Building a Sustainable Student-Led Model To Promote Research Safety in Academic Laboratories

A cademic research safety has received renewed attention since several major accidents occurred in academic laboratories in the 2000s.\textsuperscript{1,2} Accidents reported in academic laboratories, such as the flash fire at UCLA in 2008, have prompted not only the formation of institutional safety organizations including the UC Center for Laboratory Safety, but also national meetings that focus on fostering a stronger sense of safety in academia.\textsuperscript{3-5} This refreshed emphasis on safe-work practices has made safety an essential component of the holistic education for modern scientists.\textsuperscript{6}

The conventional tactic of enforcing safety at academic institutions involves a top-down approach of instituting administrative measures, which can range from mandatory onboarding safety trainings to annual safety inspections. However, such an approach has met mixed levels of success. In response to the call for change in research safety culture, a complementary bottom-up approach was introduced through safety teams.\textsuperscript{7} This new approach quickly developed, and analogous activities started sprouting throughout the United States. In 2012, the first student-led Joint Safety Team (JST) was launched from a partnership between the University of Minnesota (UMN) and Dow.\textsuperscript{8}

Building on the successful partnership with UMN, Dow invited graduate students from two additional institutions, Northwestern University and the University of Chicago, to participate in the second Dow Lab Safety Academy in October 2017. The high safety standard at Dow and the impactful outcome that the JST brought to UMN planted a seed among the Northwestern group to form a similar student safety team.

At Northwestern, the Research Safety Office consists of Environmental Health and Safety (EHS) specialists who work to ensure the safety of all research personnel. Because of the invisible yet unbridgeable barrier between university administration and the research community, the Research Safety Office faces similar challenges to other institutions with top-down approaches. Obstacles, such as a reluctance to cooperate from researchers, severely hinder the implementation of safety policies.

In efforts to advance the research community at Northwestern toward a more mature safety culture, we launched Research Safety Student Initiative (RSSI) at the end of October 2017, shortly after returning from the Dow Lab Safety Academy. The mission of RSSI is “to develop and promote a stronger culture of safety across research laboratories at Northwestern University through an increased awareness of safety hazards and a more positive mindset towards safe laboratory practices. In conjunction with Research Safety, we aim to encourage University-wide commitment to safety by providing education, resources, and training.”

Several key factors integral to the initial success and continual evolution of a new student-led safety team include student leadership, researcher participation, administrative support, support from external companies, and interactions with other student safety teams (Figure 1). Here, we share the essential elements for forming a successful student-led safety team and the strategies employed in developing RSSI initiatives, as we believe that our experiences can be readily translated to other institutions to raise safety awareness through similar student-led efforts.

As a student initiative, a strong student leadership ties the entire organization together. Students who possess a passion...
to build a safer research community are encouraged to volunteer as board members to lead and develop the blueprint of research safety strategies that can be implemented university wide. RSSI board members are presented with a significant opportunity for leadership development. Tasks can include securing funding, brainstorming ideas for activities, and developing technical content.

In order to make inroads into various technical disciplines across the research community, we elected an additional team of departmental liaisons to ensure RSSI had a variety of technical expertise and could appropriately assist the interdisciplinary research community at Northwestern. Liaisons to four departments were recruited in addition to the core leadership (a president, a vice president, an education officer, an outreach officer, a public relations officer, and a Research Safety liaison). As a result, we have been particularly successful in encouraging participation and recruiting volunteers from our broad target audience.

To share our proposed mission prior to launching, the leadership team met with university administration ranging from the Office for Research at Northwestern, the Research Safety Office, several science and engineering departments, and core research facilities. This early administrative support was pivotal in promoting the organization and facilitating our activities. For example, the Vice President for Research, Jay Walsh, who spoke at our inaugural Safety Awareness Week, emphasized that research safety is a top priority at Northwestern. Department chairs have also spoken publicly and internally to express their commitment in assisting RSSI to improve workplace safety.

To support the organization financially, over $11,000 in initial funding was secured from a combination of internal organizations (The Graduate School, the Research Safety Office, and the Department of Chemistry) and various external companies. These sponsorships have further provided students with rare opportunities of learning new technologies and networking with technical staff. Support from both internal and external agencies were critical in facilitating the implementation of all RSSI activities. For example, funding enabled advertising of activities, catering during events, and initiating prizes.

Similar student-led grassroots organizations are emerging at academic institutions across the United States. However, apart from JST at UMN, most other groups are still in their infancy, experimenting with different approaches to achieve the same goal. Discussions with such groups can help minimize reinventing the wheel and allow better translation of knowledge and experiences. Additionally, conversations among the groups have catalyzed ideas of creating a platform for student efforts to collectively and effectively share their experiences with the global research community.

