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An Analysis of Lab Inspections at the University of Kentucky

Capstone Project – Spring 2012

Rachel Eldridge
4/12/2012

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I. Executive Summary

Recent news stories about laboratory accidents in which students were severely injured and killed have brought much-needed attention to lab safety. Creating a positive safety climate on college and university campuses is very important in reducing accidents. At the University of Kentucky, all laboratories are inspected once every year, and the results are recorded in a lab inspection database. These data include the department, building, lab classification, type of violation, room number, and the name of the PI (Principal Investigator). I want to analyze inspections to find out whether department and the lab classification are significant in looking at violations. Knowing this will help safety officials provide better, more specific training to those who work in these areas, and will provide those in authority with better tools to reach people at the most appropriate level. Violations can be looked at as potential accidents and potential fines. Acting on the findings of these inspections is crucial in preventing accidents from occurring on campus.

In looking at the idea of safety climate, I considered which available variables would be best to reach this concept. I thought about using building, but it is collinear with department. Departments to some extent share space in a building. Multiple departments may be housed in a building, or one department may be split between a couple of buildings. If I used this and department, my results would be difficult to interpret Departments are under the same leadership, and lab inspection reports are distributed to department chairs as well as the PI, and other safety officials. Lab classification is important because it defines the storage and use of chemicals in that lab facility. There are four lab classifications that range from broad use and storage of chemicals to no use or storage of hazardous chemicals. There are no data on specific chemicals used, or the type of experiments that are conducted. Looking at the classification was also the best way to look at potential risk with the available data. The question I hope to answer is: Do department and classification of labs affect the likelihood of violations? I looked at the average violations per inspection by department. I also looked at the average violations per inspection by classification. Fixed effects and random affects regressions were run with inspections as the unit of analysis, looking at classification and department.

According to the regression, the null hypothesis that lab classification is unrelated to the number of violations can be rejected. The P-values are less than 0.05, which makes lab classifications statistically significant. The results indicate that the laboratories that are equipped to handle the most hazardous chemicals are more likely to have violations, whereas the laboratories that are more restricted in the use of chemicals have fewer violations. This may simply occur because there is greater risk in a laboratory where there is broad use of chemicals, as opposed to those where chemicals are simply to be stored. The coefficient increases steadily along with the classification of the lab. This reinforces the finding that labs that are equipped to handle more chemicals are more likely to have violations. Department is also an important indicator of violations. Even when the classification is accounted for, violations per department are statistically and managerially significant and vary by more than 0.5 violations above and below a mean 0.678 violations per lab. This finding would allow further investigation and targeted training to departments that need it. I would also like to know more about the type of violations by department, to learn more about trends or possible causes.

The Occupational Health and Safety Department (OHS) at UK has no authority to force labs to address any violations. Department chairs, any safety officials they designate, and most importantly, the Vice President of Research has enforcement authority. There must be procedures in place at the departmental level to ensure a commitment to safety that is perceived by employees and practiced in their daily work. Safety must be easily accessible to all employees. Proper equipment, information, and a climate where safety is the main priority are crucial. I recommend that the Vice President of Research receive a quarterly report of inspections by department and lab classification from OHS, since he has the authority to enforce lab inspection findings, and it is in his interest to make sure no accidents occur, and no fines are assessed to the University by the Occupational Safety and Health Administration (OSHA), the government agency that sets the standard for occupational exposure to hazardous chemicals in laboratories. Department chairs and PIs already receive the inspections, but having additional oversight may improve the departments who rank lower in their inspections. Because reporting at the departmental level has significance, a simplified report can be created rather than one that lists the results of every inspection on campus.

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II. Problem Statement

Due to recent events in the news regarding accidents at university and college laboratories, lab safety practices have come into the spotlight. The idea that there is a “culture of safety” and “safety climate” that develops in work places, and particularly in university labs, is something I want to examine further. By using the dependent variable departments, I am examining whether certain departments have developed a safety culture that leads them to have fewer violations.

Proper training and information are crucial to the safe operation of these labs where many staff, faculty, and students spend much of their time. Every person who works in a laboratory on campus is required to have safety training. Different types of laboratories require specific training depending on the responses to a training checklist on UK’s Environmental Health and Safety (EHS) website (Appendix 1). Another important component of safety is providing those in authority, such as the PI, department chair, dean, and the Vice President of Research, with the information they need in order to enforce safe laboratory practices. Lab inspectors from the Occupational Health and Safety Department (OHS) at the University of Kentucky (UK) must work with the departments that conduct research and teach students in order to inform them of potential hazards. Along with reporting, there must be consequences for failing to adhere to the rules.

In this project, I will analyze laboratory safety inspections at UK. I have access to the database that OHS utilizes in reporting lab Inspections. I plan to use it to break down inspections by department and lab classification in order to determine whether they affect the likelihood of violations.

This research should shed some light on patterns of violations at the University of Kentucky and allow OHS to better utilize its time and resources, as well as inform departmental stakeholders about their performance in inspections.

III Discussion of Organization/Structure

The data set from the lab inspection database has been maintained consistently over the three year period I am examining. These data are gathered

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through yearly inspections on each laboratory on campus and entered into the database by the individual who inspects the lab. The lab is not contacted before the inspection, but the timing is fairly consistent from year to year. The first version of the inspection database was started in 2002, and an improved database began in 2009. Data from the three fiscal years I examine were exported and merged into a Microsoft Excel table to enable me to look at all three years in one location.

The same individual has been conducting lab inspections over the last six years. To carry out an inspection, an inspector from OHS visits each lab and reports all violations to the PI, department chair, any safety official in the department investigated, the Director of OHS, and the Physical Plant Division if this is a facilities violation. OHS has a rubric that lists nineteen violation types and the criteria for each. See Appendix 2 for the list of all possible violations. Violations are broken down into the following categories: door signage, chemical hygiene manual, fire extinguisher, fume hood, eyewash, safety shower, controlled access, food, housekeeping, and labeling.

