Surgical Smoke Evacuation Device Implementation: A Quality Improvement Project at Doernbecher Children's Hospital

Patrick Martyak and Kim Thornton

School of Nursing, Oregon Health & Science University

NURS 703: DNP Project

Dr. Julie Soelberg

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Abstract

Surgical smoke, created via energy-generating surgical devices, is a physical, chemical, and biological hazard that adversely affects the health of exposed individuals. Smoke evacuation devices (SEDs) are readily available at Doernbecher Children's Hospital (DCH), though a 2020 gap analysis showed they are used in only 3.2% of annual smoke-generating cases. Surgical smoke evacuation legislation was introduced January 1, 2023, in Oregon, requiring hospitals and ambulatory surgery centers to prevent surgical smoke exposure in ORs. The goal of this quality improvement (QI) was to quantify the use of and track compliance of surgical smoke evacuation, while helping the facility to attain the AORN Go Clear recognition. This QI project relied on Duke University's FADE methodology to achieve the goal. Based on supply utilization, SEDs were utilized infrequently (4.06%) during the period of Covid when surgical smoke initiatives were paused, increased to 13.88% when surgical smoke awareness and education were reinstated, and spiked to 47.65% with Go Clear audits and institution of legislation for surgical smoke evacuation. A 95% compliance rate for surgical smoke evacuation (SED and non-SED devices) allowed the site to be awarded the AORN Go Clear designation. This project supports the use of multiple interventions including surgical smoke awareness and education, equipment-related factors, and policy/regulation changes to successfully implement the use of smoke evacuation devices in ORs.

Keywords: surgical smoke, operating room, occupational hazard, smoke evacuation device, pediatric hospital, quality improvement

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Problem Description

Surgical smoke, created via energy-generating surgical devices, is a physical, chemical, and biological hazard that adversely affects the health of exposed individuals. Over 500,000 healthcare providers are exposed to surgical smoke every year and perioperative staff encounter surgical smoke daily (Fencl, 2017). Many professional and regulatory agencies, including the Association of periOperative Registered Nurses (AORN) and the National Institute for Occupational Safety and Health (NIOSH), recommend smoke-free operating rooms (ORs). Recently, surgical smoke evacuation legislation has been introduced in several states and on January 1, 2023, Oregon was the sixth state to enact legislation requiring hospitals and ambulatory surgery centers to prevent surgical smoke exposure in ORs (Association of periOperative Registered Nurses [AORN], 2022; Steege et al., 2016). Smoke evacuation devices (SEDs) are considered a first-line defense against surgical smoke and remove virtually all smoke particulates from the OR environment (Swerdlow, 2020); however, implementation and compliance with SED use remains inconsistent (Jodin & Zhang, 2020; National Institute for Occupational Safety and Health [NIOSH], 1996; Steege et al., 2016).

SEDs are readily available at Doernbecher Children's Hospital (DCH), though a 2020 gap analysis showed they are used in only 3.2% of annual smoke-generating cases (Jodoin & Zhang, 2020). Since that data was collected, several local interventions have been designed to overcome barriers to SED use. To further ensure a smoke-free environment, DCH strived to achieve the AORN Go Clear Award, a designation that recognizes facilities that have taken the initiative to create a smoke-free environment. This QI project aimed to quantify the use of and track compliance of surgical smoke evacuation and ultimately help the facility attain the Go Clear recognition.

Available Knowledge

Surgical smoke is a visible and odorous plume produced using energy-generating surgical devices, such as electrosurgical or laser devices, on human tissue in the OR (Vortman et al., 2020). The plume contains 95% water vapor and 5% cellular debris in the form of particulate materials (AORN, 2016). The latter 5% can contain toxic and infectious compounds, including chemicals that are known carcinogens or mutagens, and biological elements such as viruses and bacteria. Perioperative staff are frequently exposed to surgical smoke, which may lead to acute and chronic health effects ranging from eye and nasal/oral cavity irritation, sore throat, coughing, sneezing, headache, and nausea to chronic inflammatory changes in the respiratory tract resulting in alveolar congestion, interstitial pneumonia, bronchiolitis, and emphysema (Barrett & Garber, 2003; Canicoba & Poveda, 2022). In addition, multiple biologic elements have been recovered in surgical smoke, including malignant cells, HPV, *Staphylococcus*, *Corynebacterium,* and *Neisseria bacteria* (Mowbray et al., 2013). Due to the contaminants in surgical smoke, these compounds should be removed from the OR environment to protect personnel and patients from the health hazards associated with surgical smoke.

Measures related to infection control in the OR, such as air filtration systems and wearing surgical masks, are largely inadequate in protecting staff from surgical smoke. The NIOSH determined that 15-20 filtered air exchanges per hour (as recommended by the Center for Disease Control and Prevention (CDC) for infection prevention) is insufficient for surgical smoke evacuation (1996). Standard surgical masks filter particles > 5-15 µm, and N95 respirators and high-efficiency particulate air (HEPA) filter masks filter particles > 0.3 µm (Swerdlow, 2020). Surgical smoke particulates vary in size based on the equipment used: laser (~0.3 µm), electrocautery (<0.1 µm), or ultrasonic scalpel (0.35-6.5 µm), thus masks provide inadequate protection against surgical smoke (Alp et al., 2006). SEDs are the only device that offers adequate protection to OR personnel and patients from the health hazards of surgical smoke. Components of SEDs include a capture device, a vacuum source, and a filtration source. The

capture devices consist of plume pens to substitute the standard electrosurgical pencils and tubing. The vacuum source can be centralized or portable. The SED should have at least a triple filter system, including a pre-filter (to capture larger particles), an ULPA or HEPA filter (to filter particles as small as 0.1 µm), and a charcoal filter (to adsorb gaseous odors) (AORN, 2016). SED equipment should be used for all smoke-generating surgical procedures and perioperative team members should choose equipment best suited for each procedure based on the amount of surgical smoke produced.

