Effect, researchers have employed practices such as posing as staff or not fully revealing to participants what practices are being observed *(1, 4, 9).*

### Capturing practices through video observation

No standardized, non-participatory method to capture food safety practices of individuals within a multi-user kitchen has been described in the literature. Non-participant video observation has advantages over participant observation and can be used to generate valid and reliable data. Video observation may be less intrusive than participatory observation, and observed participants may be more likely to forget that they are taking part in a study. Recordings provide researchers with the ability to manipulate the speed at which they review actions and to re-wind and re-view actions. Video observation also allows for multiple observers to view the same actions reducing coding bias. Video observation that utilizes multiple cameras also allows observers to record multiple angles, food handlers and tasks at the same time. This is especially important in foodservice settings, as many participants at various stations can contribute to one meal. Video observation could, however, be seen as more invasive to some participants, as their actions are captured for review. There may be apprehension with participants, as they cannot deny any actions that are recorded.

### Selection of technical equipment

A suite of products suitable for video observation of a foodservice setting was identified after exploring video recording technology through Internet searches for video capture equipment and software ***(Table 1).*** Laptop computers coupled with web-enabled cameras (webcams) are suitable for foodservice video observation studies. Laptop computers are suitable because of their portability and size, and webcams for their large capture frame, durability and size. Products that are easily hidden were sought, because reducing the impact of the data collection on the food handler practices is paramount. Apple MacBook laptop computers (13") are ideal (footprint of 11" × 9"), as they can be easily placed and hidden on ledges, on top of cooler units or on storage shelves, and they utilize Mac OS X operating system, suitable for selected software.

Logitech QuickCam Pro 5000 webcams are also suitable for video observation, as they were rated at CNET.com, a popular Internet electronics review site, as equipment of the best value and most compatible with the Mac OS X operating system *(35).* The field of view of Logitech QuickCam Pro 5000 was wide enough to capture a 30-foot wall from 15 feet. The webcams can also be fitted with a six-foot USB cable to allow for placement away from the laptop. Logitech QuickCam Pro 5000 captures up to 1280 × 960 pixels and records live video at 30 frames/second and does not require focusing. Logitech QuickCam Pro 5000 webcams also featured a stabilizing base, allowing for the camera to be swiveled and fixed on a specific area. Duct tape can readily be used to affix cameras, power cords and Macbook laptops in place.

*Security Spy* and *Sleepless* software was used for the video capture of food safety practices. *Security Spy,* developed as a remote video capture package, allows for timed recording and multiple camera angles and meets the small video data storage requirements. *Security Spy* also has a movement wake-up function (in which cameras are shut down until the software detects movement in the observation site) that can be utilized to conserve memory storage. *Security Spy* saves captured video in a .mov file, which is compatible for review on PCs and Macs. *Sleepless,* a program that allows MacBooks to operate while the screen is closed, was added to allow for a less intrusive instrument and equipment that could be better hidden. Recording using *Security Spy,* depending on the amount of observation movement and capture settings, used, on average, two gigabytes of storage per hour of recording per camera.

### Piloting the method

The video observation methodology was developed to allow foodservice operations to evaluate the food safety practices of their staff and, most importantly, for their food safety program staff to identify strengths and weaknesses within their training programs. A pilot of the recording and coding system was conducted to validate that actions could be captured and to identify any pitfalls and barriers to further use of the methodology. A multi-national foodservice organization was partnered with for the testing and improvement of the methodology. For the pilot, the organization provided unfettered access to facilities and personnel at one site, to allow an evaluation of the method. This exercise was also a pilot to a food handler communication evaluation project where the developed methodology was employed; however, there was not space to discuss the specifics of the techniques in the project's manuscript *(6).*

In accordance with the institution's research ethics requirements, foodservice staff who were recorded in the video observation methodology study were provided with program objectives and were told that video recording of the worksite was being undertaken to conduct research on food flow, efficiency, food handler practices and teamwork. Participants were asked to provide consent and indicate that they understood that they were participating in a pilot. When provided with the opportunity to be excluded from the study if they were uncomfortable with being recorded, one participant out of 15 elected to do so and was reassigned to tasks outside of the camera's capture field for the duration of the pilot. In the week following the consent-granting session, MacBook laptops and Logitech QuickCam Pro 5000 surveillance cameras were strategically placed at the site to capture and record participants' food preparation practices. A sample schematic of a recording set-up is provided in ***Fig. 4***; arrows denote the angle of each camera's view. The size and placement of the cameras allowed them to be seen by participants, but cameras were carefully positioned so as to not intrude on preparation areas. Equipment was installed the evening before the pilot commenced and was completed in two hours.