The violations are further broken down into categories: Serious Violations, Other-than-Serious Violations, Facility Deficiencies, Repeat Violations, and Willful Violations. Serious violations are a condition that could result in death or serious physical harm or major regulatory action against the University, and could result in OSHA penalties of $5,000 or more. Other-Than-Serious violations are conditions that could result in an accident or injury that is less than serious in nature. Repeat violations are serious violations that have been observed in two consecutive inspections (this does not include other-than-serious violations. Willful violations are observed in three or more consecutive inspections. Facility violations are problems with required equipment, such as an eyewash not functioning, or the facility lacks equipment that is required for the type of work that is conducted. This also includes a functioning fire extinguisher that has been inspected by a representative of the University Fire Marshal. The lab classification determines the equipment that is required for the work that is done

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as well as the chemical use in a particular space. Table 1 below provides the standards that apply to different settings.

Table 1. Safety Standards for Chemical Laboratories

Chemical Lab (CL) Classification:	CL-4	CL-3	CL-2	CL-1
	Broad use of hazardous chemicals	Restricted use of hazardous chemicals*	Hazardous chemical storage only	No hazardous chemical storage or use
Safety Equipment/Systems	Broad use of non-hazardous chemicals	Broad use of non-hazardous chemicals	Broad use of non-hazardous chemicals	Broad use of non-hazardous chemicals
Sprinkler	✓			
Supply and exhaust air systems	✓	✓	✓	
Labs on 100% exhaust	✓	✓	✓	
Fume hood	✓			
Sink	✓	✓	✓	✓
Eyewash	✓	✓		
Safety shower	✓	✓		
Portable fire extinguisher	✓	✓	✓	✓
Controlled access (lockable door)	✓	✓	✓	✓
Approved floor surface (no carpet)	✓	✓	✓	✓

* **Restricted use:** In a CL-3 lab, the following hazardous chemicals (see Definitions) are restricted to closed systems (e .g., HPLC, scintillation counter, etc.): gases; volatile liquids or malodorous compounds; solids that may become aerosolized in a process; liquids or solids that may become volatile at elevated temperatures; or reactions that may generate any of the preceding.

Note: CL-4, CL-3 and CL-2 labs must have sufficient HVAC controls to allow them to be maintained negatively pressurized relative to the corridor.

IV Literature Review

In January 2010, a detonation at Texas Tech University in Lubbock cost a student three fingers, severe burns, and eye damage (Vergano & Korte, 2011). Preston Brown was working with another graduate student when they decided to attempt to produce 10 grams of an explosive compound, which was 100 times more than an informal lab limit for research sponsored by the Department of Homeland Security (Vergano & Korte, 2011). There was no policy in place to require them to consult with a Principal Investigator (PI) before scaling up the experiment. The students who worked in this lab claimed that the use of goggles was a personal choice based on the perceived danger of an activity (U.S. Chemical Safety and Hazard Investigation Board, 2010). The resulting case study by the Chemical Safety and Hazard Investigation Board (CSB) challenges the academic community to create a ‘safety culture’ in university labs. CSB found

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that the Department of Homeland Security had not prescribed any safety provisions specific to the work being conducted. Safety accountability and oversight by the principle investigators, the department, and university administration at Texas Tech were insufficient (U.S. Chemical Safety and Hazard Investigation Board, 2010). There were gaps in communication and accountability between these bodies.

In 2008, a UCLA graduate student named Sheharbano Sangji, was burned over half her body when she was transferring air-sensitive chemicals (t-butyl lithium) from one container to another. She was not wearing a lab coat, and the compound got onto her sweater and ignited. She died five days later of severe burns caused from this chemical (Christensen, 2011). In this case, the professor who supervised her as well as UCLA have had felony charges filed against them. UCLA could face up to $1.5 million in fines. Two months before this happened; UCLA safety inspectors had found more than a dozen deficiencies in the same lab, some citing the lack of protective equipment and proper storage of chemicals. The corrective actions were not taken before this accident occurred. Lab accidents at schools and colleges occur 10 to 50 times more frequently than in the chemical industry (Vergano & Korte, 2011).

The CSB's Case Study of the Texas Tech University explosion found that the university's Environmental Health and Safety Department (EH&S) "had no direct communication link within the organizational hierarchy to an authority who could enforce EH&S's safety inspection recommendations with the PIs. EH&S was not required, nor expected, to report its laboratory safety inspection reports and findings to either the Vice President for Research or the Provost" (U.S. Chemical Safety and Hazard Investigation Board, 2010). At UCLA, Vice Chancellors are responsible for implementation and enforcement of UCLA's EH&S safety policy in all facilities and operations, and the Chancellor is responsible for the implementation of UCLA's EH&S safety policy at all facilities and properties under campus controls (U.S. Chemical Safety and Hazard Investigation Board, 2010). The link that connects individuals with enforcement authority and individuals who are conducting the inspections appears to be lost.

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Much of the literature regarding workplace safety places great significance on a safety culture or safety climate. The two concepts have a great deal of overlap. The safety culture is defined differently by varying sources, but most would agree to encompass commitment to safety, communication style and frequency between parts of the organization, competence, risk perceptions and attitudes, shared expectations about standards, open-minded learning, and external organizational factors. A useful definition of safety culture says that it is "the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (Wright et al. 1999). Similarly, definitions of safety climate are not all the same, but the key aspects include safety measures, arrangements, protective equipment, safety procedures, training, knowledge, the organization's members, and behavior related to safety issues. Safety climate is defined as "a set of attributes that can be perceived about particular work organizations and which may be induced by the policies and practices that those organizations impose upon their workers and supervisors" (Wu et al., 2007) For the purpose of this paper, safety culture falls under the umbrella of safety climate and the term 'safety climate' will be used from this point on.