Despite the effectiveness of SEDs and their recommendation for use by several professional and regulatory agencies, implementation and compliance with SEDs remain inconsistent. The NIOSH Health and Safety Practices Survey of Healthcare Workers conducted in 2011 found that less than half (47%) of respondents reported 100% compliance with SED use during laser surgery and only 14% of respondents reported 100% compliance with SED use during electrosurgery (Steege et al., 2016). National data on SED use in pediatric surgery is limited, though a local utilization rate of 3.2% has been reported at the project site (Jodoin & Zhang, 2020).

Barriers to SED use exist at different levels of the healthcare system: healthcare provider, organization, and environment. Barriers attributed to the individual provider include surgeon resistance, impaired surgical view, excessive noise, and lack of education (Arli, 2020; Swerdlow, 2020; Yu et al., 2022). Organizational barriers include a lack of resources, increased cost to acquire/use SEDs, and insufficient or absent hospital policies (York & Autry, 2018; Steege et al., 2016). Environmental barriers include a lack of mandates on the use of SEDs. Only twelve states have passed legislation requiring surgical smoke evacuation despite recommendations and guidelines provided by major organizations and government agencies, including both NIOSH and OHSA, and AORN and the American Society for Laser Medicine and Surgery (AORN, 2016; AORN, 2023).

Many of these barriers can be overcome by incorporating strategies for successful surgical smoke evacuation implementation. Effective strategies include interprofessional education, product

trials with evaluation, policy development, leadership support, identifying barriers, and monitoring compliance (AORN, 2021; Arli, 2020; Fencil, 2017; Heroor et al., 2022; Ogg & Wood 2017; Tan & Russel, 2017; Yu et al., 2022). Education appears to be particularly important. Notably, a large medical center in New York City observed a two-fold increase in SED use two months after education and a four-fold increase three months after education (Dobbie et al., 2017). To help institutions across the country implement a smoke-free OR program, the AORN created a comprehensive smoke-free recognition program called the AORN Go Clear Award Program™. To achieve this award, the hospital must educate staff using the materials provided by the AORN, ensure that smoke evacuators and materials necessary to achieve a smoke-free environment are available, and track compliance (AORN, 2022). This QI project helped to improve surgical smoke safety efforts by ensuring smoke evacuation utilization in DCH ORs, as well as monitoring compliance for purposes of the Go Clear Program.

Rationale

This QI project sought to quantify the use of SEDs, track compliance of surgical smoke evacuation, and assist DCH in obtaining the AORN Go Clear recognition using the FADE methodology. The FADE methodology was developed by Duke University and is a four-step approach to quality improvement that includes focus, analyze, develop, and execute stages. FADE is a cyclical process that begins with identifying an opportunity for improvement (focus), gathering information on factors that contribute to the problem (analyze), developing a solution and plan for implementation (develop), and implementing the plan (execute). By following the FADE process, team members *focused* on SED utilization at DCH, obtained and *analyzed* patterns of data quantifying the use of SEDS over time, *developed* a plan for tracking SED utilization, *executed* the plan and *evaluated* the impact of surgical smoke evacuation compliance monitoring.

Specific Aims

This QI project aimed to quantify the use of and track compliance of surgical smoke evacuation in ORs at DCH. The first objective was to evaluate report data to understand patterns of SED use over time as it relates to various local interventions implemented at DCH to improve SED use. The second was to complete weekly surgical smoke evacuation compliance audits by April 9, 2023. The completion of this QI project assisted DCH in obtaining the AORN Go Clear Award.

Methods

Context

DCH is an 80-bed pediatric academic medical center located in Portland, Oregon, and is associated with Oregon Health & Science University (OHSU). The facility performs over six thousand surgical cases per year in its nine ORs. DCH employs a diverse team of perioperative healthcare providers including physicians, advanced practice providers, nurses, surgical technicians, and various ancillary staff. In addition to these personnel, learners across various disciplines are often present in the ORs, increasing the number of individuals potentially exposed to surgical smoke. DCH currently recommends, but does not mandate, the use of SEDs. The current policy at OHSU allows surgical staff members to use "reasonable judgment" on whether SEDs are used for a surgical case. Most often, surgeon preference, as indicated on procedure cards, dictates the use of SEDs at DCH. Prior to this QI project, one of OHSU's surgical sites, the Center for Health and Healing (CHH), received AORN's Go Clear Award; however, other OHSU surgical sites (including DCH) had not yet received this designation.