Video capture locations were:

- grill and deli station (and a handwashing sink): one laptop, two cameras
- pizza station (and a handwashing sink): one laptop, two cameras
- salad, portioning, sauces and entree preparation station (and 2 handwashing sinks): two laptops, four cameras.

Recording was conducted from 6:00 a.m. to 6:30 p.m. each day for five consecutive days (business hours of the site were 7:00 a.m.–6:00 p.m.). A total of 500 hours were recorded, resulting in 62.5 hours of actual food handling. Eleven food handlers appeared in the recordings, for an average of 6 hours per handler each day. Equipment was tested

**TABLE 1. Recommendations to overcome barriers to video observational methodology**

| BARRIERS | RECOMMENDATIONS TO OVERCOME BARRIERS |
|---|---|
| ORGANIZATION | • Find an organization that supports researchers and values research objectives (training evaluation, baseline of practices).<br>• Approach a champion within the organization who has administrative responsibility.<br>• Ask the champion to make initial contact with site operators.<br>• Directly present recording and ethics information to participants. |
| ANGLES | • Avoid capturing backs of participants (as it is difficult to see practices).<br>• Try to place cameras so they point across a station (left to right) as opposed to directly (to reduce blocking).<br>• Use multiple angles on the same station to reduce blocking potential. |
| EQUIPMENT | • Plan equipment positions and test viewing area prior to installation.<br>• Assess whether ladders, extension cords and powerbars are needed.<br>• Ask participants for the best power outlet sources.<br>• Ask participants if food production equipment (such as ice bins, trays, racks) will move throughout the day.<br>• Use duct tape to affix cameras and wires. |
| STAFF CONCERNS | • Providing the objectives of the recording in advance of recording start time and allowing for informed consent<br>• Providing assurances that recorded actions will not be used in a disciplinary manner and that recorded actions are confidential and will be used to improve food handler training strategies |
| RECORDING SPACE | • Backup data from laptop computers (via external hard drive) each day if possible.<br>• Ensure computers have adequate memory to record an entire observation session. |
| CODING OF PRACTICES | • Train coding team to discuss ambiguity of practices.<br>• Have clear definitions for cross-contamination and use recorded videos in training.<br>• Speed up video replay when food handlers are not in frame, slow down replay when they are.<br>• Use multiple screens for coding.<br>• Conduct an inter-coder reliability test. |