In fulfilling our team’s mission, we have adopted the following three strategies: dissemination of information and resources, active participation from students, and feedback-driven initiatives. These approaches have helped energize enthusiasm toward safer laboratory practices at Northwestern, using examples of past and ongoing RSSI activities (Table 1).

### Table 1. Summary of RSSI Initiatives

| initiative                                      | implementation date |
|------------------------------------------------|---------------------|
| Online presence                                | Nov 2017            |
| Safety minute library                          | Jan 2018            |
| Safety Awareness Week                          | Feb 2018            |
| Laboratory safety walk-through                 | Apr 2018            |
| Distribution of safety equipment               | Jun 2018            |
| Summer ice cream social                        | Jul 2018            |
| Safety training for first-year graduate students during orientation | Sep 2018 |
| Safety designate information panel             | Oct 2018            |

### Dissemination of Information and Resources

We discovered early on that the lack of safety awareness among researchers can be largely attributed to the difficulty in finding relevant information. Despite previous efforts carried out by the Research Safety office, including quarterly meetings for safety designates from each lab, the majority of the research community still finds it frustrating and time-consuming to acquire safety information. Often, a web search brings conflicting reports as to the best practices for handling a particular chemical or process. To address these concerns, we worked toward making the technical safety information more readily accessible, and available in a variety of formats with a consistent standard.

Safety information based on gathered input has been a key element in RSSI activities. For example, safety fliers were distributed during three summer social events in 2018, where an average of ~100 researchers participated in each monthly social. Furthermore, we maintain an active website (https://northwesternrssi.wixsite.com/rssi) with resources ranging from safety minute slides, archives of previously distributed materials, upcoming events, and links to useful websites.

To further minimize barriers to safer conduct in research laboratories, we distribute safety equipment free of charge. To date, we have distributed 160 secondary containers for NMR tubes, 65 dispensers for safety glasses, gloves ON/OFF stickers for research instrument use, and portable fire extinguishers for home use. We publicize distribution of safety equipment via our website, email list, as well as...
concurrent RSSI events. For instance, we provided sign-up sheets for safety glasses dispensers at our socials to boost their visibility. These efforts have helped minimize barriers to safer conduct in research laboratories.

Active Participation from Researchers

As a student-led organization, we fully leverage our influence among peers. To effectively promote a more positive mindset toward safe laboratory practices, we recruit volunteers and provide incentives to maximize engagement from researchers. By providing researchers with opportunities to get involved and actively promote safety, we encourage the community to shift toward a more self-sustainable safety culture.

RSSI volunteers are recruited from various research backgrounds to act as anchors within their own research communities. Their volunteering efforts not only increase their own awareness of safety but also make them safety ambassadors who actively promote safety education among their peers.

The “safety minute”, which is a 1 min presentation on a safety-related topic, is an excellent example of successful peer influence. Currently, three departments (Chemistry, Chemical and Biological Engineering, and Materials Science and Engineering) have adopted this practice for their weekly colloquia. We discovered that attendees pay greater attention to the safety message when the presenter is an acquaintance or a friend, indicating that peers can have a greater long-term impact on improving the culture than EHS staff or administration. To date, the RSSI safety minute library consists of 77 topics arranged in 8 different categories.

The laboratory safety walk-through offers a platform for volunteers to learn about safety from the perspective of an EHS specialist. We believe that learning by doing is key in instilling a positive safety mindset. Assuming the role of an inspector, volunteers identify potential safety hazards in other research laboratories and evaluate the effectiveness of their peers in conducting science safely. In 2018, the highest scoring research laboratories were awarded small monetary prizes to recognize their effort in upholding high safety standards. An additional possible benefit is that discussion of research projects during an inspection may lead to fruitful collaborations. In 2018, 27 volunteers (graduate students and postdoctoral scholars) inspected 17 research laboratories (out of 34 invited) from Chemistry and Chemical and Biological Engineering.

We also host an annual Safety Awareness Week (Figure 2), through which we promote safety awareness with talks, discussion panels, workshops, and booths. The 2018 kickoff event was attended by ~100 researchers, followed by a catered reception to allow attendees to network with potential employers. Teams of volunteers are assigned shifts to present at the booth, increasing participation through engagement with peers, with the added draw of snacks and free gift totes, mugs, and buttons. On average, we received a daily of ~160 researchers at the booth in 2019. By incorporating different types of incentives, we can overcome the initial barrier for participation and effectively engage researchers.