Although SEDs are available in every OR, with three additional portable SED units to serve out-of-OR surgical procedures, a recent QI project at DCH found that the SED utilization rate for surgical smoke producing procedures was only 3.2% (Jodoin & Zhang, 2020). The most commonly cited barriers to SED utilization at DCH included surgeon preference, device inconvenience (bulkiness), and impaired surgical field visualization. Additional barriers to use include noisiness, environmental waste concerns,

and staff comfort level. Several interventions have been implemented at DCH in response to many of these barriers (appendix H). To ensure ease of access to SED devices, each OR has a stand-alone Buffalo filter SED. In response to the increased noise produced by some SED devices, DCH obtained Visiclear SEDS. New SED equipment did not appear to significantly improve utilization rates and therefore the focus shifted towards culture change. Culture change largely involved education related to the hazards of surgical smoke and SED use, including education through flyers and posters in high-traffic areas, mandatory AORN Go Clear Award online surgical smoke modules (mandatory for nursing staff), and SED vendor education for surgeons and perioperative RNs. In response to staff concerns about increased environmental waste, non-SED pens were removed from prepackaged surgical sets, which were included in the sets regardless of alternative SED availability. Finally, DCH revised its surgical-smoke evacuation policy to align with the recent state legislation. Increased SED utilization is necessary at DCH because as of January 1, 2023, Oregon House Bill 2622 was enacted, mandating healthcare employers to implement policies that require surgical smoke evacuation while performing surgical procedures (Appendix C) (2021). As a result of this project and other measures, DCH has now joined OHSU's Center for Health and Healing in receiving the AORN's Go Clear Award designation.

Interventions

To understand patterns of SED use over time related to various local interventions implemented at DCH to improve SED use, team members first evaluated baseline data from prior QI work, which quantified the use of SEDs from November 1, 2019, to October 31, 2020. Team members then analyzed surgical procedure cards, supply utilization reports, and case volume reports for SED use over three time intervals. These time intervals included November 1, 2020, to April 30, 2022, during the surgical smoke initiative pause related to Covid (hereafter referred to as the Covid-pause), May 2, 2022, to December 31, 2022, when surgical smoke education and awareness was reinitiated after the Covid-pause, and January 1 to April 30, 2023, when legislation requiring surgical smoke evacuation began.

To quantify the use of and track compliance of surgical smoke evacuation in ORs at DCH, team members performed surgical smoke evacuation compliance audits using the AORN Go Clear Audit tool, which includes 5 metrics, as shown in Table 1. Audits were performed via direct observation in each OR weekly. Staff were informed of audits two to four weeks prior to the beginning of audits via email and morning huddles. Prior to audits, auditors were trained in the use of the audit tool by the Smokeless OR Committee Chair. The auditors dressed in surgical attire and were present in the OR for a defined period while collecting the data. Auditors were identified as auditors in the OR. Auditors conducted audits manually, then audit data was entered into an electronic system by the Smokeless OR Committee Chair.

Table 1

AORN Go Clear Audit

	Yes	**No**
Surgical smoke is evacuated on any smoke generating procedure with smoke evacuator, laparoscopic filter, and suction with inline filter		
The smoke evacuation device is positioned as close as possible to the generation of surgical smoke, within two inches		
An additional standard suction is used to evacuate fluid		
Perioperative team members wear personal protective equipment to dispose of contaminated filters and smoke supplies		
Smoke evacuation filters are used according to manufacturer's directions for use (e.g. single use)		

Measures

The outcome and process measures considered for this project are illustrated in Table 2. Measure data was collected via AORN Go Clear audits, surgical case volume records, and procedure card records. Appendix G provides operational definitions and data collection procedures for individual measures.

Table 2

Evaluated Measures

Outcome Measures	Process Measures
1. Percentage of cases utilizing SEDs prior to legislation 2. Percentage of cases utilizing SEDs after legislation	1. Number of cases audited 2. Number of surgical smoke producing cases at DCH 3. Percent of staff completing required AORN surgical-smoke educational modules or its equivalent (physician waivers) 4. Number of procedure cards requesting SEDs

Analysis

To quantify the use of and track compliance of surgical smoke evacuation in operating rooms at DCH, audit information was organized and analyzed using Microsoft Excel software. Analysis included a percentage of overall audited surgical smoke evacuation utilization and compliance for each of the five compliance audit metrics (Table 1), represented in graphical form. A run chart was used to evaluate the trend of compliant versus non-compliant audit metrics. Data from procedure cards and surgical case volume records were analyzed and organized in tabular form in Microsoft Excel as well. The percentage of SED use at the three pre-determined time intervals was calculated by dividing the number of cases utilizing SEDs (numerator) over the total number of potential surgical smoke generating cases (denominator) during the time interval. To understand patterns of SED use over time as it relates to various local interventions implemented at DCH to improve SED use, a run chart was created with the data taken from surgical procedure cards, supply utilization reports, and case volume reports over the three time intervals.

Ethical considerations

Ethical considerations for this QI project included safe handling of surgical smoke evacuation audit data and surgical report data and anonymity of the auditees. All data was secured via OHSU encryption, password protection, and/or two-factor authentication. This project was reviewed by the OSHU Institutional Review Board to meet the designation of a non-human subject research (IRB ID# 00025249). No conflicts of interest are reported by the authors of this QI project.

Results

Results are presented below. SED supply utilization data can be found in Appendix I and Go Clear audit data can be found in appendix J.

SED Supply Utilization Data

Supply utilization data (Appendix I, Tables 1-3) illustrate results for three time periods including data from November 2020 - April 2022 when a covid pause on surgical smoke education was performed (period 1), May 2022 - December 2022 when surgical smoke awareness and education was reinstated (period 2), and data from January 2023 - April 2023 after surgical smoke legislation went into effect in Oregon and Audits for the Go Clear award were performed (period 3). Results include the total number of surgical smoke generating procedures (excludes non-surgical smoke producing procedures [dental, GI, ophthalmology]), the number of SEDs utilized each period, and the percentage of surgical smoke producing procedures that used SEDs.

