## Utilizing Remote Covert Observation in Food Manufacturing and Processing Environments to Assess Hand Hygiene Compliance Ellen W. Evans<sup>\*1</sup>, Rebecca L. A. Evatt<sup>2</sup>, Emma J. Samuel<sup>1</sup>, Catherine Bunston<sup>2</sup>, Sharon Mayho<sup>1</sup> & Elizabeth C. Redmond<sup>1</sup> <sup>1</sup>ZERO2FIVE Food Industry Centre, Cardiff Metropolitan University, Wales, United Kingdom. Food Protection for AFP 2019 Image: Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Image: Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop yn Buddsoddi mewn Ardaloedd Gwledig Image: Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Ewrop an Agricultural Eurol for Image: Cronfa Amaethyddol Ewrop ar gyfer Datblygu Gwledig: Cardiff Metropolitan University ZERO2FIVE<sup>°</sup> <sup>2</sup>Cardiff School of Sport and Health Sciences, Cardiff Metropolitan University, Wales, United Kingdom. \*corresponding author: elevans@cardiffmet.ac.uk







# Introduction

Hand hygiene is one of the most effective methods for preventing cross contamination. Food handlers have a major role in the prevention of foodborne illness during food production<sup>1</sup>, and consequently, failure to properly wash and dry hands effectively is frequently implicated in the spread of foodborne illness<sup>2</sup>.

Ensuring hand hygiene compliance in food manufacturing/processing environments is therefore of utmost importance to ensure food safety. However, assessment methods can influence the validity and reliability of information that can be captured.

Although informative, food safety cognition (e.g. knowledge, attitudes, self-reported practices or intentions) are not indicative of actual behaviour and may be subject to biases<sup>3</sup>. While food handlers may demonstrate food safety awareness, this knowledge does not necessarily translate into actual safe behaviour or practices<sup>4</sup>. For this reason observational data are superior to survey data<sup>5</sup>.

Despite observational data indicating the actual practices implemented by food handlers, researcher presence in overt (direct) observation of behaviour can cause reactivity bias<sup>6</sup> such as the Hawthorne Effect, whereby behaviour may be altered to accommodate the observer present.

Whereas remote covert observation, such as using closed-circuit television (CCTV) camera video surveillance, can provide repeated and comprehensive analysis over a sustained period where familiarity with existing workplace CCTV cameras may reduce reactivity bias'.

There is a need to explore the potential use of remote covert observation in food manufacturing and processing environments to assess hand hygiene compliance.



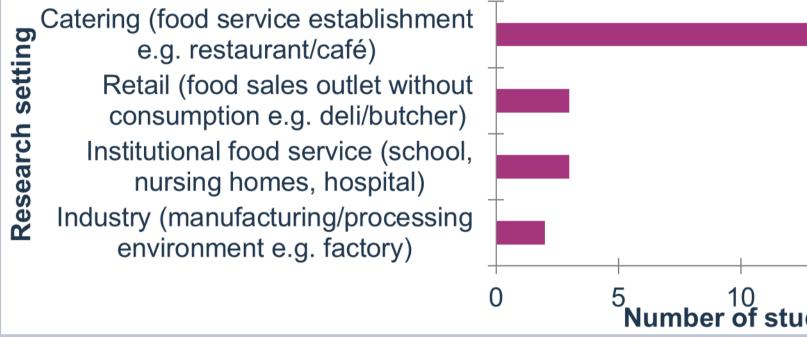
This mixed-methods research approach explores the use of covert observation in food manufacturing/processing environments.

## Methods

- Professional food-handler food-safety research studies (n=20) were identified, reviewed, and summarised findings according to assessment of knowledge, attitudes, self-reported practices and observed behaviours, relating to key components of food-safety.
- In-depth interviews with managers/technical supervisors from food and drink manufacturing businesses (n=11) identified hand-hygiene protocols, training procedures and explored the acceptability of video-observation to assess compliance.
- An evaluation audit of CCTV cameras (n=122) in food manufacturing/processing sites (n=3).
- Structured remote covert observation of hand hygiene practices in food manufacturing businesses (n=2). Footage from the production hand hygiene areas (24 hours) were reviewed to assess compliance with procedure. Observed practices were recorded using a specifically designed Qualtrics database.
- Ethical approval was granted by the school research and ethics committee.

