Practical Applications of the Food Handling Practices Model

Julia Marasteanu, FDA, OC Econ

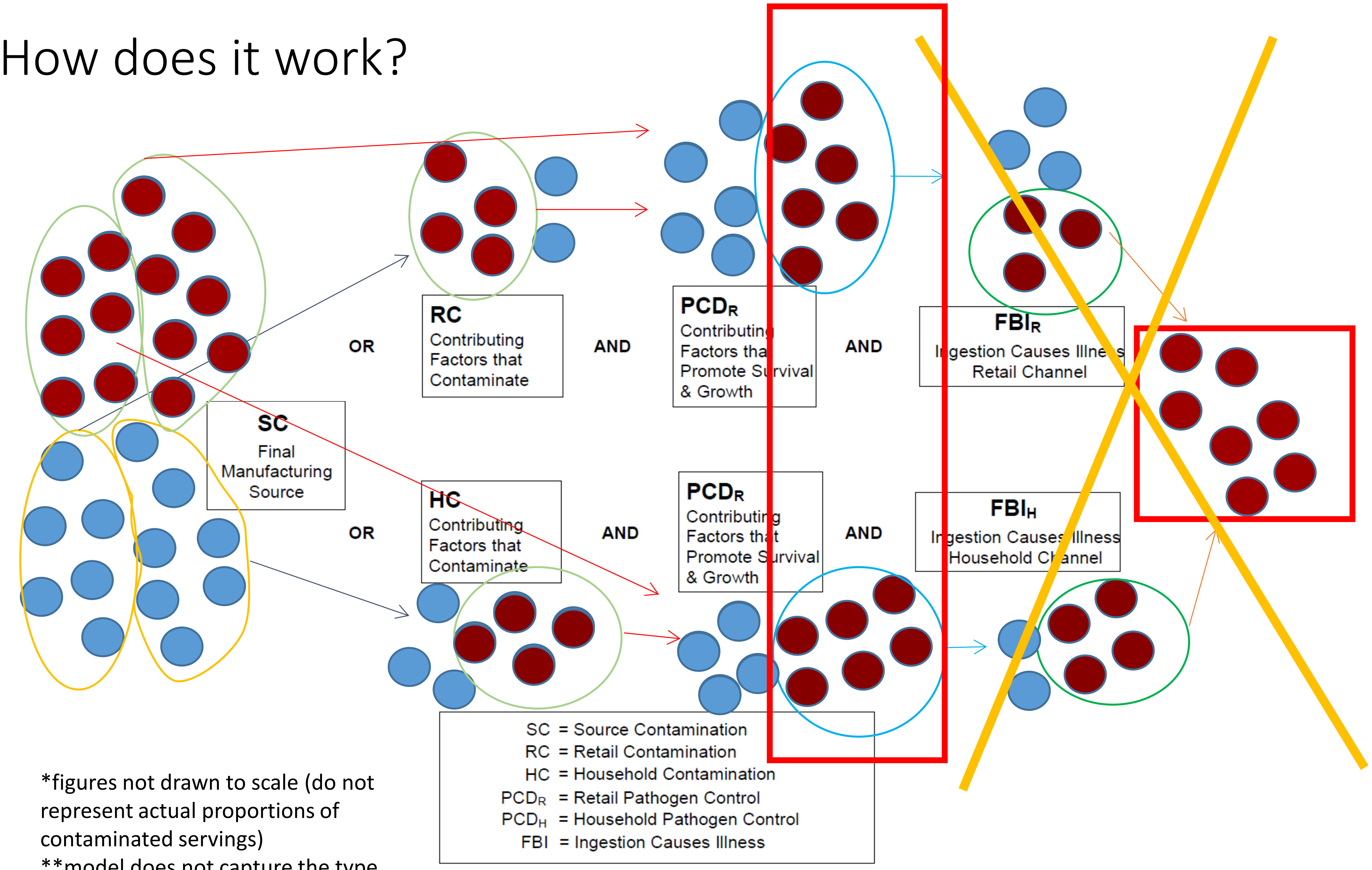
What is the Food Handling Practices Model?

- It is a quantitative model that estimates potential public health benefits ("potentially avoidable cases of food borne illnesses") associated with changes in food handling practices in retail and household establishments
- This was a collaboration between the Research Triangle Institute (RTI) International, and the Food and Drug Administration (2003)
- Data sources and Expert Elicitation updated by Eastern Research Group (ERG) (2009)
- Publicly available to download and use at http://foodrisk.org/resources/display/27

How does it work (what are our parameters)?