According to research by Wu et al., factors that affect safety climate significantly include having a safety manager committed to safety, a safety committee, safety training, accident experience, and type of employee. This says that if managers take safety seriously, and employees receive training on proper procedures, then employees will perceive a stronger safety climate. Accident experience shows that a person who has experienced a workplace accident or has witnessed one will perceive a weaker safety climate. The perception of safety climate was also found to correlate with age and length of tenure since long-term employees are more likely to have witnessed or experienced accidents. Managers and supervisors perceive safety differently than regular employees, ranking the manager's commitment and emergency responses higher than other employees (Wu et al, 2007). Beus et al. goes further and

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shows that accidents in the workplace are more likely to affect safety climate than safety climate to affect accidents. Safety climate is not a one-way concept (Beus, 2010). If an accident occurs, the perception of safety climate goes down significantly not just for the individual who experienced the accident but also for those who are there to witness it. If the perception of safety climate decreases, accidents are more likely, and accidents decrease perception of the safety climate, causing a cycle to occur that could result in an increase of accidents. Beus suggests that the best way to prevent additional accidents is to follow any accident with training and retraining to improve the safety climate.

At the University of Kentucky, individuals working in labs are part of departments. The department chair is in charge of these departments, and those who have authority in labs are the PI of the lab and any internal safety authority designated within the department. These people have a pivotal role in establishing the safety climate. A big part of that would be protecting workers from any potential threat discovered in a lab inspection. I would expect to find similarities in safety procedures, personal protective equipment use, and training utilized within departments. This is because the department chair and PIs would be in charge. Of course, it is possible that labs operated independently by different researchers could differ. Still, I expect departments to share levels of concern, training, and responsiveness to the reports of OHS. Training is provided by OHS, and there is a Chemical Hygiene Committee that meets monthly to discuss safety issues. If an accident occurs, it is required to be reported to OHS. Important components of a good safety climate are available at UK, and should be utilized.

The Occupational Safety and Health Administration (OSHA) was established by Congress in the Occupational Safety and Health Act and was signed into law by President Richard M. Nixon on December 29, 1970. OSHA's mission is to "assure safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance". OSHA has tailored a standard for occupational exposure to hazardous chemicals in laboratories, which is often referred to as the

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"Laboratory Standard" (OSHA, 2011). Under this standard, a laboratory is required to produce a Chemical Hygiene plan which addresses specific hazards in its location and its approach to them. This plan includes chemical procurement and storage, how to handle spills, personal protective equipment, housekeeping, proper signage, and information and training (OSHA, 2011).

The University of Kentucky also has procedures it follows in terms of yearly inspections, and emailing department heads and PIs their reports. The chemical hygiene plan is located in each laboratory, and the chemical inventory is kept in an online format called E-Trax. This tracks chemicals from purchase to disposal (University of Kentucky Chemical Safety Committee 2011). This is all done in order to be in compliance with the OSHA's Laboratory Standard. The University of Kentucky Environmental Health and Safety Division, which includes OHS, is structured such that the Vice President of Research has the authority to enforce the safety practices in laboratories above the authority of the department chairs. His ability to ensure compliance would depend upon having a well-organized timely report that highlights the labs most at risk. With over a thousand labs on campus, a report such as this could ease communication between individuals and departments, and assist in enforcement, which is the key to compliance.

V Research Design/Methodology

The question I hope to answer is: Do department and lab classification affect the likelihood of violations? In narrowing down which variables to use I considered using building as a dependent variable. Perhaps PIs in a building behaved similarly, but building is collinear with department. Departments to some extent share space in a building. Multiple departments may be housed in a building, or one department may be split between two buildings. If I used this and department, my results would be difficult to interpret. Departments are under the same leadership, and lab inspection reports are distributed to department chairs as well as the PI and other safety officials. Lab classification is important because each lab facility's classification dictates the storage and use of chemicals. I thought that looking at lab classification was also the best way to

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think about potential risk, given the available data. There is not any information in the database regarding the type of experiments or the chemicals used.

Also, when sorting the data, I made some observations. The database would benefit from having a dropdown menu of all potential entries instead of being entered by hand. If there were a dropdown, different spellings and abbreviations would not require cleanup in making reports by department, building, college, or class. For example, Agricultural Engineering is sometimes reported as Ag. Engineering or Ag Engineering, which makes sorting difficult. Lab Classification was sometimes entered as Class2 or Class 2. It was not easy to create a query in Access or Excel without cleaning it up first. If there were an accident or immediate need for a report, the effort to get the data prepared may take some time, especially in cases where large categories, such as building or department, are needed. Also, some of the fields were listed as other, or NA, or simply left blank in some situations. Vacant labs were left blank sometimes or sometimes marked vacant in the department field. Some of the inconsistencies were likely the result of the data being imported from two separate databases.

There were rare occasions where a lab would be inspected more than one time in a year. This occurred very infrequently, and I did not remove each of these occurrences over the three year period examined here. They occurred for a variety of reasons. A lab may have been moving, or a new PI began working in a lab. These were not necessarily related to violations.

There were also occasions where there is only one inspection in the three year period for a specific department. These could be labs that UK no longer inspects, such as BCTCS labs, or they became part of a different department over the time period studied here. If there are numerous violations in that inspection, that department as a whole may look dangerous, when we are only looking at a single inspection. There were also quite a few departments that had only one laboratory to inspect each year. While it may be only one lab inspected over the three years, numerous violations are cause to be concerned no matter how many labs the department has.

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Ethical considerations include drawing attention to specific individuals. In some cases, there is only one lab in a department, which may simplify identifying that PI. While the Lab Inspection Database includes the names of every PI and room numbers, no names and rooms are mentioned in my research. No personal information about these PIs is in my research. The lab inspection is the focus of my research, not the PI. The PI is included in the database because any violations found are the responsibility of that person. By listing specific departments, the department chair, or other responsible individuals for the lab inspections may be easy to identify.

The OHS Department gave me the data they collected from yearly laboratory inspections that were entered by hand into a database. The data I worked with originated from two very different databases that were consolidated for my use on this project.