- Period 1 included 7,829 procedures and 318 SEDs were utilized for a SED utilization rate of 4.06%.
- Period 2 included 3,971 procedures and 551 SEDs were utilized for a SED utilization rate of 13.88%.
- Period 3 included 1,843 procedures and 878 SEDs were utilized for a SED utilization rate of 47.65%.

Go Clear Award Audit Data

Data obtained for application to the Go Clear Award (Table J1) include whether compliance was met (an answer of "yes") for the questions listed in Figure J1. Each operating room producing surgical smoke was audited once weekly for a period of three months, for a total of 84 audits. Nine of the twelve weeks had an OR compliance rate of 100%. Two of the twelve weeks had a compliance rate of 86%. One

of the twelve weeks had a compliance rate of 71%. The overall OR compliance rate for the period of 12 weeks was 95% (Chart J1).

Discussion

Summary

The aim of this QI project was to quantify the use of and track compliance of surgical smoke evacuation in ORs at DCH. Primary findings from this project include:

- Utilization (Chart I1): Based on supply utilization data analyses, SED use increased from 4.06% to 13.88% after the covid pause ended and surgical smoke awareness and education was reinstated. SED use increased again to 47.65% after surgical smoke legislation went into effect in Oregon and Audits for the Go Clear award were performed.
- Tracking compliance (Table J1): Based on Go Clear Audit data, there was a 95% compliance rate for surgical smoke evacuation during surgical smoke generating procedures after surgical smoke legislation went into effect in Oregon.
- AORN Go Clear recognition: After meeting the criteria and submitting the application, the DCH surgical team received the AORN Go Clear Award - Gold Recognition Level in April 2023.
- Methodological framework: Duke University's FADE methodology was applied to track SED utilization and compliance: *focusing* on SED utilization at DCH, obtaining and *analyzing* patterns of data quantifying the use of SEDS over time, *developing* a plan for tracking SED utilization, and *executing* the plan and *evaluating* the impact of surgical smoke evacuation compliance monitoring.

Interpretation

SEDs were historically underutilized at DCH, though recent trends indicate SED use is increasing. Previous data showed that SEDs were utilized for only 3.2% of annual cases at DCH (Jodoin & Zhang,

2020). This current QI project showed SED utilization rates were lowest during period 1 at 4.06% and SED utilization rates drastically increased to 47.65% during period 3. These trends can be explained by several factors, including surgical smoke awareness and education, equipment-related factors, and policy/regulation changes.

The trend in SED use was relatively flat in period 1, began slowly increasing in period 2, then sharply increased at the midpoint of period 2. There was a 9.82% increase in SED utilization between periods 1 and 2. This was likely the result of reinstating surgical smoke awareness and education after these efforts were paused following the Covid-19 outbreak. Awareness and educational efforts included posters in highly trafficked areas and mandatory online surgical smoke education modules completed by OR staff members. The improvement in SED utilization between periods 1 and 2 shows the beneficial impact that staff education and awareness had SED utilization at DCH. This finding is consistent with other studies, where education appears to be a significant indicator of SED utilization (Arli, 2020; AORN, 2021; Dobbie et al., 2017; Fencil, 2017; Heroor et al., 2022; Ogg & Wood, 2017; Ostapovych & Vortman, 2022; Tan & Russel, 2017; Yu et al., 2022). DCH ORs also began removing standard (non-SED) electrocautery devices during period 2 on account of previous environmental waste concerns of disposing of the standard electrocautery devices, which likely further increased utilization of SEDs. The sharp increase in SED use at the mid-point of period 2 (September 2022) is difficult to account for because multiple interventions were implemented within the same time period. The extent to which each intervention led to increased SED utilization is unknown; however, it is apparent that awareness, education, and equipment-related factors improved SED utilization at DCH.

The trend in SED use continued to sharply increase during period 3. Between periods 2 and 3, there was a 33.77% increase in SED utilization. The improvement in SED utilization between period 2 and 3 is likely a result of continued staff education, in-person OR audits, local policy revision and state-wide surgical smoke evacuation legislation. Based on observations from study team members, in-person

audits appeared to increase SED utilization, whereas during audits, OR staff would often obtain SED equipment if it was not already available for use. These results demonstrate the power of the Hawthorne effect, which refers to the alteration of behavior as a result of being observed (Bruchez et al., 2020). It is possible that OR staff were more likely to be compliant with surgical smoke evacuation during direct observation (e.g. audits). Although not specific to SED utilization, literature has shown drastic improvements in compliance rates of hand hygiene due to the Hawthorne Effect (Bruchez et al., 2020; Eckmanns et al., 2006), so it is plausible the Hawthorne Effect played a role in this project as it relates to SED use. Next, a former QI project on SED use at DCH postulated that surgical smoke legislation would improve SED utilization and this QI project supports that claim. Though Oregon surgical smoke evacuation legislation was likely influential in increasing DCH's SED utilization, the extent to which is unknown. Several states, including Texas and Ohio, have failed to pass surgical smoke evacuation legislation in recent years, however both states have high numbers of surgical centers who have been recognized by the AORN's GoClear designation. This shows that though surgical smoke legislation is likely impactful in improving SED utilization, it is the combination of multiple interventions that lead to the greatest improvement in SED utilization (Yu et al., 2022). Overall, the improvement in SED utilization between periods 2 and 3 cannot be attributed to any single intervention. Rather, the bundle of interventions, including increased surgical smoke awareness and education, equipment-related factors, in-person audits, and Surgical Smoke legislation, worked in conjunction to lead to a drastic increase in SED utilization.

