



Exploring the World of Science

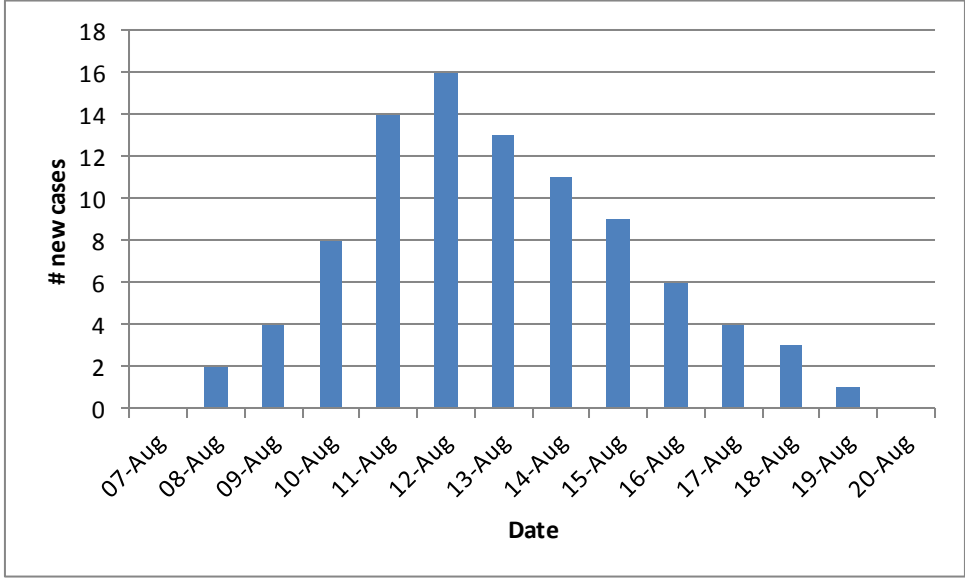


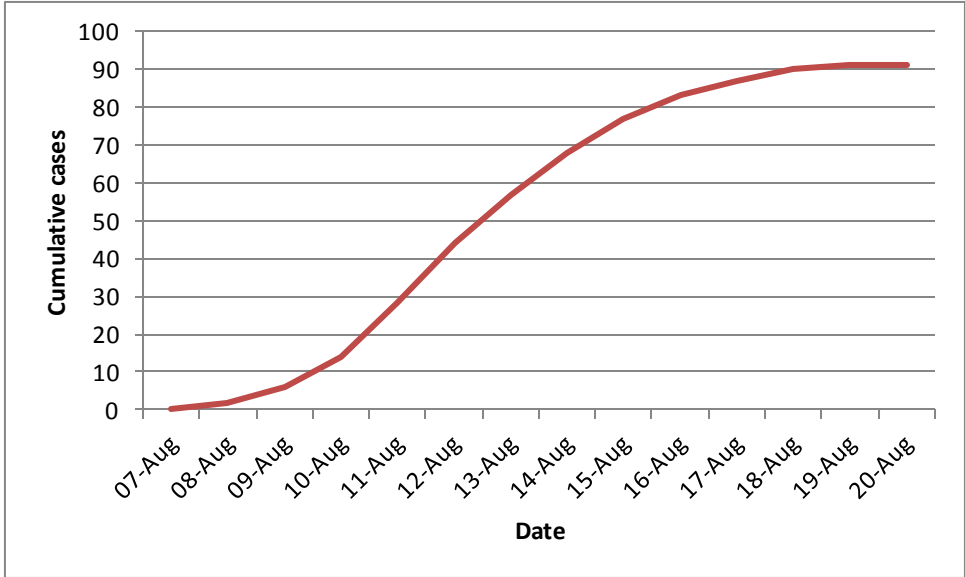
1st Annual MIT Science Olympiad Invitational Tournament

Disease Detectives

(KEY)