### Review of food handler food safety research CCTV camera survey in food manufacturing Manufacturing industry Interviews Identified food-handler food safety studies Presence of CCTV cameras in manufacturing Hand hygiene protocols A total of 20 research studies detailing professional food-handler food The audit evaluated CCTV camera positions in a food manufacturing with managers/technical supervisors in manufacturing businesses (n=11) determined each manufacturer had unique handsafety data were identified and reviewed. Half (50%) of were published business across three subsidiary sites to assess the field-of-views and etween 2013 – 2017. Countries where data collection was conducted identify potential surveillance-system refinement. ygiene protocols with variable requirements or details (Figure 4). included Austria, Brazil, China, Ghana (n=2), Lebanon, Malaysia, Standard Operating Procedure Hand Washing Procedure Portugal, Saudi Arabia, Serbia, Slovenia (n=2), Spain, UK (n=2), USA Section: Working Procedure Department: \*\*\*\*\* Task Hand Washing Responsibility General Operatives / Department Supervisors Research study settings Training / Skills Required On site training Tooling & Personal Protective PPE Equipment Required PPE Time Training Started: Time 1. Push sleeves up a good 3 inches above the wrist. Image: Comparison of the wrist. All food handling settings were included in reviewed studies (Figure 1). The majority included catering establishments (75%). Fewer were 3 South a state of and the state of and Take soap from dispenser labelled 'Hand Soap' and rub soap all over Ensure that hands are thoroughly cleaned. conducted in retail and high-risk food service environments (15%). This Rinse hands with warm water until the water runs clear 5 Brand Turn tap off by pushing lever with elbow or knee. study determined a lack of research detailing food-handler food safety Dry hands with blue paper towels or use the hand dryer. Place paper towels in bins provided. in the food manufacturing industry (10%). Given the volume of food roduced by the sector data detailing these food-handlers is required. Reason for Revision Open REVISION NO: 01 ISSUE DATE: 26.04.11 AUTHORISED BY: Page 2.012 e.g. restaurant/café) Figure 7. Dome CCTV camera. Figure 8. C-mount camera. Figure 4 Examples of hand washing procedures from three companies. A total of 122 on-site cameras including c-mount and dome cameras (Figure 7 and Figure 8) were identified including: nursing homes, hospital) Use of video cameras in food manufacturing 58 cameras in the raw meat production site. It was common for manufacturers to have cameras recording activity, Number of studies 32 cameras in the cooked meat production site. which were predominantly used for security and referred to in the event of an incident, accident or complaint (Figure 5). Cameras were Figure 1. Professional food handler setting in food businesses (*n=20*). 32 cameras in the ready-to-eat food production site. perceived positively as a deterrent to theft or malpractices. **Research methods** All cameras were in fixed positions with zoom function capability. Each *"I think one of our good aspects is that"* camera was motion sensitive and captured footage when triggered by iere are a lot of cameras evervwhere The data collection methods most frequently used in the reviewed people are more likely to do things studies, were self-complete questionnaires (80% of studies) and interviews (35%) (Figure 2). Observation of behaviour was less correctly in that sense because the "We installed cameras above our picking know they are being monitored but it stations in the fridge, because we had been a good deterrent." The number of cameras were dictated by the capability of the camera customers came in that they hadn't (Company J) received their product, yet the CCTV footage systems (≤64 in the large raw meat production site and ≤32 in footage showed it clearly went into the *"I've seen everything... for example...* rugs or fighting or any sort of behaviour the smaller production sites). box, so that throws up then potentiall roblems... health and safety, accidents to pull a fast one on us, or two and everything. Cameras are really somewhere between the item beind useful, not so much in the hygiene Location and purpose of cameras in manufacturing picked to going to the customer it's bein taken from the box, and that's happened ersonal hygiene side, but more the health and safety HR side.' in the past where drivers have been (Company C) found to be taking stuff." The audit of CCTV camera positions determined that: 'I only use the cameras if I think there's (Company D). an issue, or l've had a complaint come in 35% of cameras were positioned in stores (ambient/refrigerated) which I want to go and investigate. Observation Self-complete Focus group Interview (Company B) and despatch/warehouses; areas populated the least by foodquestionnair operatives. Data collection method Figure 5. Quotes regarding the use of video cameras in food manufacturing 25% of cameras focused on vulnerable access/egress points (e.g. Use of video cameras to assess hand hygiene main entry doors/corridors) and personal security (e.g. staff lockers). **Research measures** 8% of cameras included in-vision hand decontamination areas at Despite having cameras recording activity in hand hygiene areas, h methods influence the data that can be measured. Given point of entry or within production . However, only 5% offered manufacturers had neither the resource nor the time to conduct uestionnaires were most frequently used, assessment of knowledge monitoring perspectives on precise employee hand hygiene structured periodic compliance observations in comparison to company and self-reported practices were most frequently determined (Figure practices protocol. Positive attitudes were expressed towards using cameras for ). Determination of attitudinal data, actual behaviour along with such purposes. It was discussed that the presence of cameras may not Of the 24 available hand hygiene areas across the three sites, current encourage consistent desirable hygiene practices as familiarity and camera positioning offered vision of only 25%. complacency were potential influencing factors (Figure 6). Knowledge It was determined that with minor camera angle adjustment, the CCTV system could provide increased hand-hygiene observational *"I think the staff generally were so busy, so stressed, so working long hours, so wanted to go home that they forgot altogether about the cameras, and I think while now so I think everybody is used to them and obviously it does form part of the staff generally were so busy, so stressed, so working long hours, so wanted to go home that they forgot altogether about the cameras, and I think while now so I think everybody is used to the staff generally were so busy, so working long hours, so wanted to go home that they forgot altogether about the cameras, and I think while now so I think everybody is used to the staff generally were so busy, so working long hours, so wanted to go home that they forgot altogether about the cameras, and I think while now so I think everybody is used to the staff generally were so busy, while now so I think everybody is used to the staff general the staff generally were so busy, while now so I think everybody is used to the staff general the* Behaviour opportunities to 67% of identified hand hygiene areas. Attitudes hen cameras are installed most places the site security so they're fine. Temperatures Findings they generally do forget they're there." Obviously it's raised then when we have an issue, 'this is what we can actually see,' it is visual on the shop floor, 'please "But I think over time you do get a little bit complacent, they get so used to "But I think over time you do get a little put in place'. No one's got a problem with While not a substitute for management presence within production, 2 4 6 8 10 12 14 16 CCTV if strategically positioned can offer substantial insight into seeing them being there, so I think they don't do their job anymore." the cameras there." Number of studies workflow processes, inform training and proactively indicate health, (Company B). safety and food-hygiene malpractices. (Company G). Figure 6. Quotes regarding familiarity with video cameras and complacency. A well-designed system, modified and adapted as production layouts Finding change, offer food-operator evidence of due diligence and compliance Findings in the event of an investigation. Although vast food handler research exists, there is a lack of data from food manufacturing environments, the majority of research focuses on Conducting regular and structured CCTV assessments are practical Cameras are commonly used to identify issues, but can be useful to catering and hospitality Also the majority of research and may identify field-of-views that are ineffective, duplicated or assess hand hygiene compliance, familiarity with cameras may reduce orates the measures of food safety knowledge and self-reported defunct; releasing cameras for valuable use elsewhere in the business. reactivity bias, thus footage indicates actual hand hygiene behaviour.