When sorting these data initially, I examined average violations per inspection. There were 2,702 violations in total in 3,980 inspections, an average of 0.678 violations per inspection. The maximum number of violations in one inspection is seven. Inspection is my unit of analysis. I made two bar charts. One illustrates average violations per inspection by department, and the other illustrates average violations per inspection by classification. The average violations per department varied drastically from one department to another. The top ten violating departments are shown in Figure 1. The classification chart, Figure 2, shows that the wider the use of chemicals permitted in the facility, the average violations per inspection increase. The Access queries used in these charts are available in Appendix 3.

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Figure 1

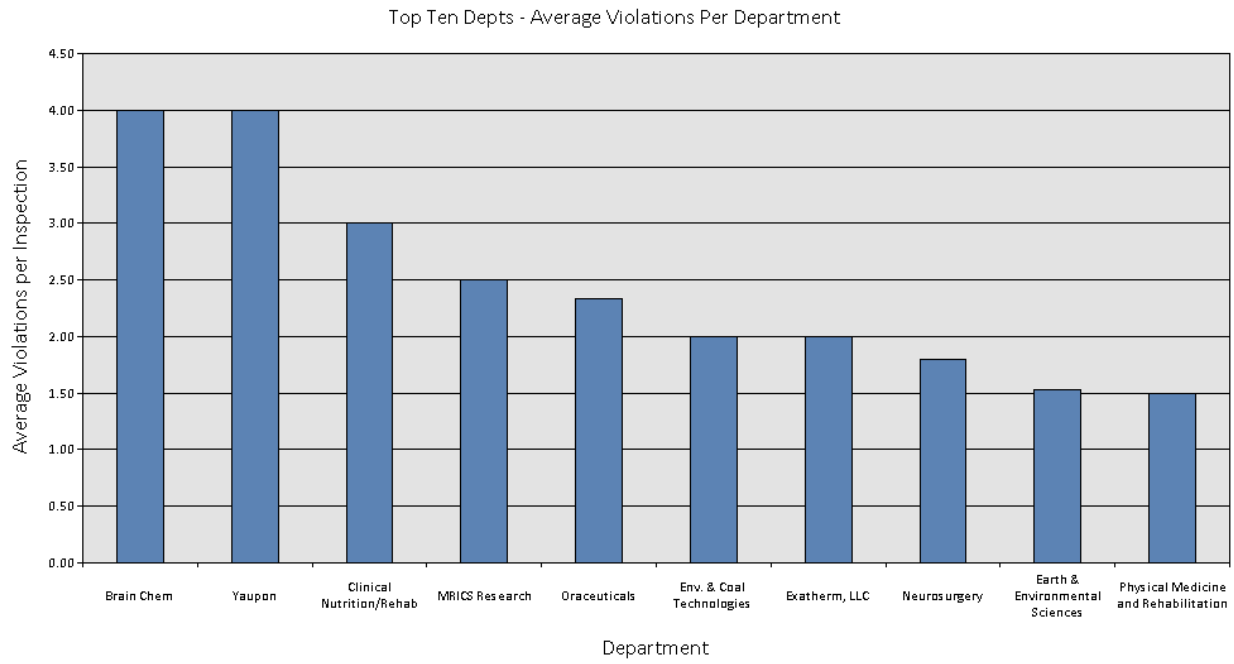

Figure 2

In order to estimate the effect of lab classification and department on violations, a regression analysis was estimated based on the equation.

$$Y_{dl} = b_0 + b_1x_{dl} + b_1x_{2dl} + b_1x_{3dl} + b_1x_{4dl} + b_1x_{5dl} + (\alpha_d + \varepsilon_{dl})$$

The regression was run for fixed effects and again for random effects. This distinction refers to the method by which the departmental identities are controlled in the regression. Fixed effects use a set of 115 dummy variables for 116 departments. Random effects assume the departments are part of the regression disturbance and are uncorrelated with lab classification. That is, departments using similar labs have no greater or lesser tendency to have violations in those labs. That assumption can be tested, and here, there is no

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statistical evidence that departmental effects are correlated with the extensiveness of chemical use. So random effects, which assume no correlation between departments and lab classification, are acceptable here.

Departments have highly variable numbers of labs, ranging from 1 to 299, with a mean of 34.2. Note that no correlation is one thing, while no effect of department is another. In fact, departments are quite different, some having more violations than others, given the classification of labs that they have. This is estimated using random effects, and is an average over the labs that a department runs.

Fixed effects estimates are presented first. Lab classification has statistically significant effects. The r square is low, but there is statistical evidence that the more extensive the use of chemicals, the more violations, on average.

Fixed Effects:

# of Inspections	3970	Labs per Dept		
# of Departments	116		Min	1
R-Squared			Avg	34.2
within	0.036		Max	299
between	0.040			
overall	0.038			

Total Violations	Coef	Std. Err	t	P>|t|
Class 2	0.255	0.091	2.81	0.005
Class 3	0.443	0.121	3.67	<0.001
Class 4	0.604	0.089	6.78	<0.001
Other	0.048	0.106	0.45	0.655
_cons	0.251	0.085	2.95	0.003
S.D. of fixed eff	0.681			
S.D. of disturb.	0.959			
rho	0.297			

(Fraction of variance due to fixed effects)

As noted, random effects are acceptable here because the correlation is low between departmental effects and types of labs. Random effects estimations follow. The conclusions concerning lab classification are unchanged.

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Random Effects:

# of Inspections	3970	Labs per Dept		
# of Departments	116		Min	1
R-Squared			Avg	34.2
within	0.036		Max	299
between	0.043			
overall	0.039			

Total Violations	Coef	Std. Err	t	P>|t|
Class 2	0.247	0.088	2.80	0.005
Class 3	0.440	0.118	3.73	<0.001
Class 4	0.585	0.087	6.75	<0.001
Other	0.015	0.104	0.15	0.884
_cons	0.290	0.100	2.91	0.004
S.D. of fixed eff	0.516			
S.D. of disturb.	0.959			
rho	0.224			

(Fraction of variance due to fixed effects)

Using random effects estimates, the departments are ranked according to the average number of violations given the types of labs they run. Figure 3 and 4 show rankings of departments with the lowest and highest residual violations, adjusted for lab classification. The mean is 0.678, so an effect of -0.5 or +0.5 is large relative to the mean.