Feedback-Driven Initiatives

Since RSSI was founded, the program has constantly readjusted, reorganized, and restructured. When researchers voice their concerns, needs, and comments, it is important to redesign or modify initiatives to address their feedback. We rely heavily on the input from our departmental liaisons both before and after activities. For example, we have found that due to the differences in departmental culture, some departments prefer to have safety minutes presented by a volunteer from the hosting faculty’s research group, while others use a volunteer sign-up list.

At Northwestern, the feedback-driven model led us to promote the distribution of secondary containers for NMR tubes free of charge which was motivated by several incidental spills. This presented the opportunity to mitigate safety risks associated with transporting NMR samples by hand, such as broken glass and small chemical spills. To provide easy access, RSSI collaborated with the core NMR facility and set up free pickup locations near the instruments. Additionally, as the use of the safety minute library grew, RSSI received requests to include topics for engineers and teaching laboratories. The expansion of the RSSI safety minute library is an area of active and continuous effort.
Having witnessed the initial shift toward a more positive mindset among Northwestern researchers since the launch of RSSI, we believe that a student-led effort can bring long-lasting impact to any campus research community. Undoubtedly, new challenges will surface as the research community grows. However, such changes also present new opportunities and alternative avenues in which we can shape the safety culture at our home institutions. With the framework we have mapped out here, we envision an acceleration of the formation of analogous student-led initiatives worldwide. Moreover, we hope our insights can assist student leaders and EHS specialists during the inception and early development of similar safety teams at academic institutions.

Xiaodi Wang  
Agnes E. Thorarinsdottir  
Department of Chemistry, Northwestern University, Evanston, Illinois 60208, United States  
Mark Bachrach  
Michael B. Blayney  
Research Safety, Northwestern University, Evanston, Illinois 60208, United States

Author Information  
E-mail: Michael.blayney@northwestern.edu.

ORCID  
Agnes E. Thorarinsdottir: 0000-0001-9378-4454

Present Address  
§(M.B.) Dana-Farber Cancer Institute, Boston, Massachusetts 02215.

Funding  
This work was financially supported by Research Safety and the Department of Chemistry at Northwestern University. Activities in this work were also sponsored by the following: the Northwestern University Materials Research Science and Engineering Center, funded by the National Science Foundation (DMR-1720139), MilliporeSigma, and Salus, Inc.

Notes  
Views expressed in this editorial are those of the authors and not necessarily the views of the ACS. The authors declare no competing financial interest.

Acknowledgments  
The authors acknowledge Dow for the invitation to attend the Dow Lab Safety Academy and for its continuous support. We thank JST from UMN and other safety teams for helpful discussions. We also express our gratitude to the Research Safety staff at Northwestern for their untiring support. Additionally, we acknowledge all our current and past RSSI board members and event volunteers. Lastly, X.W. and A.E.T acknowledge their advisors: Professors Julia Kalow and T. David Harris for their trust and support.

REFERENCES  
(1) Creating Safety Cultures in Academic Institutions: A Report of the Safety Culture Task Force of the ACS Committee on Chemical Safety; American Chemical Society: Washington, DC, 2012.

(2) Bertozzi, C. R. Ingredients for a Positive Safety Culture. ACS Cent. Sci. 2016, 2, 764–766.

(3) UC Center for Laboratory Safety. https://cls.ucla.edu/ (accessed April 25, 2019).

(4) Kemsley, J. N. Learning From UCLA. Chem. Eng. News. [Online] 2009, 87, 29–31–33–34. https://cen.acs.org/articles/87/131/Learning-UCLA.html

(5) Czornyj, E.; Newcomer, D.; Schroeder, I.; Wayne, N. L.; Merlic, C. A. Proceedings of the 2016 Workshop Safety By Design - Improving Safety in Research Laboratories. J. Chem. Health Saf. 2018, 25, 36–49.

(6) Sigmann, S. Chemical Safety Education for the 21st Century — Fostering Safety Information Competency in Chemists. J. Chem. Health Saf. 2018, 25, 17–29.

(7) Alaimo, P. J.; Langenhan, J. M.; Tanner, M. J.; Ferrenberg, S. M. Safety Teams: An Approach To Engage Students in Laboratory Safety. J. Chem. Educ. 2010, 87, 856–861.

(8) McGarry, K. A.; Hurley, K. R.; Volp, K. A.; Hill, I. M.; Merritt, B. A.; Peterson, K. L.; Rudd, P. A.; Erickson, N. C.; Seiler, L. A.; Gupta, P.; Bates, F. S.; Tolman, W. B. Student Involvement in Improving the Culture of Safety in Academic Laboratories. J. Chem. Educ. 2013, 90, 1414–1417.