Published data regarding SED utilization is limited. Earlier studies in adult settings reported 14% utilization (Steege et al., 2016), and more recent studies reported utilization of 30% or greater (Ostapovych & Vortman, 2022). Our project found a SED utilization rate of 47.65% in a pediatric setting. Literature quantifying the use of SEDs in pediatric settings is sparse. A large academic pediatric hospital conducted an evidence-based practice analysis of SED use but did not report actual utilization rates or

track compliance (Waddell, 2010). In studies that tracked SED utilization and/or compliance, interventions similar to those implemented this QI project were used, including a surgical smoke evacuation policy, staff education, and ensuring adequate access to SEDs. Direct OR audits at DCH for this QI project were a notable variation from other comparable endeavors. It is likely that direct OR audits, as opposed to solely evaluating historical procedure card data, led to higher compliance rates/utilization of SEDs. In general, because multiple interventions were implemented simultaneously throughout this project and other recent studies evaluating SED utilization, the impact of each intervention is unknown, but this demonstrates that a combination of interventions is effective at increasing SED utilization (Ostapovych & Vortman, 2022).

As a result of this project, DCH joined 280 surgical centers in receiving the AORN Go Clear Award (as of May 10, 2023). OR audits revealed an overall smoke-evacuation compliance rate of 95% at DCH, which is higher than the 47.65% utilization rate noted from procedure card data. This can be explained in that direct OR audits allowed the QI team to account for surgical smoke evacuation when a SED was not present. It was deemed acceptable for surgical teams to use a standard suction device for surgical procedures that produce little surgical smoke if an in-line smoke filter on the suction device tubing was present, and a separate suction device was used for fluid evacuation. When evaluating procedure card data, cases that used the standard wall suction to appropriately evacuate surgical smoke, and thus did not have a SED noted on the procedure card data, were assumed to be non-compliant, which likely led to a false decrease in SED utilization rates. Still, DCH is now recognized as a gold-level recipient of the AORN's Go Clear Award.

This QI project found that through increased education and awareness, the removal of non-SED electrocautery devices, audits, local policy revision, and State-level surgical smoke evacuation legislation, DCH improved its SED utilization rate from 4.06% to 47.65%. Direct OR audit results show DCH having a 95% compliance rate for which the AORN recognized DCH with a gold-level Go Clear

Award designation. The combination of interventions implemented throughout this QI project promoted high levels of SED utilization. Surgical centers that desire to improve SED utilization in their facilities should focus on each of these areas of intervention as they strive to promote a smoke-free OR environment.

Strengths & Limitations

Strengths of the study include the use of an established audit tool through the AORN, baseline data from previous projects at DCH regarding surgical smoke evacuation (Jodoin & Zhang, 2020), and data analysis over an extended period (~2.5 years) with over 13,500 data points. Following the AORN pathway to a smoke free OR is a strength of the project and helped align the site with recent surgical smoke evacuation legislation in Oregon. Other institutions can easily follow the same process through the AORN Go Clear Award Program™ to achieve a surgical smoke-free environment.

Throughout this project, simultaneous interventions occurred, including education, auditing, and surgical smoke evacuation legislation initiation, so it is difficult to decipher which intervention had a greater impact, or more likely, if it was a combination of both. There is also a marked difference in utilization rates between the procedure card data (utilization) and audit data (compliance) (47.65% and 95%, respectively). This likely relates to the broader application of surgical smoke evacuation as an act of removing surgical smoke (audit data), rather than specifically requesting a SED (procedure card data). The procedure card data captures a percentage of SED use for all surgeries at DCH. GI scope procedures, ophthalmology, and dental were excluded in data analysis on the assumption that surgical smoke was not produced; however, all other surgeries were included. It is possible that some procedures included in the analysis did not utilize electrosurgical or laser devices, which may have resulted in skewed results. Also, procedure card data was limited to whether a SED was requested, and this was assumed to be actual utilization, though it is possible that a SED was requested and not used. Finally, the act of being observed may have influenced the results of the audit data.

Conclusions

This QI project demonstrated that promoting surgical smoke awareness and education, auditing utilization, and policy/regulation changes are effective interventions for achieving a smoke-free surgical environment. Though our results are specific to the setting in which the project was conducted, these interventions would likely translate successful outcomes for other similar endeavors.

Though surgical smoke evacuation legislation exists, regulation efforts are modest. Oregon House Bill 2622 states that the Department of Consumer and Business Services will ensure compliance during on-site inspections. ORS 441.087 states that these inspections are only required to take place a minimum of once/year (2021). Future procedure card data analysis could reveal if efforts to maintain a smoke-free surgical environment were achieved without concurring audits.

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Appendix A

Members of QI Project Team

OHSU Nurse Anesthesia Program Faculty

- Dr. Julie Soelberg, PhD, CRNA
    - DNP Project Chairperson Assistant Professor
    - OHSU Nurse Anesthesia Program

DCH OR Go-Clear/ Smokeless OR Team

- Nancy Bates, RN
    - Go Clear Coordinator
- Kimberly Berrera Estrada, Scrub Tech
    - Go Clear Assistant Coordinator
- Duyen Liang, Specialty Practice Leader
- Keri Koszela, MD, Anesthesiologist
- Julie Soelberg PhD, CRNA
- Erik Wolfswinkle, MD, Plastic Surgeon

Appendix B

Letter of Support from Implementation Site

Letter of Support from Clinical Agency

Date: 11/16/2022

Dear Kimberlee Thornton & Patrick Martyak,

This letter confirms that I, Duyen Liang, allow Kimberlee Thornton & Patrick Martyak access to complete their DNP Final Project at our clinical site. The project will take place from approximately January 1, 2023, to June 1, 2023.