Figure 3

Department	Dept. Effect on Mean
VDL	-0.594
CAER	-0.525
Plant Pathology	-0.516
Vacant or N/A	-0.498
Other	-0.454
Pediatrics	-0.451
Surgery/Neurosurgery	-0.448
Environmental Sciences	-0.407
Pharmacy Practice & Science	-0.376

Departments in Figure 3 are less likely than average to have violations when they are inspected. Figure 4 illustrates the departments more likely than average to have violations when they are inspected.

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Figure 4

Department	Dept. Effect on Mean
Exatherm, LLC	0.536
Neurosurgery	0.547
Mechanical Engineering	0.584
Earth & Environmental Sciences	0.598
Yaupon	0.701
MRICS Research	0.720
Brain Chem	0.777
Mining Engineering	0.803
Electrical Engineering	0.819
Oraceuticals	1.032

This research cannot explicate the reasons for departments being above or below the expected number of violations given the lab classification. There could be random events, good or bad management, or more or less effort to prescribe and enforce proper procedures, as illustrated in the literature review. What is clear is that departments differ by large amounts relative to the mean.

VI Analysis and Findings

According to the regressions, the null hypothesis that lab classification is unrelated to the number of violations can be rejected. The more chemical use, the more violations, on average. The labs classified as other are used as refrigerator rooms or storage not related to chemicals and do not contain chemicals. The results indicate that the laboratories that are equipped to handle the most hazardous chemicals are more likely to have violations, whereas the laboratories that are more restricted in the use of chemicals have fewer violations. This may occur because there is greater risk in a laboratory where there is broad use of chemicals, as opposed to those where chemicals are simply to be stored. However, the risk of serious accident might also be higher. The coefficient increases steadily along with the classification of the lab. This reinforces the finding that labs that are more equipped to handle more hazardous chemicals are more likely to have violations.

Department is also an important indicator of violations. Even when the classification is accounted for, violations per department are statistically and managerially significant and vary by more than 0.5 violations above and below a mean 0.678 per lab. The rankings presented here would allow further

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investigation and targeted training to departments. It also would also be interesting to know more about the breakdown of these violations by department in order to see what may be affecting these violations. If a department is primarily housed in an older facility, perhaps this would make them have more facility violations which are less controllable. That would indicate a priority infrastructure need, given the dangers of stored chemicals. I would like to know more about the faculty in these labs and the chairs of these departments. I would like to know what the departments with fewer violations do with their lab inspection results as opposed to those with a larger number of violations. How do their actions differ, and what kinds of actions should be encouraged in order to lower violations? Is there more involvement on the part of department chairs? How do those with fewer violations approach safety? Could this be brought to other departments to create a stronger safety climate? I would also like to know if the average tenure in a department relates to the likelihood of violations. I think answering these questions would help gather even more information about the safety climate in the UK labs.

Given the literature, creating a strong safety climate on UK's campus is very important, especially when dealing with laboratories on campus. Knowing that departments do differ across campus in their average violations, perhaps efforts in training and retraining could be targeted to those areas with higher numbers of violations in order improve the safety climate. There is a mix of faculty, staff, and students who must work together and ensure each other's safety. Students must learn safe lab practices from responsible faculty and staff who make safety a priority and are clear about procedures and rules. This is the only way to make sure that accidents like those at Texas Tech and UCLA do not occur more frequently.

VII Recommendations/Conclusion

When considering safety in UK labs, it is encouraging to know that UK has safety committees, safety officials, and training available to employees. Despite these indicators of a good safety climate, there is only so much that OHS can do to ensure lab safety. OHS has no authority over labs to force them to address

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any violations. Departmental procedures must be in place in order to ensure a commitment to safety that is perceived by employees and practiced in their daily work. Safety must be easily accessible to all employees. Proper equipment, information, and a climate where safety is the main priority are crucial.

I recommend that the Vice President of Research receive quarterly reports from OHS containing the top violating departments and lab classification of each. He has authority over departments to enforce lab inspection findings, and it is in his interest to make sure no accidents occur or fines are assessed to the University. Reporting based on department and lab classification has significance. Labs that have numerous violations and contain more hazardous chemicals should be addressed with greater urgency, because there is more potential risk in these labs. It is important to produce reports that make it easy to understand departmental and lab classification differences that exist, in order to determine where further attention should be focused.

Limitations

This research cannot identify the seriousness of violations nor the reasons for differences across lab classifications and departments, because the data show only the inspection and the results. The data are extensive but are only as good as the collection, coding, and maintenance of the data set, and in assessing violations, considerable amount of human judgment is involved. The only explanatory variables available are lab classification and department, and other variables such as experience of faculty and students, age of buildings, and lab activity (exactly what as opposed to how much) would be useful. None of these would eliminate differences but would explain them more clearly.

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Appendix 1 http://ehs.uky.edu/rescklst.html

Environmental Health and Safety
Training Checklist

The following questions are designed to help you assess the environmental health and safety training requirements of your research project. If you answer "yes" to a numbered question, then compliance will require "yes" answers to the questions that follow. These requirements are applicable to everyone who works on the research project-principal investigators, technicians, students, postdocs, visiting researchers, volunteers, etc. The training classes below are provided by the Environmental Health & Safety (EH&S) office. In addition to the EH&S classes, most of the areas require principal investigators to provide lab-specific or project-specific training for everyone working on the project. If you have questions, you may contact EH&S at 257-3845.

1) Will chemicals be used?

☐ Yes ☐ No

If used in a lab, has everyone who will be working with chemicals completed **Chemical Hygiene Plan/Laboratory Safety** training?

☐ Yes ☐ No

If used somewhere other than a lab, has everyone who will be working in an area where chemicals will be used completed **Hazard Communication** training?

☐ Yes ☐ No

Has everyone who will be working with chemicals completed **Hazardous Waste** training?