#	Points	Answer and points breakdown Total points possible = 200 Tiebreakers (in order of precedence): 6g, 11, 4, 8c, 16b
0	5	5 points for writing team number on every page of answer sheet
1	5	<p>1 point each:</p> <ol style="list-style-type: none"> 1. Agent: the disease causing entity. Can be a virus, bacteria, parasite, but also an environmental factor (such as dust, noise, air pollution), etc. 2. Host: the organism in which the agent, if biological, lives and reproduces in, causing disease. If a non-biological agent, simply the organism in which the disease or condition occurs. 3. Environment: How the agent and host are brought together, physical location and time dependent. The disease then occurs via some mode of transmission, the mechanism in which the agent comes into contact with the host, allowing it to cause disease. Mode of transmission examples include sneezing (suspended air droplets), direct physical contact, mosquito bite, etc. <p>2 points: This triad represents the components needed for transmission of an infectious disease. All three must be identified in order to properly characterize an outbreak.</p>
2	4	<p>Outbreak: Higher than usual occurrence of disease or condition in a specified period of time, population, and location.</p> <p>Epidemic and Pandemic can be defined similarly, but these terms are differentiated by scale: outbreak < epidemic < pandemic, where outbreak takes place in community, epidemic in a country or region, pandemic over continents or globally.</p> <p>Endemic: a disease with a constant prevalence and incidence in a population. Does NOT necessarily indicate a particularly high level of the disease, only that it is constantly present and in the case of infectious disease has sustained transmission without external input.</p> <p>1 point per definition</p>
3a	2	<p>False Case-only epidemiological studies contain only cases, so no statements can be made about the risk posed by any particular exposure. Case-control, cohort, and experimental studies can provide information on disease risk associated with exposures.</p>
3b	2	<p>True</p>
3c	2	<p>False A disease vector in which the disease agent undergoes an essential stage of its life cycle is known as a <u>biological vector</u>.</p>
3d	2	<p>False Experimental bias introduces <u>systematic error</u> to epidemiological studies.</p>
3e	2	<p>False Dose-response gradient requires different levels of exposure, which is not true of smoking and not-smoking.</p>
3f	2	<p>False Index case is designated as the one from which cases of a particular cluster are suspected as originating from (in the case of an infectious disease). Does</p>

		not necessarily have to be the first case identified.								
3g	2	True								
3h	2	False In natural experiment, the “experimental” and “control” groups are determined by some exogenous factor, like state-specific regulations.								
4 T3	4	Any two of the following, for 2 points each, other reasonable explanations also accepted: <ul style="list-style-type: none"> • Efficacy of the vaccine itself • Duration of protection granted by vaccine • Ease of transmission for the disease, esp. person-to-person (agent infectivity) • Size of agent reservoir • Population density, rural vs. urban • Characteristics of individuals being immunized • Duration of infectivity 								
5	4	2 points for definition: Vertical transmission (vertically transmitted infection) – infection passed from mother to embryo, fetus, or baby during the course of pregnancy, childbirth, and/or breastfeeding 1 point each for 2 examples: <ul style="list-style-type: none"> • Toxoplasmosis • Rubella • HIV • Chlamydia • Syphilis • Varicella zoster (chicken pox) • Cytomegalovirus • Herpes simplex 2 (neonatal herpes simplex) 								
6a	6	1 point each for X/Y axis (label and units), 2 points for general histogram, 2 points for making it a bar chart (not scatterplot) 								
6b	2	Point-source outbreak								
6c	4	<table border="1"> <tr> <td>Date</td> <td>8/7</td> <td>8/8</td> <td>8/9</td> <td>8/10</td> <td>8/11</td> <td>8/12</td> <td>8/13</td> </tr> </table>	Date	8/7	8/8	8/9	8/10	8/11	8/12	8/13
Date	8/7	8/8	8/9	8/10	8/11	8/12	8/13			

		<table border="1"> <tr> <td># new cases</td> <td>0</td> <td>2</td> <td>6</td> <td>14</td> <td>28</td> <td>44</td> <td>57</td> </tr> </table> <table border="1"> <tr> <td>8/14</td> <td>8/15</td> <td>8/16</td> <td>8/17</td> <td>8/18</td> <td>8/19</td> <td>8/20</td> </tr> <tr> <td>68</td> <td>77</td> <td>83</td> <td>87</td> <td>90</td> <td>91</td> <td>91</td> </tr> </table> <p>Full points for correct values, no partial credit</p>	# new cases	0	2	6	14	28	44	57	8/14	8/15	8/16	8/17	8/18	8/19	8/20	68	77	83	87	90	91	91
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6d	6	<p>1 point each for X/Y axis (label and units), 2 points for general cumulative distribution, 2 points for making it scatter plot and then connecting the dots to form a curve (cannot be a bar chart)</p> 																						
6e	3	<p>Total cases*0.5 = 45.5, which means the median case occurred on 8/13. From 8/1 to 8/13 is an incubation period of 14 days.</p> <p>1 point for correct value, 2 points for showing work and knowing to find the median case.</p>																						
6f	2	<p>Incubation period represents the time between exposure and onset of symptoms indicative of the disease. For a disease caused by an infectious agent such as virus or bacteria, incubation period is the time when the agent is multiplying the body but may not be exerting detrimental physiological effects yet.</p>																						
6g T1	4	<p>Any two of the following, for 2 points each, other reasonable answers also accepted:</p> <ul style="list-style-type: none"> • Difficult to recall exact nature of exposures after a long period of time has passed • Many possible exposures may be suggested for the long incubation period • Exposed individuals more likely to have left the area of surveillance (if tourists, have left the country, etc), disease less likely to be reported • Individuals may contract secondary infections or diseases during this period, confounding symptoms and diagnosis 																						
6h	2	Food poisoning																						
7	12	<p>1 point for each class of agent, 1 point for each example.</p> <p>Classes of agent accepted:</p>																						