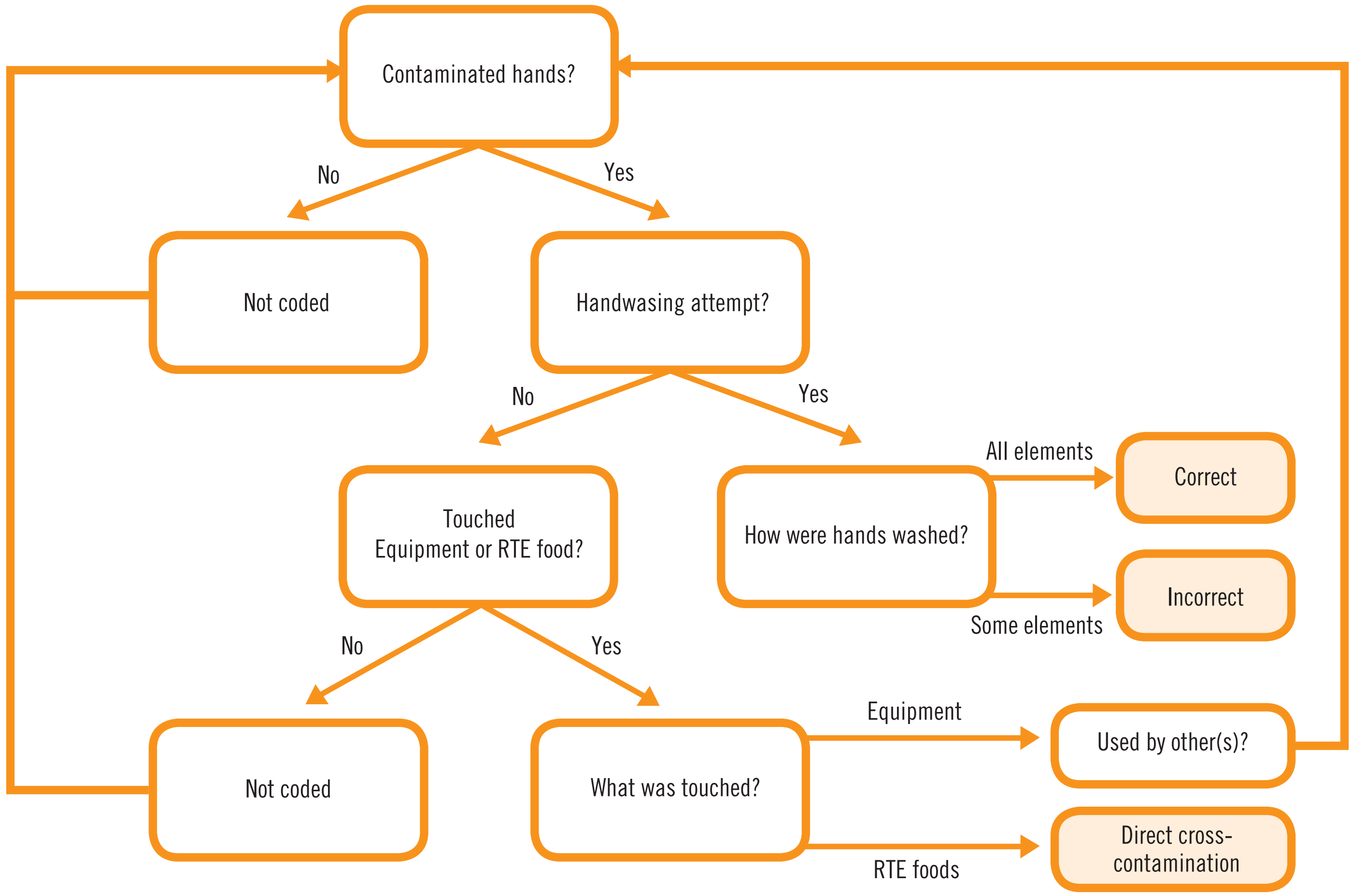


*Figure 1. Handwashing decision tree derived from literature and observation of community meal events*

at the start and end of each day's production to ensure proper recording and to verify that Security Spy and Sleepless did not fail and that actions were successfully captured.

### Sample coding schemes: development of food safety practice coding decision trees

A decision tree to code actions, needed to compare the food safety practices of food handlers, was developed using definitions from the U.S. Centers for Disease Control and Prevention's identified risk factors for foodborne illness, coupled with the WHO's factors leading to foodborne illness *(2, 62)*. These definitions were supported by a review of scientific literature that focused on risky food safety practices *(1, 9, 23, 53)*. Handwashing and cross-contamination are identified as the most problematic of food handlers' practices within a foodservice setting *(9, 24, 25)*. Definitions of food safety practices from the literature coupled with foodservice inspection criteria *(20, 60)* led to the decision to focus the video observation methodology on capturing and cataloguing handwashing and cross-contamination incidents.

To develop a coding decision tree for the actions, a participant observation exercise of community meal events (CMEs) was conducted *(7)*. A convenience sample of three community dinners at three churches within the Greater Toronto area was used. Food handlers at CMEs are typically volunteers, preparing food outside of their own homes, who may be using a communal kitchen and may not be accustomed to the experience of preparing food for a large group and the associated time constraints. Observers positioned in food preparation areas were trained to catalogue all food preparation actions in chronological order. This information served to strengthen coding definitions by providing a sense of rate and frequency of actions (handwashing elements and types of cross-contamination) and information on viewing angles.