(n=4) and Vietnam



requently used (30%).



Figure 2. Research methods utilised in reviewed studies (*n*=20).

robiological and temperature data were less frequent.

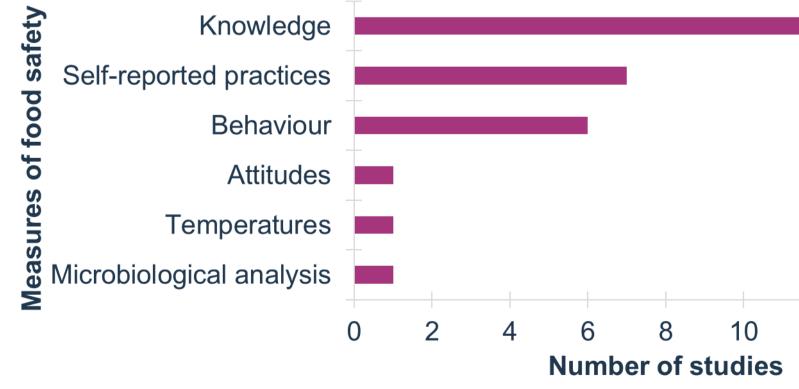


Figure 3. Food safety measures included in reviewed studies (*n*=20)

practices suggesting there is a lack of observational data.

## Results



## Hand hygiene observation in a bakery

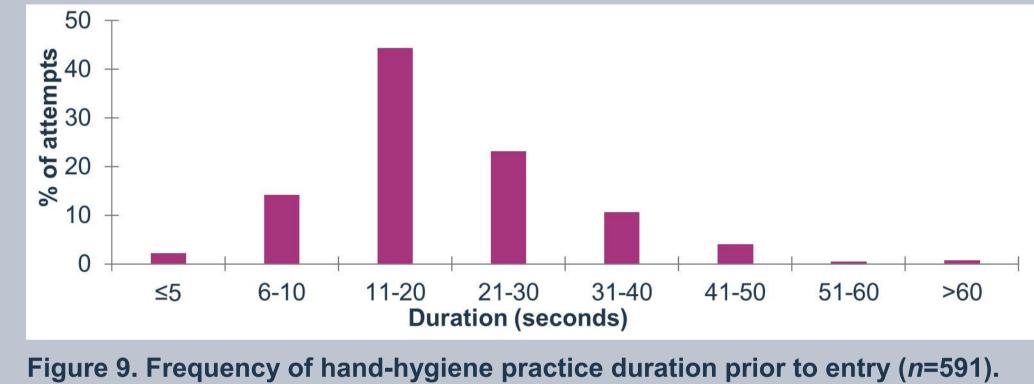
### Hand hygiene compliance when entering production