This letter summarizes the core elements of the project proposal, already reviewed by the DNP Project Preceptor and clinical liaison:

- **Project Site**:
  Doernbecher Children's Hospital
  700 SW Campus Dr.
  Portland, OR 97239

- **Project Plan:**
  - Identified Clinical Problem: Surgical smoke evacuation devices are currently underutilized at Doernbecher Children's Hospital. Beginning January 1, 2023, Oregon becomes the sixth state enacting legislation mandating the use of smoke evacuation devices intraoperatively. Doernbecher Children's Hospital will need to be in compliance with this new legislation.
  - Rationale: Using the FADE methodology, audits will be performed on a weekly basis in Doernbecher operating rooms for approximately 6 months.
  - Specific Aims: This QI project aims to quantify the use and track compliance of SEDS in operating rooms at DCH. Primary objectives include evaluating report data to understand patterns of SED use over time as it relates to various local interventions implemented to improve SED use and completing weekly surgical smoke compliance audits by May 31, 2023. We aim for the culmination of this project to assist DCH in obtaining the AORN Go Clear award.
  - Methods/Interventions/Measures: Through 9 smoke evacuation device audits per week, the percentage of cases utilizing SEDS/compliance with SED legislation will be monitored.
  - Data Management: Percentage of cases utilizing SEDs/compliance with SED legislation will be monitored. Data will not contain any patient identifiers.
  - Site Support: Doernbecher Children's Hospital will allow access to their operating rooms for the purpose of auditing smoke evacuation devices 9x per week.

During the project implementation and evaluation, Kim and Patrick will provide regular updates and communicate any necessary changes to the DNP Project Preceptor.

Our organization looks forward to working with this student to complete their DNP project. If we have any concerns related to this project, we will contact Kim and Patrick and Julie Soelberg.

Regards,

Duyen Liang, Specialty Practice Leader
DNP Project Preceptor (Name, Job Title, Email, Phone):
vand@ohsu.edu 503-418-2190


Signature

11/30/22
Date Signed

Appendix C

Oregon Legislation

Passed by House April 27, 2021

Repassed by House June 8, 2021

.....
Timothy G. Sekerak, Chief Clerk of House

.....
Tina Kotek, Speaker of House

Passed by Senate June 7, 2021

.....
Peter Courtney, President of Senate

Received by Governor:

.....M.,....., 2021

Approved:

.....M.,....., 2021

.....
Kate Brown, Governor

Filed in Office of Secretary of State:

.....M.,....., 2021

.....
Shemia Fagan, Secretary of State

Appendix D

IRB Approval Letter

OREGON HEALTH & SCIENCE UNIVERSITY

IRB MEMO

Research Integrity Office
3181 SW Sam Jackson Park Road - L106RI
Portland, OR 97239-3098
(503)494-7887 irb@ohsu.edu

NOT HUMAN RESEARCH

December 28, 2022

Dear Investigator:

On 12/28/2022, the IRB reviewed the following submission:

Title of Study:	Surgical Smoke Evacuation Device Implementation: A Quality Improvement Project at Doernbecher Children's Hospital
Investigator:	Julie Soelberg
IRB ID:	STUDY00025249
Funding:	None

The IRB determined that the proposed activity is not research involving human subjects. IRB review and approval is not required.

Certain changes to the research plan may affect this determination. Contact the IRB Office if your project changes and you have questions regarding the need for IRB oversight.

If this project involves the collection, use, or disclosure of Protected Health Information (PHI), you must comply with all applicable requirements under HIPAA. See the HIPAA and Research website and the Information Privacy and Security website for more information.