Notational analysis was used to record actions and their frequencies. Notational analysis, a generic tool used to collect observed events and place them in an ordered sequence *(26)*, has been used to track food safety behaviors, enabling the recording of specific details about events in the order in which they occur by associating a time-stamp with actions *(9)*. This is especially useful when looking at sanitation steps limiting cross-contamination, or the use of common food contact surfaces and equipment. Notational analysis has been used in both non-participant and participant consumer food safety behavior observations studies as well as participant foodservice observation *(9, 23, 53)*. During the observation of practices at CMEs, cross-contamination (both direct and indirect) and hand hygiene were seen as the most frequent food safety risk actions, reflective of published literature *(7)*. Action decision trees were developed for

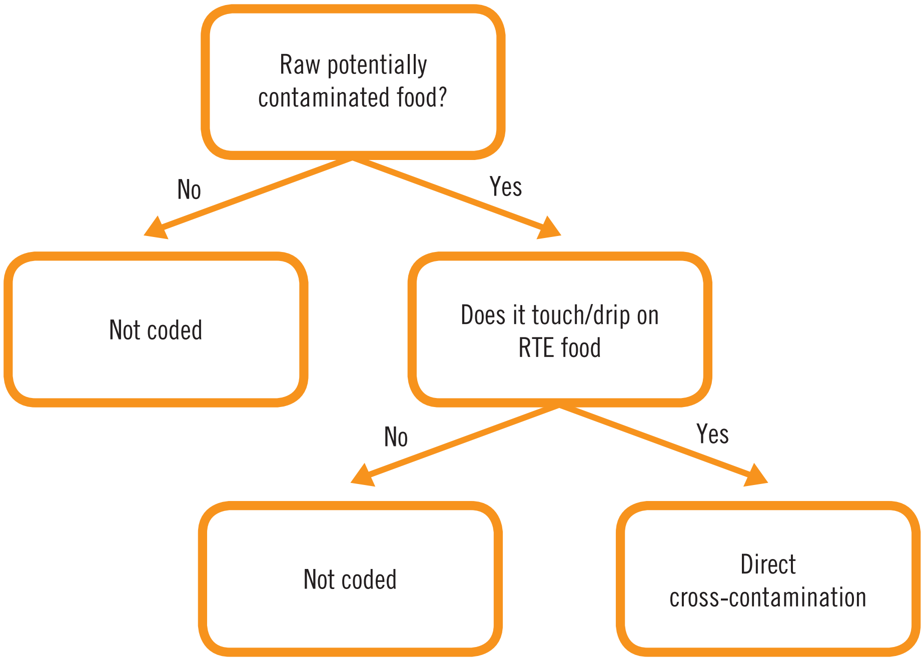


*Figure 2. Direct cross-contamination decision tree derived from literature and observation of community meal events*