		<ul style="list-style-type: none"> • Virus • Bacteria • Parasite • Protist • Prion • Chemical – pollutants, heavy metals • Physical - noise • Biological (if it is explained that microbes are part of this) • Potential allergens – food allergy, pollen • Intrinsic factor – genes, congenital defect, nutrient deficiency • Foreign cells – transplants, transfusions
8a	2	Zoonosis – any process where an infectious disease is transmitted between different species of animals (most commonly refers to animal to human)
8b	2	1 point each: Malaria, Rabies, Cholera, Ringworm, etc.
8c T4	8	<p>Population growth means greater pressure on natural habitats, increased chance of exposure to wild animals, increased risk of zoonotic transmission. Examples of mechanisms:</p> <ul style="list-style-type: none"> • Handling of bushmeat • Domestic animals coming into contact with wildlife • Habitat destruction or greater proximity leads to species coming to live in developed areas (ie raccoons, coyotes, deer) • Global warming and changes in climate/weather patterns causing changes in the habitable range of disease vectors (ie mosquitoes and West Nile) • Breakdown of public health infrastructure • Expansion of irrigation or hydroelectric projects (malaria, other mosquito-borne diseases) • Civil unrest, bioterrorism (ie anthrax) <p>2 points for general explanation, 2 points each for mechanism</p>
9a	8	<p>1 point for correct value, 1 point for calculations shown. Can be given as decimal or percentage.</p> <p>Sensitivity: $90/(90+40)= 0.69$ Specificity: $150/(150+60)= 0.71$ PPV: $90/(90+60)= 0.6$ NPV: $150/(150+40)= 0.78$</p>
9b	6	<p>This is a very unreliable diagnostic test. As indicated by the sensitivity of 0.69, only 69% of true positive cases can be captured by the test, with the remaining patients possibly missing out on treatment because the test did not show that they had the disease. As a diagnostic test, cannot be relied upon for finding accurate values of incidence and prevalence, or as a criterion for “confirmed” cases during an outbreak investigation. As indicated by the specificity, only 71% of true negatives are being captured; many people without the disease are actually being told they have tested positive. PPV and NPV, also low, again indicate general unreliability of the test’s results to predict actual disease status.</p> <p>Full or partial credit rewarded for reasonable interpretation of the results.</p>
9c	4	The PPV represents the likelihood that an individual who has tested positive actually has the disease. A PPV of 0.6 means that 40% of patients who are told they have tested positive actually do not have the disease. This represents extra stress to the patients themselves, who may end up having to

		undergo or pay for expensive follow-up procedures and further testing. It also represents a burden to the healthcare system which must devote resources to treating these “healthy” patients.
9d	2	“Confirmed” cases, not possible or probable/suspect
9e	3	Sensitivity: $150/(150+20)=0.88$ With the assumption of independence, multiply sensitivities of Test A and Test B: $0.88*0.69=0.61$ 1 point for correct value, 2 points for calculation
9f	4	2 points each for any of the following, other reasonable answers also accepted: <ul style="list-style-type: none"> • Many “confirmed” cases will be missed Any epidemiological studies will end up incorporating false positives into the “disease” group • Incidence and prevalence not accurately calculated • Disease reporting by healthcare officials will be inaccurate • Difficult to implement control measures
10a	4	Yes to both: <ul style="list-style-type: none"> • Incidence = # new cases/population/time • Prevalence = incidence*average duration 1 point for affirmative, 1 point for explanation
10b	4	Incidence: $15/375,000/1=x/10,000$ $x=0.4$ cases per 10,000 people per year Prevalence: $(15/375,000)*0.5=0.00002$ proportion of population with disease at any given time. Can also be expressed as percentage: $0.00002*100=0.002\%$ 1 point for value (must include units), 1 point for calculation
10c	2	$15/375,000=0.00004$ risk per year 1 point for value (including unit), 1 point for calculation
10d	1	Cohort study, or experiment (however, usually unethical)
10e	1	Case-control study, or cross-sectional study
11 T2	6	2 points each for any of the following, other reasonable answers also accepted: <ul style="list-style-type: none"> • Improved reporting/surveillance or diagnostic technique • Increased awareness or publicity of disease, so more people visit healthcare providers • Increase in number of susceptible individuals (ie tourism season, refugees) • New system in place for case detection • Laboratory error • False-positive test results
12a	6	Relative risk can be calculated in cohort study (odds ratio too, but it’s actually only an approximation for RR so it doesn’t make sense to calculate it) $RR=[a/(a+b)] / [c/(c+d)]$ However, in the format the data is given, the “c” and “d” boxes must be calculated for each exposure.

