

LAB SAFETY

How to capture and use near-miss lab-incident reports in academia

Systems can be large or small, expensive or cheap—either way they're worth the effort, leaders say

by **Ariana Rimmel**

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Credit: Courtesy of Steven Butler

University of Minnesota chemistry graduate student Steven Butler pushes one of the wider, stabler carts that his department procured after analyzing chemical transportation spills.

Evicting chemical waste from an academic laboratory can be an awkward task. With squeaky-wheeled carts and wobbly solvent jugs, spills can happen. But if no one gets hurt, small spills and other close calls are rarely documented.

Not so at the University of Minnesota Twin Cities. Researchers in the university's Departments of Chemistry and Chemical Engineering and Materials Science are encouraged to report near-miss incidents to catch safety hazards before they escalate, chemistry professor Ian Tonks says. So when Tonks and his colleagues got a spate of reports of chemical spills that all occurred when transport carts tipped over, they were able to identify the cause and solve the problem.

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A near miss—sometimes called a close call or a good catch—is an unsafe event that falls short of causing significant injuries, property damage, or release of hazardous materials into the environment. Local, state, or federal government agencies may require employers to report those more significant incidents. But it's just as important to document events where little or no harm is done, such as equipment failures, minor injuries, and unexpected chemical reactions, because they can point to interventions that may prevent major accidents in the future.

When Tonks and his colleagues at UMN analyzed 5 years of their **Learning Experience Reports**, which department members use to communicate safety concerns and near misses in chemistry, the team found that the most common incidents involved spills, small fires, and equipment failures. Out of 85 reports submitted to the system, 10 were near misses that warranted further investigation, and 3 necessitated an injury report (*J. Chem. Educ.* 2021, DOI: [10.1021/acs.jchemed.0c00133](https://doi.org/10.1021/acs.jchemed.0c00133)). Considered in conjunction with the waste spill reports, these results show that, without a way to document near-miss incidents, chemists are missing out on crucial data for improving research safety, Tonks says.

C&EN spoke with researchers and safety officers at five universities that have adopted near-miss reporting programs about the challenges of implementing these systems and the benefits they impart in an academic environment. Representatives from UMN; Texas Tech University; the University of Chicago; the University of California, Santa Barbara; and Yale University all agree that it takes time and energy to get a new reporting system off the ground. They also all say that near-miss reporting promotes a stronger, more collaborative safety culture and fewer accidents.

"For other institutions that are thinking about this," says Texas Tech chemistry professor Dimitri Pappas, "it's absolutely worth the effort."

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BUILDING A SYSTEM

The near-miss incident reporting system at Texas Tech was born out of a lab explosion. In 2010, a chemistry graduate student was scaling up the synthesis of a nickel hydrazine perchlorate derivative when the reaction detonated. The student sustained multiple injuries in the explosion, including the loss of three fingers.

The **accident was investigated by the US Chemical Safety and Hazard Investigation Board (CSB)**, which found that lessons from two previous but less severe incidents could have helped prevent the 2010 explosion had they been formally documented and communicated. The CSB concluded that “entities looking to improve safety should encourage the reporting of such incidents, even when injuries or damage do not result, as accidents and near-miss reports indicate critical areas where safety controls may be needed.” In response, Texas Tech launched its **Safety Concerns and Near Misses (SCAN) reporting system**.

SCAN collects reports from every department on campus through a custom-built online portal in which **anyone at the university can submit a narrative description and even photos** of a situation that poses a safety concern. “We tried to make it as open ended as possible,” says Pappas, who helped develop SCAN. The portal includes a technical definition of safety concerns and near misses, but the person submitting information is not required to make that distinction in order to submit a concern to SCAN. As a result, SCAN logs reports on everything from leaky solvent caps to potholes. “I think it’s a good thing,” Pappas says, because it reduces barriers that could discourage users from making a report. It’s better to be safe than sorry, he says.



Credit: Jessica Freeze

Yale University Chemistry Department's Joint Safety Team created QR code magnets that can go on desks and fume hoods to direct researchers to its near-miss reporting site.

The University of Chicago has a similar campus-wide reporting system called the **UChicago Accident/Incident Reporting (UCAIR) system**. People can submit reports to UCAIR through an online reporting form or a mobile app. Campus-wide systems like these can be expensive to set up and operate. Sa-Lin Bernstein, the director of business integration in the office of research safety at UChicago who oversaw the development of UCAIR's IT infrastructure, says the software and mobile app cost around \$16,000 to build and advertise. Nikolai Evdokimov, a chemical safety officer at UCSB, notes the ongoing cost of safety officers' time to **review and investigate reports**. But the benefit of broad, centralized systems is that they keep tabs on chemical hazards beyond the lab, such as in theater departments and operations facilities.

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At the same time, smaller-scale efforts can also be effective. The UMN department-level learning experience system runs entirely on Google Forms and is maintained by a **student-run organization called the Joint Safety Team**.

“**L**ab walk-throughs are now quite boring in our department.”

— *Ian Tonks, chemistry professor, University of Minnesota Twin Cities*

The key is to make sure that reporting forms are easy to find and submit, the people who've developed these systems say. It is important to include fields that allow reporters to provide a narrative description of what they witnessed or experienced. It can also help to ask the reporter to suggest what circumstances led the incident to be a near miss rather than a serious accident, and how they would advise others to avoid the same situation.