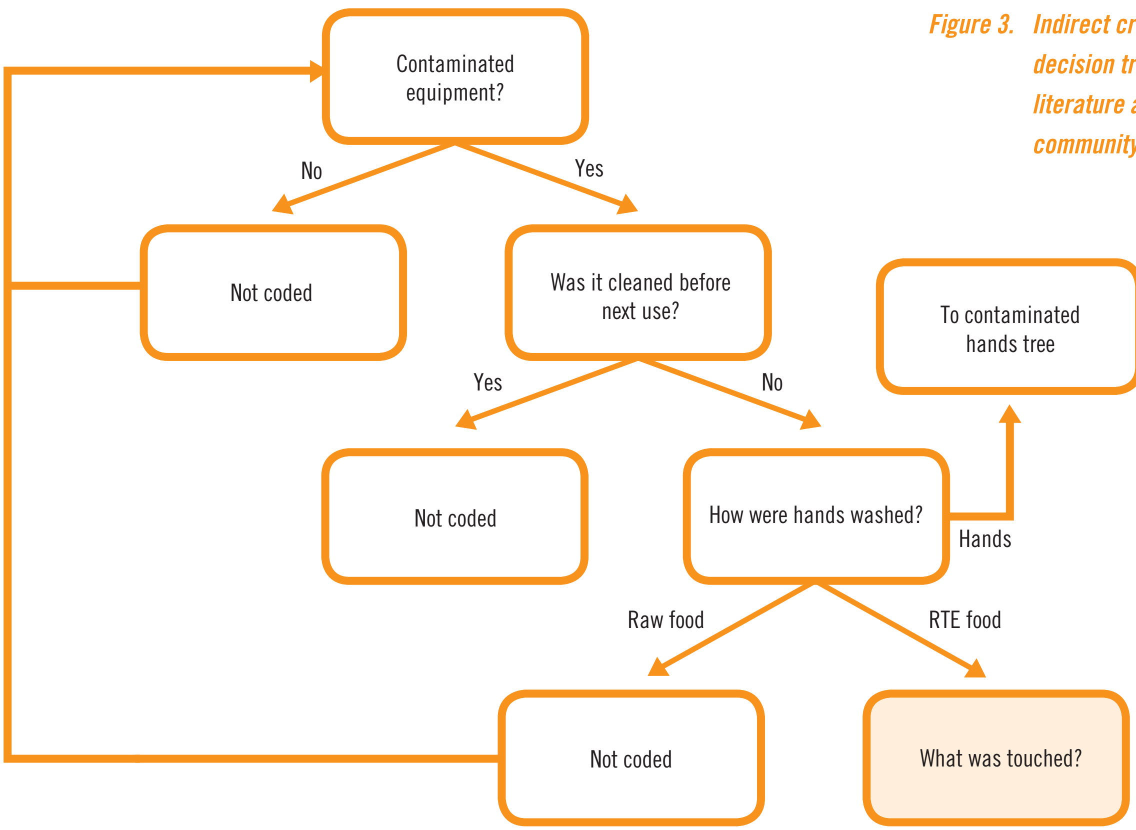


*Figure 3. Indirect cross-contamination decision tree derived from literature and observation of community meal events*

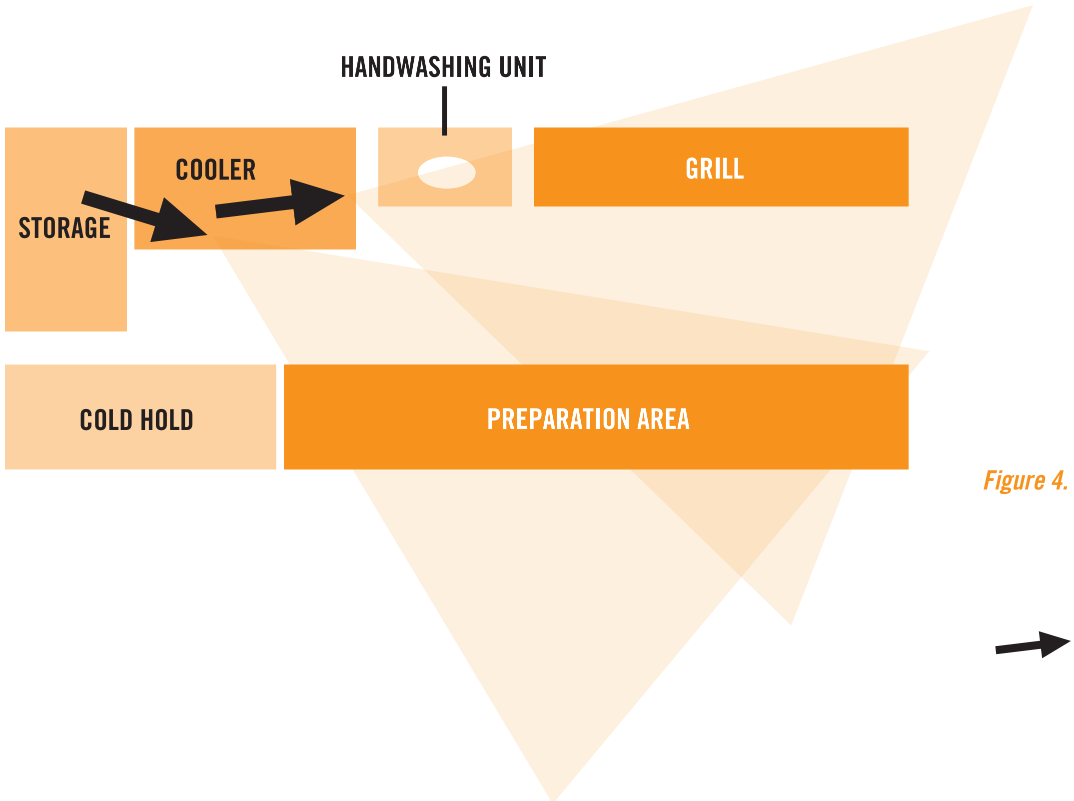


*Figure 4. Foodservice video observation set-up schematic (grill and deli station example)*

handwashing *(Fig. 1)*, direct cross-contamination *(Fig. 2)* and indirect cross-contamination *(Fig. 3)*.