☐ Yes ☐ No

2) Will radioactive materials be used?

☐ Yes ☐ No

Has everyone who will be working with radioactive materials completed radiation safety training? (see below)

☐ Yes ☐ No

Research personnel whose work involves the handling of radioactive materials are required to attend:
(a) **On-Site and Beginning Radiation Safety** prior to working with radioactive material.
(b) **Basic Radiation Safety** within 4 months of completing (a).
Training is also required for principal investigators, lab managers, and others who have significant radioactive materials experience and previous safety training, but are new to UK. These personnel must complete:
(c) **Advanced Radiation Safety** within 4 months of their authorization.

Will X-ray be used?

☐ Yes ☐ No

Has everyone who will use X-ray completed **On-Site and Beginning X-ray Safety Training**?

☐ Yes ☐ No

3) Will human blood, body fluids, or tissues be used?

☐ Yes ☐ No

Has everyone who will be working with human blood, body fluids or tissues completed **Blood-borne Pathogens** training?

☐ Yes ☐ No

4) Will lasers be used?

☐ Yes ☐ No

Has everyone who will be using a class IIIB or IV laser completed **Laser Safety** training?

☐ Yes ☐ No

5) Are portable fire extinguishers available for use?

☐ Yes ☐ No

Has everyone who will be permitted to use a fire extinguisher in an emergency completed **Fire Extinguisher Use** training?

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☐ Yes ☐ No

6) Will respirators be used?

☐ Yes ☐ No

Has everyone who will be using a respirator completed **Respirator Use** training?

☐ Yes ☐ No

7) Will any equipment be used or serviced for which an unexpected restarting could cause injury?

☐ Yes ☐ No

Has everyone who will be working with this equipment completed **Lockout/Tagout** training?

☐ Yes ☐ No

8) Will a Biological Safety Cabinet be used?

☐ Yes ☐ No

Has everyone who will be working in or with a Biological Safety Cabinet completed the online training on using a biological safety cabinet?

☐ Yes ☐ No

9) Will the research project involve any of the following OSHA-regulated activities? Using powered platforms (e.g., lifts, scissors lifts, booms); working in a high-noise area; working at heights (>6 feet); transporting explosive agents; entering hazardous confined spaces (e.g., silos and manure pits); using powered industrial trucks (e.g., forklifts); welding, cutting and brazing; working in grain handling facilities; or SCUBA diving.

☐ Yes ☐ No

(If any of the above activities may be encountered during the research project, contact the EH&S office to conduct an analysis of the work and develop a training program.) Have all affected persons completed the training program designed by EH&S?

☐ Yes ☐ No

10) Will any "dangerous goods" be shipped?

☐ Yes ☐ No

Has everyone who will be preparing dangerous goods for shipment completed training on the U.S. Department of Transportation (DOT) hazardous materials regulations and the International Air Transportation Association (IATA) dangerous materials regulations?

☐ Yes ☐ No

("Dangerous goods," as defined by U.S. DOT, include explosives, compressed gases, flammable liquids and gases, oxidizers, reactives, poisons, infectious substances, radioactive materials, and corrosive materials.)

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Appendix 2

	Door Signage	CHP Manual	Fire Extinguisher	Fume Hood	Eyewash	Safety Shower	Controlled Access	Food	Housekeeping	Labeling
Serious Violations		None	No Fire extinguisher	Sash above working height during use	Blocked/ obstructed eyewash	Blocked/ obstructed		Evidence consistent with eating and/or drinking in the lab	Means of egress, i.e., aisles, doorways blocked	Chemical containers not labeled
			Fire ext. discharged and not reported	Alarm rendered inoperable via tampering		Shower activation handle tied back		Storage of food in lab area		Illegible container labels
				Using hood when not certified						Label incomplete • No chemical name
			Fire ext. blocked	Baffles obstructed						
				Incompatible chemical utilized with standard fume hood • Perchloric acid						
Other-than- serious Violations	None	Not completed	Fire ext. not in wall mount	Excessive chemicals/equipment in hood			Lab left unlocked and unattended		Chemical stored in aisle ways – obstructing egress and spill potential	Food stuffs utilized for research not labeled for intended use, i.e., "food not to be used for human consumption"
	Incomplete	Varying of degrees of incomplete • No SOPS for Select Carcinogens, Reproductive Toxins and Acutely Toxic Chemicals • No Chemical Inventory • No lab specific training documentation • Incomplete ID page • Information not current					Children in lab		Slip/Trip hazards – power and extension cords, liquids on floor	
	Outdated/incorrect information						Pets in lab		Overabundance of combustibles	
Facility Deficiencies			Fire ext. not inspected annually	Hood in alarm mode	Non-compliant eyewash	No shower				
			Fire ext. not charged – "not in the green"	Alarm not functioning	No eyewash	Non-compliant shower • No stay open valve				
			Fire ext. not mounted	No flow indicator and/or alarm		Handle height greater than 69				

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	Chemical Storage	Flammable Storage	Hazardous Waste	Compressed Gas Cylinders	Peroxide Formers	PPE	Electrical	Training	Other
Serious Violations	Incompatible chemicals stored together • Acids/bases • Flammables/oxidizers • Organic acids/Inorganic acids • Water reactives/water or water-based compounds • Oxidizers stored on incompatible shelf material	Storage amounts exceed Solvent Storage Policy	No label	Unsecured	Not dated for disposal in accordance with guide sheet	Not wearing PPE in accordance with CHP PPE Hazard Assessment	Damaged/frayed power cords		
	Containers not sealed properly	Flammables stored in unapproved refrigerator	Label incomplete • "Hazardous Waste" not on label • No date as to when full • No name of contents listed	Not secured properly	Not disposed of by mfg'er expiration date	Improper storage • Contamination of PPE • Degradation of PPE	Use of appliances not UL listed for application • Blenders • Heat guns/hair dryers		
	Containers compromised • Corroded • Cracked • Leaking	Unapproved flammable storage cabinet • Three latch inoperable • Not FM or UL listed	Waste not ticketed for pick-up when container full	Exceeding limits for storage per UK policy		Improper PPE selected			
		Cabinet not closed	Open containers of HW	Toxic gases not in continuously ventilated hood or gas cabinet[1]. Would include but not be limited to: arsine, diborane, germane, phosphine, nitric oxide, methyl bromide, boron trifluoride, chlorine, chlorine trifluoride, dichlorosilane, hydrogen fluoride, nitrogen dioxide, phosgene, sulfur tetrafluoride, ammonia, boron trichloride, boron trifluoride, carbon monoxide, carbonyl sulfide, ethyl chloride, hydrogen bromide, hydrogen chloride, hydrogen sulfide, silane, and disilane		Improper use of PPE • Improper type • Wearing gloves outside of lab			
		Vent caps removed	Evidence of improper disposal	Incompatible gases stored together • Flammables/oxidizers					
				Utilizing regulator as isolation device					