Sincerely,

The OHSU IRB Office

Appendix E

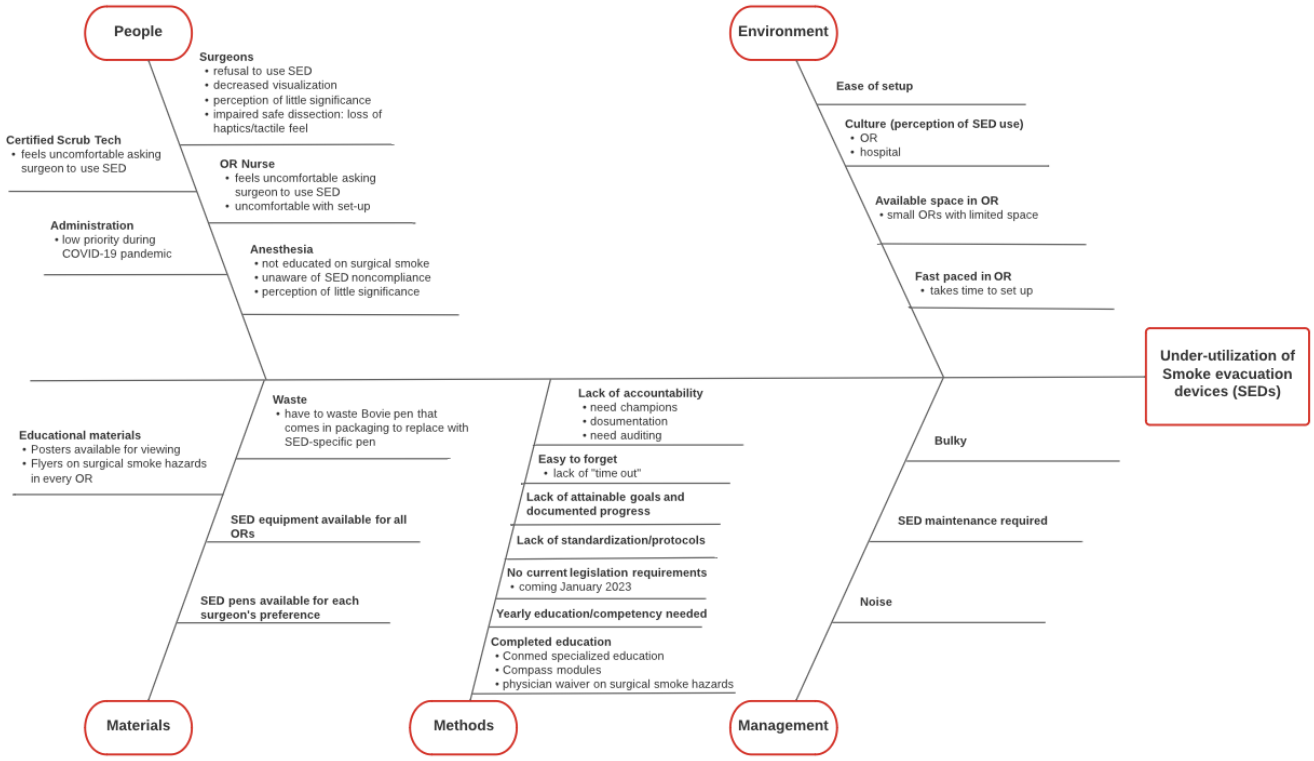
Estimated Projected Timeline

	2022	2023					
	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.-Sep.
Finalize project design/approach	X						
Complete IRB determination	X						
Baseline data analysis		X					
AORN Go Clear Audits		X	X	X			
Final data analysis					X		
Complete final paper						X	
Prepare for project dissemination							X