Proportions	Probabilities that factor occurs (contamination)	Probabilities that, given the factors occur, the servings are contaminated	Probabilities that factor occurs (pathogen control)	Probabilities that, given the factors occur, the pathogens in the servings are allowed to grow and multiply	Probabilities that noticeable foodborne illness occurs
Annual servings of the ith food category consumed in the United States	Probability that inappropriate hand washing occurs	Probability that inappropriate hand washing leads to contamination	Probability that inappropriate time or temperature for cooking occurs	Probability that inappropriate time or temperature for cooking leads to pathogen growth	Probability that ingestion results in noticeable FBI
Probability that a serving of the ith food category is contaminated with the jth pathogen when it leaves the final supply source	Probability that inappropriate bare-hand contact with RTE foods occurs	Probability that inappropriate bare-hand contact with RTE foods leads to contamination	Probability that inappropriate time or temperature for reheating occurs	Probability that inappropriate time or temperature for reheating leads to pathogen growth	Probability that FBI requires medical treatment
Proportion of annual servings of the ith food category that reaches final consumers through a retail establishment	Probability that inappropriate bare-hand contact with RTC foods occurs	Probability that inappropriate bare-hand contact with RTC foods leads to contamination	Probability that inappropriate time or temperature for cooling occurs	Probability that inappropriate time or temperature for cooling leads to pathogen growth	Probability FBI that requires hospitalization
Proportion of total annual servings of ith food category served or sold to consumers by the jth category of retail food establishment	Probability that inappropriate gloved-hand contact with RTE foods occurs	Probability that inappropriate gloved-hand contact with RTE foods leads to contamination	Probability that inappropriate time or temperature for cold holding occurs	Probability that inappropriate time or temperature for cold holding leads to pathogen growth	Probability FBI that causes death
Proportion of annual servings of the ith food category bought by consumers from the jth category of retail food establishment for further preparation by households, which have been further handled or repackaged by the retail establishment	Probability that inappropriate gloved-hand contact with RTC foods occurs	Probability that inappropriate gloved-hand contact with RTC foods leads to contamination	Probability that inappropriate advance preparation occurs	Probability that inappropriate advance preparation leads to pathogen growth	
Proportion of annual servings of ith food bought from a source other than a retailer (e.g., farmers market, CSA)	Probability that inappropriate sanitation or cleaning of cutting boards/other cutting surfaces occurs	Probability that inappropriate sanitation or cleaning of cutting boards/other cutting surfaces leads to contamination	Probability that inappropriate time or temperature for hot holding occurs	Probability that inappropriate time or temperature for hot holding leads to pathogen growth	
Proportion of annual servings of ith food bought from retailer k, but not handled or repackaged by the retailer	Probability that food handling by ill person occurs	Probability that food handling by ill person leads to contamination	Probability that food kept at room temperature too long occurs	Probability that food kept at room temperature too long leads to pathogen growth	
Proportion of annual servings of food sold by the jth category of retail food establishment that is consumed without further preparation by a household	Probability that food handling by colonized asymptomatic carrier occurs	Probability that food handling by colonized asymptomatic carrier leads to contamination	Probability that inappropriate thawing of frozen foods occurs	Probability that inappropriate thawing of frozen foods leads to pathogen growth	
Proportion of annual servings of food sold by retailer k, that require further preparation at home	Probability that inappropriate sanitation of equipment or utensils occurs	Probability that inappropriate sanitation of equipment or utensils leads to contamination	Probability that food served raw or lightly cooked occurs	Probability that food served raw or lightly cooked leads to pathogen growth	
Proportion of annual servings of food that are prepared by the jth category of household					

How does it work?



*figures not drawn to scale (do not represent actual proportions of contaminated servings)

**model does not capture the type and level of contamination

How we determine how many circles are red: Binomial Distribution

S_i~B(N_{Si}, **P(S_i)**)

The binomial distribution is a discrete probability distribution of the number of successes (in our case, **when serving of food is contaminated/ the circle is red**) in the sequence of n **independent yes/no experiments** (in our case, **the number of annual servings of the ith food category consumed)**, each of which yields success with probability **P(S_i)**.

Binomial Distribution: How do we use it to get our number of interest?

“**Monte Carlo simulation** performs risk analysis by building models of possible results by substituting a range of values—a *probability distribution*—for any factor that has inherent uncertainty. It then calculates results over and over, each time using a different set of random values from the probability functions. Depending upon the number of uncertainties and the ranges specified for them, a Monte Carlo simulation could involve thousands or tens of thousands of recalculations before it is complete. Monte Carlo simulation produces distributions of possible outcome values.”

Source: http://www.palisade.com/risk/monte_carlo_simulation.asp

What does this mean?

- Let's say we want to estimate the value of x, where $x \sim B(6, 1/2)$
- We flip a coin 6 times, and record the number of successes (heads).
- Then we repeat that process again
- And again
- And hundreds, or even thousands of times
- We then take the average of all of these repetitions (or samples), and use that as an estimate of the value of x.

How do we run it?

- The FHPM operates using Microsoft Excel combined with Microsoft Access and the add-in application software @Risk
- Define, select and run an initial baseline scenario, which comprises specific settings of the model's 1,546 parameters
  - The model runs a Monte Carlo simulation using Excel and @Risk, creating distributions for 78 random variables included in the model
  - The baseline scenario defines the parameters to match the current state of the world, according to the researcher's knowledge
- Modify one or more parameters that define the baseline scenario to create a change scenario, and run another Monte Carlo simulation
  - The modifications express changes in parameter values that the user expects to occur because of implementing of a regulation, rule, or any other change under analysis

*Thanks to Richard Bruns for figuring out how to run the model with updated software!

Quick Tricks

- The model is linear (for the most part)
- We only need to run one change scenario for each violation/retailer type and violation/household type combination in order to infer many other scenarios
- If reducing the incidence of improper hand washing in grocery stores by 10% eliminates, for example, 528 illnesses, we can infer that a 20% reduction will eliminate 528*2 = 1056 illnesses, or that a 5% reduction will eliminate 528/2 = 264, etc.
- We can also add the results of individual changes (e.g., a 10% decrease in the incidence of inappropriate hand washing in grocery stores and a 10% decrease in the incidence of inappropriate hand washing in seafood stores) to infer the results of combining different changes
- We cannot do the above when combining changes at the contamination stage and pathogen control stage for the same retailer type or household type combination because one stage feeds into the other

Let’s see how it works….