### Coding of practices (pilot)

Following the pilot video capture, food handlers' actions were coded for analysis. While observational coding checklists and decisions trees have been developed for consumer food safety studies *(28)*, kitchens used in foodservice systems can typically have multiple stations, depending on the service system. These may include storage, raw product preparation, portioning, deli, grill, and hot-holding. Foodservice is a fast-paced, complicated system driven by time constraints and profits, where multiple meals are assembled for multiple clients *(41, 42)*.

Three trained researchers coded the actions recorded through the video capture by using the established decision trees. The researchers viewed one full day of data together, and then the following days separately. Fifteen actions (five each of handwashing, indirect cross-contamination and cross-contamination) were selected by the primary researcher and provided to the other coders to conduct an inter-coder reliability test. Agreement was arrived at in coding 13 of the 15 actions; both of the disagreed actions were indirect cross-contamination. Discrepancies were resolved by further reviewing of the actions and a retraining exercise. As a result of the ambiguity, the lead researcher reviewed and confirmed all further cross-contamination coding.

The pilot study demonstrated that food safety practices of foodservice staff could successfully be captured, reviewed and coded. Practices were aggregated as total cross-contamination events and incorrect handwashing events. A total of 118 total cross-contamination events (both direct and indirect) and 125 incorrect handwashing (defined as not using all elements of handwashing) were collected and coded during the pilot.

## DISCUSSION

### Limitations of the methodology

Barriers to the use of video observation methods at foodservice were uncovered. Organization, equipment and data coding barriers are provided in *Table 1.* Logistical issues, ethics and access to real-life foodservice operations during business hours are often seen as limitations to the use of video observation methodology. *Table 1* provides recommendations to overcome such barriers. Finding a good partner organization and learning the technical capabilities of the equipment allow for a smooth capture of food handling practices. As coding bias is the biggest threat to the validity of a video observation study, training coders by using video evidence and then reviewing a selection of actions as coding is occurring can reduce this bias *(51)*.

The non-participant video observational method can provide a catalogue of reliable information not available through self-reported or indicator means (such as inspection results) and can be used by food safety risk managers and communicators to develop interventions, but it is not without limitations. Video observation can be expensive, time consuming and obtrusive. Video observation on its own can provide information on the frequency of an action and how well an action (such as handwashing) is conducted, and pairing video observation with other methods such as surveys and self-report assessments provides a powerful tool for risk analysis. However, the technique still suffers from limitations as to generalizability of results, especially with regard to whether the recorded behaviors are sustained over time. While video observation methodology can provide a much more detailed set of behaviors in a specific system and allows for more accuracy than inspection data, this technique still provides only a snapshot of practices over a relatively short time. To overcome these limitations, a longer observation period with a random selection of segments and events can be used to better describe food handler behaviors.

Observation of practices has been used in the past to recreate an outbreak scenario and to allow investigators to view potentially risky behaviors *(5).* While investigating an outbreak due to *Clostridium perfringens* epidemiologically linked to roasted turkey served in a school cafeteria, Bryan and colleagues asked food handlers to recreate the situation that led to the outbreak so investigators could record their practices and elicit information about where food safety problems might have occurred *(5).* Bryan and colleagues stated that the information derived from the epidemiological study alone was not enough to allow investigators to make suggestions to correct the handling and preparation and reduce the risk of further outbreaks *(5).* In an observational study, actual food safety practices can be explored and microbiology can be tracked (or recreated), and this information can be fed into risk assessment calculations.

The information derived through video observation, when coupled with microbiological information such as the recreation of cross-contamination events with known pathogen loads, can provide a valuable tool for showing the spread and magnitude of food safety risks within a system. Studies that combine microbiological sampling, risk assessment and observation provide depth not achievable by using any of the methods alone. To further allow comparison between individuals and explore behavioral models, food handlers can be assigned comparable risk scores derived from observed practices and other data arrived at by survey or interview, as has been done with individual consumers *(52, 53).*

Video observation of practices can also be used to explore baseline food safety practices of food handlers and compared to post-intervention frequencies, and can provide a true evaluation of the effectiveness of a training or communication program. Observation of practices can aid food safety risk management teams in designing processes, equipment and communication tools to address the practices that occur at foodservice and is appropriate for further developing food safety strategies throughout the food system, including primary production, processing, retail and food handling in the home.

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