Appendix F

Cause and Effect Diagram

Team: Martyak & Thornton **Project:** SED Use at DCH



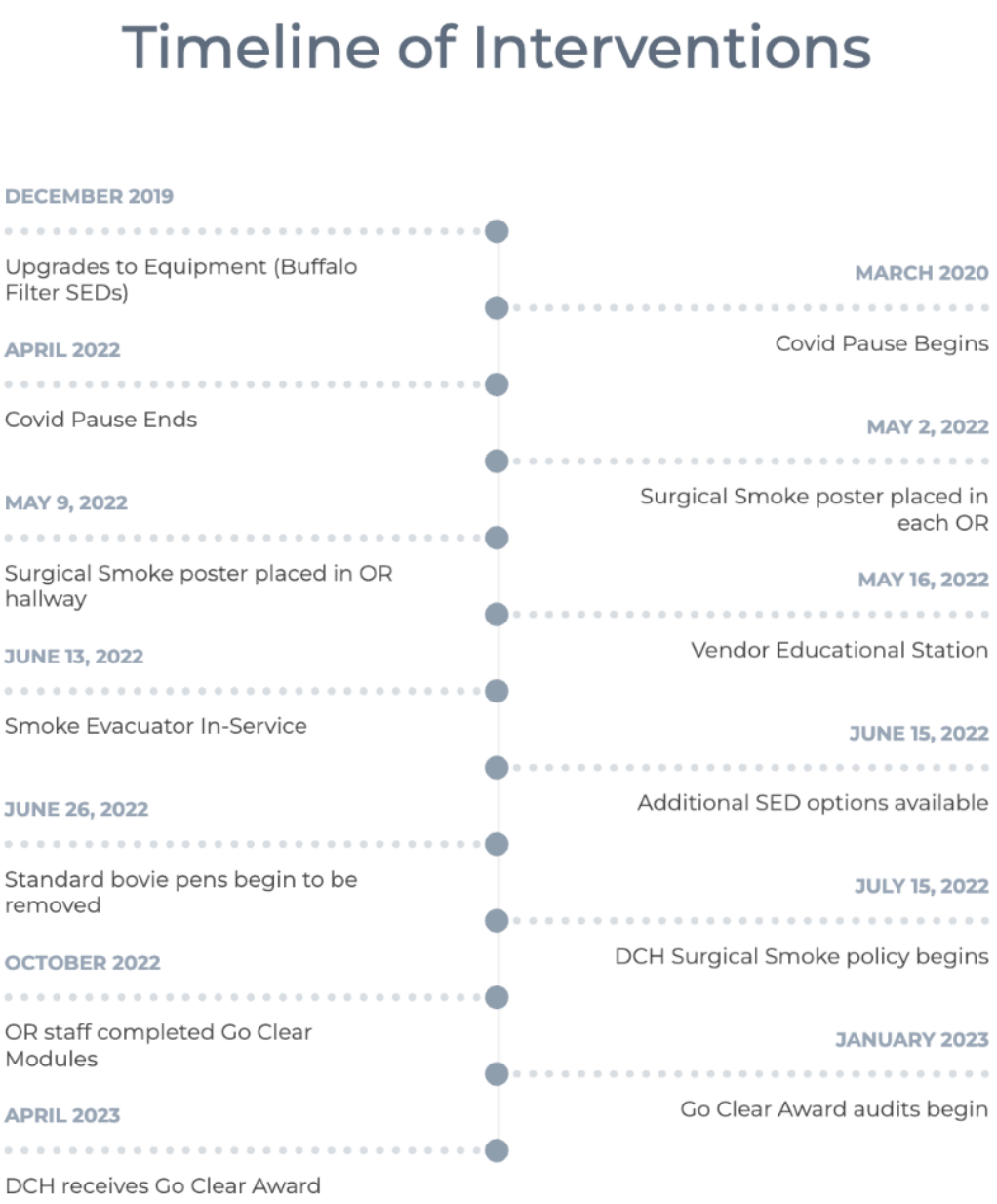
Appendix G

Operational Definitions and Data Collection Procedures for Individual Measures

Measure	Type	Definition	Data Collection
Percentage of cases utilizing SEDs/compliance with SED legislation	Outcome Measure	The number of OR cases that used SED when indicated [numerator] divided by the total number of OR cases where SEDs were indicated [denominator] from January 9, 2023 to April 9, 2023	AORN Go Clear Audits
Number of cases audited	Process Measure	Total number of cases audited from January 9, 2023 to April 9, 2023	AORN Go Clear Audits
Number of surgical smoke producing cases at DCH	Process Measure	Total number of cases producing surgical smoke from January 9, 2023 to April 9, 2023	Surgical case volume records
Percent of staff completing required training	Process Measure	The number of preoperative staff that completed training [numerator] out of the number of preoperative staff assigned to training [denominator]	AORN Go-Clear module records
Number of procedure cards requesting SEDs	Process Measure	Total number of procedure cards requesting SEDs	Procedure card records

Appendix H

Timeline of Interventions



Appendix I

Procedure Card, Supply Utilization, and Case Volume Report Data Results

Table I1

Period 1: November 2020 – April 2022 (Covid pause)

Procedures from Nov & Dec 2020	832
Procedures from Jan-Dec 2021	5271
Procedures from Jan-April 2022	1726
Total Procedures from Nov 2020-April 2022	7829
# SEDs utilized	318
% Procedures Using SEDs	**4.06%**

*****Procedures total excludes GI, Optho, & Dental

Table I2

Period 2: May 2022 – December 2022 (Surgical Smoke Awareness and Education Reinstatement)

Total Procedures from May-Dec 2022	3971
# SEDs utilized	551
% Procedures Using SEDs	**13.88%**

*****Procedures total excludes GI, Optho, & Dental

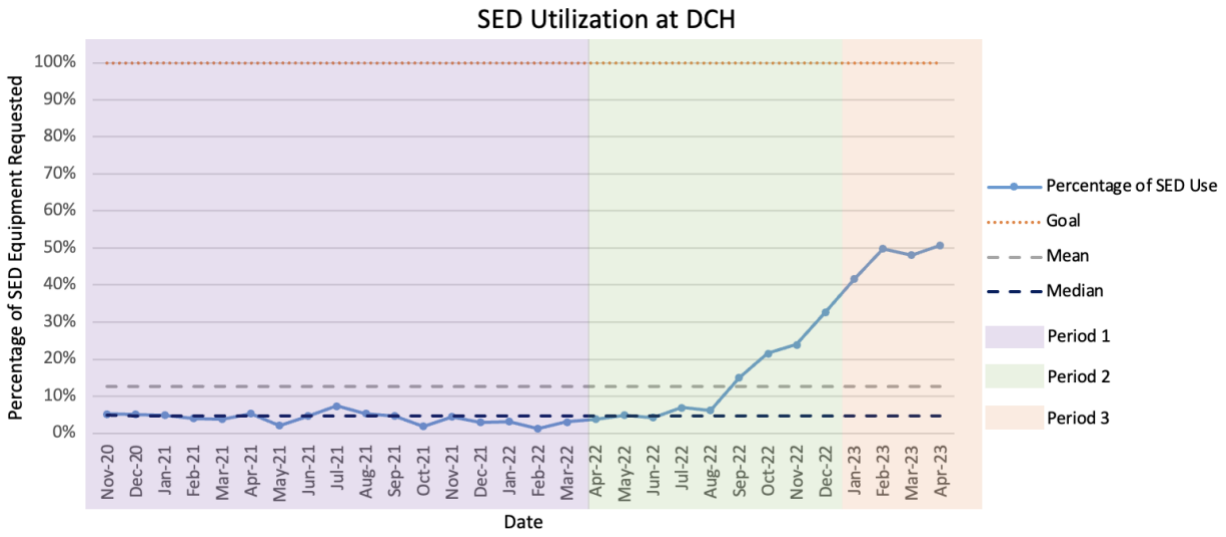
Table I3

Period 3: January – April 2022 (Legislation for Surgical Smoke Evacuation Instated)

Total Procedures from May-Dec 2022	1843
# SEDs utilized	878
% Procedures Using SEDs	**47.65%**

*****Procedures total excludes GI, Optho, & Dental

Chart I1



* Period 1: November 2020 – April 2022 (Covid pause)
Period 2: May 2022 – December 2022 (Surgical Smoke Awareness and Education Reinstatement)
Period 3: January – April 2022 (Legislation for Surgical Smoke Evacuation Instated)

Appendix J

Go Clear Award Audit Data

Table J1

Compliant (Yes = 1; No = 0)													
OR	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Total
1	1	1	1	1	1	0	1	1	1	1	1	1	
2	1	1	1	1	1	1	1	1	1	1	1	1	
3	1	1	1	1	1	1	1	1	1	1	1	1	
4	1	1	1	1	1	1	1	1	1	1	1	1	
5	1	1	0	1	1	1	1	1	1	0	1	1	
8	1	1	1	1	1	1	1	1	1	0	1	1	
9	1	1	1	1	1	1	1	1	1	1	1	1	
Compliance Rate	100%	100%	86%	100%	100%	86%	100%	100%	100%	71%	100%	100%	95%

Chart J1