LOWERING THE REPORTING BARRIER

A near-miss reporting system isn't helpful if no one uses it, Pappas says. Once the infrastructure is in place, researchers need to know that the resource exists—and they have to feel safe filing a report.

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Getting the word out is a matter of advertising, experts say. All five universities include information about the importance and logistics of near-miss reporting in laboratory safety training. They also market the system prominently on their websites. Some departments even print QR codes on posters and hood magnets that link directly to the submission portal.

Beyond advertising, departments also may need to build trust that the information provided in near-miss reports will be used to make labs safer, not punish those involved. "The number one rule for safety is it shouldn't be punitive, it should be cooperative," Tonks says. One way to emphasize that is by allowing reports to be submitted anonymously so that researchers aren't afraid of retribution from an adviser or colleague. All five schools contacted by C&EN allow anonymous reporting.



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Another strategy is to enlist the people most involved in lab operations. Texas Tech recruits someone from each department—a professor, staff member, or student—to serve on a safety committee and investigate near misses and safety concerns with environmental health and safety staff. These department liaisons are financially compensated for their work on safety matters. "It's a considerable investment," upward of \$15,000 a year, says Matt Roe, the assistant vice president for environmental health and safety at Texas Tech. But it pays off in trust built within the departments. "We started to get the questions directed to us, instead of us coming in after the fact and trying to fix them," Roe says.

Student-led organizations can also play a critical role in sharing lessons learned from near-miss investigations. Sarah Zinn, a chemistry graduate student and founding member of the **UChicago Chemistry Department's Joint Student Research Initiative**, says that student outreach is about "building relationships and making sure that people understand the resources are there to serve them." Though this student group is not involved in UCAIR investigations, it does ensure that department members are aware of lessons learned from reported incidents. Zinn says that a bottom-up approach to communication helps build confidence among students that reporting a near miss won't be used against them.

At UMN and UChicago, executive members of these student groups receive stipends to support this work. **Yale's Chemistry Department has a similar student-run Joint Safety Team**, says Jessica Freeze, former president of the organization. Though the team are unpaid volunteers, Freeze says that creating opportunities that "get over the activation barrier" for submitting a report can help build a stronger safety culture, making things better for everyone. In addition, firsthand experience with research safety monitoring has helped students stand out in job applications after they graduate, especially at industry and national labs, Freeze says.

RESPONDING TO BUILD TRUST

Part of building trust in near-miss reporting systems is responding to the concerns that researchers submit. That means investigating the incident and sharing the relevant findings with the community members who are most affected.

Anonymous reporting can make these investigations challenging, safety officers say. But with sufficient narrative details from the report itself, the identity of the reporter may not be necessary to address concerns raised by an incident, especially if the system allows reporters to recommend changes. But maintaining confidentiality is of the utmost importance so that reporters don't fear retaliation.



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“When someone puts in an anonymous tip, you have to maintain anonymity no matter what,” Pappas says. Even if a reporter must be identified in order to investigate the near miss, their identifying information must be removed from any data or reports documenting the findings, safety officers say.

After UMN recognized the spill risk from chemical-waste transport, Tonks and his colleagues made sure every lab had access to wide, stable carts and made it department policy to use them. “We’ve never had a spill from waste disposal since then,” Tonks says.

At UCSB, near-miss reports flagged that many close calls occurred when researchers conducted experiments outside their primary field, especially when working with collaborators on interdisciplinary research projects, Evdokimov says. This led the university to change its training curriculum so that students are more aware of how to respond to near misses and accidents across multiple types of hazards, Evdokimov says.

The results and recommendations from the investigation also need to be accessible. The UMN Joint Safety Team **publishes on its website its findings in Learning Experience Reports**. Texas Tech and other universities write up lessons learned about incidents from their own campus as well as noteworthy reports from other institutions; they also include examples in their safety-training curricula. Freeze says that her group at Yale hopes to add a button to the department’s chemical inventory system that will link to near-miss reports associated with specific compounds.

CREATING LASTING CHANGE

For other departments and universities interested in developing a near-miss reporting system, UChicago’s Bernstein says it’s crucial to think carefully about the information technology infrastructure—whether custom software or a spreadsheet—that can do the things people need. And while top-down and bottom-up approaches can both build trust in these systems, safety advocates agree that it’s best when everyone from undergraduates to university presidents feel empowered to advocate for safer lab practices.

“If it weren’t being used, [SCAN] would be a horrible failure,” Pappas says. Pappas himself has used SCAN to draw attention to a lab maintenance issue because he knows the reports are taken seriously.

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Implementing such systems can have wide-ranging benefits. Researchers at many of the institutions that spoke to C&EN say the rate of incidents at their universities has decreased since they started tracking near misses. “In general, safety compliance has increased dramatically,” Tonks says. “Lab walk-throughs are now quite boring in our department.”

Improving safety can also help make chemistry more accessible, Freeze says. She points out that the number of undergraduate research positions in chemistry labs is often limited by whether an adviser feels these students will be safe. This creates an extra barrier for students trying to gain experience, and “that’s a problem when thinking about diversity, equity, and inclusion,” Freeze says.

And ultimately, taking a forward-thinking approach to safety to address concerns before someone gets hurt puts chemists in a better position to do good science. “It’s just part of your job,” Pappas says.

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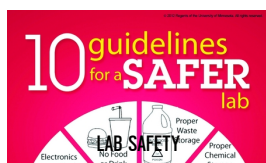
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