In Company I, a total of 1333 occurrences of food handlers passing through the production hygiene lobby were observed over a period of 24 hours, of which 674 were entering production. On 70 occasions (10% of those entering), staff failed to attempt hand cleaning.

Of 604 attempts to implement hand hygiene practices prior to entering production, only 2% (13 attempts) were compliant with procedure.

- 78% of attempts used soap to wash hands.
- 45% of attempts wetted hands prior to applying soap.
- 42% of attempts included the use of sanitiser.

2% of attempts failed hand washing/drying and used sanitiser only. The protocol stated the procedure should take 40—60 seconds (from wetting hands through to drying). Duration ranged from 1–69 seconds Figure 9). Only 6% of attempts exceeded 40 seconds. The median duration of hand hygiene procedure was 17 seconds.



Significant behavioural differences between staff Food handlers (identifiable in white overalls) were observed

implementing hand-hygiene practices of significantly longer durations (Md=19 seconds, n=456) than engineering and hygiene staff (identifiable in blue overalls) (Md=15 seconds, n=135) (U=25066.5, z=-3.281, *p*<0.001, *r*=0.12).

It was also determined that engineers/hygiene staff were significantly less likely (p<0.05) of wetting hands first, using soap, rubbing hands palm to palm and were significantly (p<0.001) more likely of failing to attempt to implement any hand hygiene procedure (Table 1).

Table 1. Significant differences in observed hand hygiene practices at point of entry of food handling staff (*n*=503) and hygiene/engineering staff (*n*=171)

Observed practices		Hygiene / engineering	Statistical analysis
No attempt to implement	9%	19%	X² (1, <i>n</i> =674) = 11.75, <i>p&lt;0</i> .001, <i>phi</i> = 0.137
Wet hands with water first	51%	30%	X² (1, <i>n</i> =674) = 21.19, <i>p</i> <0.001, <i>phi</i> = -0.181
Apply soap	81%	70%	X <sup>2</sup> (1, <i>n</i> =674) = 7.34, <i>p</i> <0.05, <i>phi</i> = -0.108
Rubbing hands palm to palm	68%	59%	X <sup>2</sup> (1, <i>n</i> =674) = 4.54, <i>p</i> <0.05, <i>phi</i> = -0.086
Rinse hand with water	88%	78%	X <sup>2</sup> (1, <i>n</i> =674) = 8.67, <i>p</i> <0.005, <i>phi</i> = -0.118
Dry with single use towel	76%	73%	<i>p</i> >0.05
Duration >40 seconds	6%	3%	<i>p&gt;0</i> .05
Use of hand sanitiser	37%	39%	<i>p</i> >0.05
Compliant attempt	2%	1%	<i>p</i> >0.05