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	Chemical Storage	Flammable Storage	Hazardous Waste	Compressed Gas Cylinders	Peroxide Formers	PPE	Electrical	Training	Other
Other-than- serious Violations	Fume hood utilized for storage while actively being utilized for chemical operations			Valve caps not on cylinders in storage		Improper attire	Ext cords utilized for permanent wiring	All affected employees not received Chemical Hygiene Plan/Laboratory Safety Training	No vacuum trap utilized with vacuum source
							Use of multiple power strips inline	All affected employees not received Lab Specific Training	Utilizing chipped or broken glassware
							No strain relief on energized cords		Improper disposal of glassware (deposited in regular trash in lab)
									Overfilled sharps container
									No annual certification of biological safety cabinet

[1]All gases that have NFPA Health Hazard Ratings of 3 or 4
All gases that have a NFPA Health Hazard Rating of 2 without physiological warning properties
Pyrophoric gases

Violation Classifications

Other-than-serious - a condition that could result in an accident or injury that is less than serious in nature

Serious - a condition that could result in death or serious physical harm or major regulatory action against the University (penalties of $5,000 or more)

Repeat - a like serious violation observed in two consecutive inspections

Willful - a like serious violation observed in three consecutive inspections

Note: When two or more individual violations are found which, if considered individually represent Other-than-serious violations, but considered in relation to each other create a condition that could result in death or serious physical harm or major regulatory action against the University (penalties of $5,000 or more), the individual violations will be documented as serious.

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Appendix 3

Average Violations by Class

qryViolations by Class								
Lab Category	CountOfID	SumOfOther1	SumOfSerious	SumOfRepeat	SumOfWillful	SumOfFacility	Total Violations	Avg Violations/Inspection
Class 1	166	39	19	3	0	0	61	0.37
Class 2	1206	350	229	15	0	49	643	0.53
Class 3	162	73	48	1	0	4	126	0.78
Class 4	2165	885	835	49	3	43	1815	0.84
NA	281	36	20	0	0	1	57	0.20
	3980	1383	1151	68	3	97	2702	0.54

Average Violations by Department

qryViolations by Dept								
Dept	# Inspections	Other	Serious	Repeat	Willful	Facility	Total Violations	Avg Violations/Inspection
Yaupon	1	1	3	0	0	0	4	4.00
Brain Chem	1	2	2	0	0	0	4	4.00
Clinical Nutrition/Rehab	1	1	2	0	0	0	3	3.00
MRICS Research	2	3	2	0	0	0	5	2.50
Oraceuticals	6	5	8	1	0	0	14	2.33
Exatherm, LLC	2	4	0	0	0	0	4	2.00
Env. & Coal Technologies	1	1	1	0	0	0	2	2.00
Neurosurgery	5	7	2	0	0	0	9	1.80
Earth & Environmental Sciences	15	10	13	0	0	0	23	1.53
Physical Medicine and Rehabilitation	2	0	3	0	0	0	3	1.50
Electrical Engineering	35	24	25	3	0	0	52	1.49
Otolaryngology	3	3	1	0	0	0	4	1.33
Surgery/ENT	3	2	2	0	0	0	4	1.33
Merchandising, Apparel, & Textiles	3	0	2	0	0	2	4	1.33
Mining Engineering	38	30	14	5	0	0	49	1.29
Escent Technologies	4	3	2	0	0	0	5	1.25
Pathology	4	4	1	0	0	0	5	1.25
Mechanical Engineering	68	50	33	1	0	1	85	1.25
Neurology	12	7	6	0	0	1	14	1.17
Clinical Lab Sciences	29	24	6	2	0	0	32	1.10
Physics & Astronomy	105	64	32	6	0	7	109	1.04
Forestry	25	13	11	0	0	1	25	1.00
Pharmacy Practice & Science	1	1	0	0	0	0	1	1.00
Clinical & Reproductive Science	1	0	1	0	0	0	1	1.00
Preventive Medicine	2	1	1	0	0	0	2	1.00
General Surgery	6	2	4	0	0	0	6	1.00
Power Generation & Utility Fuels	1	0	1	0	0	0	1	1.00
Obstetrics & Gynecology	9	5	3	0	0	1	9	1.00