		<p>Sample calculation for family history: $[25/(25+30)] / [(15+9+12)/(60+50+302)] = 0.4545/0.08738 = 5.20$</p> <p>Smoking RR = $0.2/0.12 = 1.66$ Prolonged NSAID use = $0.153/0.133 = 1.15$ None of the above = $0.038/0.35 = 0.11$</p> <p>1 point for correct value, 2 points for the correct sample calculation</p>
12b	6	<p>2 points for providing explanation for RR values: Relative risk tells you how much more likely someone with a certain characteristic (such as family history) is to develop the condition being studied. So, from the RR calculated, we can conclude that individuals in the study population with a family history of IBD are 5.2 times more likely to develop IBD than individuals without family history. The same can be said of smoking and prolonged NSAID use.</p> <p>2 points for comparing magnitude of RR values: Relative magnitudes of the RRs for these three exposures can also be commented on – family history presents a significantly greater risk of disease than either prolonged NSAID use or smoking.</p> <p>2 point for reasonable explanation of the “none of the above” RR: The group with no specified risk factors (may not necessarily mean no risk factors of any kind pertaining to IBD, just none that are specified by this study) has a negative value for IBD – since exposure is not specified, this cannot be called a “protective effect.”</p>
12c	2	<p>Exposure may have a “protective” effect – individuals with this exposure are LESS likely to get the disease; the exposure does not present additional risks.</p>
12d	4	<p>2 points each for any of the following, other reasonable answers also accepted:</p> <ul style="list-style-type: none"> • Since participation in studies is usually voluntary, individuals may choose to leave the study • Individuals may become deceased. • Insufficient data is collected for some individuals and researchers may need to chose to drop their data from the study.
12e	2	<p>Depending on the characteristics of the individuals being lost to follow-up, the incidence and RR being reported by the cohort study may be under- or overestimated. In the case of high-risk individuals, may see lower values for incidence and RR of certain exposures, and a different ranking of RRs between exposures being test.</p>
12f	3	<p>Results must be generalizable to the population from which the cohort study is drawn. This means the prevalence of demographic characteristics, possible risk factors, and exposures must be representative of the population</p>
13	4	<p>2 points: In a retrospective cohort study, the disease status of the individuals included in the study is actually already known.</p> <p>2 points: However, data is collected for as comprehensive a cohort as possible by “looking back” in time for medical and/or exposure records, and calculations are performed as in a regular cohort study.</p>
14a	1	<p>Smallpox</p>
14b	2	<p>Disease must only occur in human beings, no possibility of zoonotic transmission or animal reservoir</p>

14c	2	Dogs infected with <i>D. medinensis</i> represent an animal reservoir of the disease agent which can provide a source of infection in additional cases in humans. In order for global eradication to be achieved, the agent needs to be eliminated from all possible sources; this has been discovered to include dogs in Chad.
14d	2	Incubation period of dracunculiasis has a median time of 1 year, so at least a full calendar year without reported cases must be observed to show that there are no infected individuals in the population who may develop the disease.
14e	4	2 points each for any of the following, other reasonable answers also accepted: <ul style="list-style-type: none"> • Difficulty in maintaining active disease surveillance in WHO certified countries and countries in which the disease is endemic • Lack of clean drinking water • Insecurity, violence in Mali and South Sudan • Infected dogs in Chad
14f	4	Active surveillance measures: households in villages in which dracunculiasis is endemic are searched daily for individuals with signs and symptoms suggestive of disease. Passive surveillance: requested from healthcare providers
15a	4	2 points each: <ul style="list-style-type: none"> • ETUs were operating at full capacity (no beds available) for certain periods of the Ebola outbreak, and patients were turned away – this capped the number of ETU admissions rates for some weeks • Refusal to report cases of Ebola or burials, resistance to cremation
15b	4	2 points: A proxy is a choice of measurement that is used to <u>indirectly</u> measure a different parameter of the population being studied. 2 points: Recognize that each of the measurements reported in this study were used as proxies for true incidence of new cases of Ebola
16a	4	2 points: Selection bias 2 points: Did not capture data from individuals in this age group who do not attend public or private schools (ie homeless, home-schooled, etc). Depending on the risk factors and preferences of those excluded from the study, the reported prevalence and type of tobacco use among this age group may deviate from the “true” values.
16b T5	8	2 points each: Recall or response bias 2 points each: <ul style="list-style-type: none"> • Respondents may lie about their experiences with tobacco use (response bias) • Respondents may not remember the nature of their experiences with tobacco use (recall bias)
16c	2	New tobacco products, with marketing that may target those in younger age groups: e-cigarettes, hookah, dissolvable tobacco