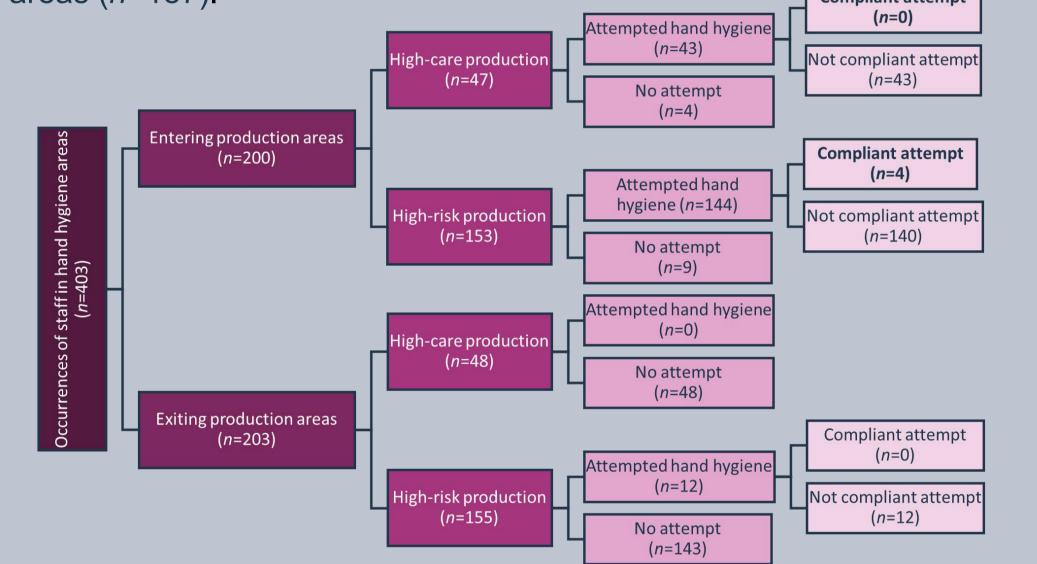
### Finding

Although the majority implemented hand-hygiene practices, extensive malpractices were observed that were contrary to the hand hygiene procedure and may compromise food-safety during food production.

Cognitive research is required to explore potential factors that influence hand hygiene differences between hygiene/engineering staff and food nandlers and identify the potential barriers that exist for staff to adequately implement hand-hygiene practices. Such data can inform the development of bespoke training resources.

On 13 occasions, food-handlers were observed failing to attempt mplementation of hand-hygiene practices prior to entering the production areas. No significant differences (p>0.05) in failing to attempt hand hygiene practices were determined between high-care (9%) and high-risk (6%). All subsequent analyses focuses on the observed attempts to

areas (*n*=187).



<b>Observed practices</b>	High-care production	High-risk Production	Statistical analysis
Push sleeves up above wrists	9%	24%	X <sup>2</sup> (1, n=187) = 4.516 p<0.023, phi = 0.155
Wet hands with water first	56%	69%	p>0.05
Wet hands after soap	44%	31%	p>0.05
Apply soap	98%	99%	p>0.05
Rubbing all parts of hands	23%	13%	p>0.05
Dry with paper towel or drier	100%	99%	p>0.05
Washing duration >20s	7%	4%	p>0.05
Use of hand sanitiser	65%	76%	p>0.05
Compliant attempts	0%	3%	p>0.05

practices.





### **Observation in High-Care and High-Risk**

### Attempts to implement hand hygiene

In Company F, a total of 403 occurrences of food handlers passing through the two pre-production hand hygiene areas were observed; 203 exiting production, 200 entering production.

As indicated in Figure 10, of these; 47 instances were food-handlers entering high-care production where cakes and ready-to-eat pies are manufactured and 153 instances were food-handlers entering high-risk production were sandwiches and salads are produced.

implement hand hygiene practices prior to entering the two production Compliant attempt

Figure 10. Hand hygiene attempts according to occasion, area and compliance.

### Significant behavioural differences between areas

Pushing sleeves 3 inches above the wrist prior to commencing handwashing (as described in company protocol) was significantly more frequently observed (p<0.005) in the high-risk area (24%) than the high-care area (9%). No other significant differences were determined in observed hand hygiene practices (p>0.05) in the two pre -production hand hygiene areas (Table 2).

Although <99% utilised soap, only 56–69% wetted hands before applying soap and 76–91% failed to push-up sleeves. Failure to rub all parts of hands was widespread (<87%) and 24–35% failed to apply sanitiser Consequently >98% of observed hand hygiene attempts prior to entering the two production areas were not compliant with company protocol.

Table 2. Observed hand hygiene practices prior to entering high-care (n=43) and high-risk (*n*=144) production areas.

### Finding

Despite different food handlers working in the two areas, extensive hand hygiene malpractices were observed in both that were contrary to company protocol. Findings suggest the need for bespoke training to inform food handlers of identified site-specific issues to improve

## Significance of study

- utilised in food handler food safety studies has not p conducted. Completion of this study has identified the in-depth systematic literature review to further explore the topic particularly in relation to food manufacturing environments.
- Video-observation data provided an in-depth insight into handhygiene compliance in industry. Which has identified site-specific issues to inform the development of a training and educational intervention to improve hand-hygiene practices among staff.
- . The observational studies conducted at two very different manufacturing sites in terms of size, process, product category and certification have determined significant hand hygiene malpractices, suggesting that such issues may be prevalent in the food manufacturing industry.
- Cognitive research is required alongside observational data to explore potential factors that influence hand hygiene practices, such as the differences between hygiene/engineering staff and food handlers and identify the potential barriers that exist for staff to adequately implement hand-hygiene practices.
- Further research is required to explore the potential cognitive, technical, societal, organisational and cultural factors that may influence staff motivation and ability to adequately implement hand hygiene practices.

## Acknowledgements

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