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qryViolations by Dept								
Dept	# Inspections	Other	Serious	Repeat	Willful	Facility	Total Violations	Avg Violations/Inspection
3H	4	2	2	0	0	0	4	1.00
Transposagen	2	1	1	0	0	0	2	1.00
Psychology	6	4	2	0	0	0	6	1.00
Biofuels & Env. Catalysis	1	0	1	0	0	0	1	1.00
Center for Nanoscale Science & Engineering	6	1	5	0	0	0	6	1.00
Toxicology	53	34	18	1	0	0	53	1.00
Surgery/Cardiothoracic	9	6	3	0	0	0	9	1.00
Chemistry	299	132	132	14	0	8	286	0.96
Chemical & Materials Engineering	111	36	64	3	0	1	104	0.94
Pharmaceutical Sciences	189	86	72	1	0	14	173	0.92
Entomology	122	23	83	0	0	1	107	0.88
Rehabilitation Sciences	8	5	2	0	0	0	7	0.88
ASTeCC	27	12	11	0	0	0	23	0.85
KY Geological Survey	24	4	16	0	0	0	20	0.83
Physiology	118	57	36	4	0	0	97	0.82
USDA	15	1	8	0	3	0	12	0.80
Biomedical Engineering	61	26	15	0	0	7	48	0.79
Radiation Medicine	12	5	4	0	0	0	9	0.75
Surgery/Urology	16	9	3	0	0	0	12	0.75
Nutrition & Food Science	42	20	11	0	0	0	31	0.74
Kentucky Transportation Center	15	8	3	0	0	0	11	0.73
Microbiology & Immunology	146	56	45	0	0	6	107	0.73
Anatomy & Neurobiology	78	40	16	1	0	0	57	0.73
Markey Cancer Center	44	17	10	1	0	4	32	0.73
Surgery	29	13	6	2	0	0	21	0.72
Biochemistry	160	57	45	9	0	4	115	0.72
Animal & Food Sciences	70	18	32	0	0	0	50	0.71
Ophthalmology	20	6	8	0	0	0	14	0.70
Horticulture	44	20	9	1	0	0	30	0.68
KTRDC	50	23	10	1	0	0	34	0.68
Vacant or NA	3	1	1	0	0	0	2	0.67
Anthropology	3	2	0	0	0	0	2	0.67
Environmental Toxicology	3	0	2	0	0	0	2	0.67
General Clinical Research Center	3	1	1	0	0	0	2	0.67
Biological Sciences	198	81	33	3	0	7	124	0.63
Center for Robotics Manufacturing	13	6	2	0	0	0	8	0.62
Pediatric-Research	10	1	3	0	0	2	6	0.60
UK Extended Campus	20	7	5	0	0	0	12	0.60
Cardiovascular	25	9	6	0	0	0	15	0.60

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qryViolations by Dept								
Dept	# Inspections	Other	Serious	Repeat	Willful	Facility	Total Violations	Avg Violations/Inspection
Research Center								
Dental Hygiene Clinic	5	2	1	0	0	0	3	0.60
Kinesiology	12	6	0	1	0	0	7	0.58
Plant & Soil Science	203	55	52	1	0	8	116	0.57
SCoBIRC	90	24	23	0	0	3	50	0.56
Pharmacology	56	15	11	0	0	3	29	0.52
Pharmacy	29	7	8	0	0	0	15	0.52
Anesthesiology	6	2	1	0	0	0	3	0.50
Center for Biomedical Engineering	2	1	0	0	0	0	1	0.50
Biotechnology	2	0	1	0	0	0	1	0.50
Geography	4	2	0	0	0	0	2	0.50
Preventive Medicine and Environmental Health	2	0	1	0	0	0	1	0.50
Medicine	6	3	0	0	0	0	3	0.50
Nanomite	2	0	1	0	0	0	1	0.50
Scout Diagnostics	2	1	0	0	0	0	1	0.50
Oral Health	52	11	7	2	0	5	25	0.48
Civil Engineering	48	10	11	2	0	0	23	0.48
Internal Medicine	153	42	25	1	0	3	71	0.46
Veterinary Science	128	32	17	0	0	0	49	0.38
Regulatory Services	80	3	22	0	0	2	27	0.34
Advanced Genetics Technologies Center	3	1	0	0	0	0	1	0.33
Radiography	3	1	0	0	0	0	1	0.33
Naprogenix	6	1	1	0	0	0	2	0.33
Center on Aging	132	27	16	0	0	1	44	0.33
Education Curriculum and Instruction	3	1	0	0	0	0	1	0.33
Pediatrics	36	9	2	0	0	0	11	0.31
Oral Diagnosis	18	2	1	0	0	2	5	0.28
CAER	80	3	19	0	0	0	22	0.28
Orthopaedic Surgery	4	0	1	0	0	0	1	0.25
Preservation	4	1	0	0	0	0	1	0.25
Plant Pathology	60	3	10	0	0	1	14	0.23
Dentistry	9	1	1	0	0	0	2	0.22
Ag Engineering	95	8	10	0	0	2	20	0.21
VDL	38	6	0	0	0	0	6	0.16
Environmental Management	7	1	0	0	0	0	1	0.14
Other	59	2	2	2	0	0	6	0.10
Vacant or N/A	38	3	0	0	0	0	3	0.08
Tissue Bank	2	0	0	0	0	0	0	0.00
Agronomy	2	0	0	0	0	0	0	0.00
Advanced Semiconductor	2	0	0	0	0	0	0	0.00
KY Space Program	2	0	0	0	0	0	0	0.00
Transposagen BioPharmaceuticals	2	0	0	0	0	0	0	0.00
Tracy Farmer Center	3	0	0	0	0	0	0	0.00
Vindico Nanobiotechnology	1	0	0	0	0	0	0	0.00

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qryViolations by Dept								
Dept	# Inspections	Other	Serious	Repeat	Willful	Facility	Total Violations	Avg Violations/Inspection
Surgery/Transplant	3	0	0	0	0	0	0	0.00
Surgery/Neurosurgery	6	0	0	0	0	0	0	0.00
Surgery/General	6	0	0	0	0	0	0	0.00
Central Supply	3	0	0	0	0	0	0	0.00
Seikowave	2	0	0	0	0	0	0	0.00
Environmental Sciences	3	0	0	0	0	0	0	0.00
Orthopedics	3	0	0	0	0	0	0	0.00
Outrider Technologies	2	0	0	0	0	0	0	0.00
Physics	1	0	0	0	0	0	0	0.00
Clinical Laboratory	4	0	0	0	0	0	0	0.00
Pharmacy Practice and Science	7	0	0	0	0	0	0	0.00
Pharmacy Laboratory	3	0	0	0	0	0	0	0.00
Shared	2	0	0	0	0	0	0	0.00
	3980	1383	1151	68	3	97	2702	0.73

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