**PROPOSAL TITLE**:

Reducing Unnecessary Radiation Exposure from Chest X-rays in Lung Transplant patients.

**PROJECT LEADS:**

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**Cardiac Surgery:** Tom Nguyen, Chief, Division of Adult Cardiothoracic Surgery

**Thoracic Surgery:** David Jablons, Chief, Section of Thoracic Surgery

**Senior APEX Analyst:** John Hillman, Adult Business Line Finance

**ABSTRACT:**

Routine dailychest x-rays (CXRs) have been historically preformed as a “*standard procedure*” following lung transplantation at UCSF. However, many of these CXRs are ordered in asymptomatic patients without any impact on the overall clinical course and/or management, resulting in: 1) unnecessary patient radiation exposure, 2) unnecessary utilization of the already limited radiological resources (time and personnel), 3) increased cost to the patient and, 4) reduced net revenue for each transplant case rate. Moreover, these unnecessarily performed CXR may result in sleep disruptions, as they are typically obtained between 03:00-05:00 am.

Therefore, after reviewing our practice, the surgical Advanced Lung Disease (ALD) service developed a new protocol with the primary intent to reduce the number of CXRs performed on the immediate post lung transplantation patient without compromising care. Currently, UCSF lung transplant program performs between 75-80 lung transplants per year, putting it in the top 10 for volume in the country while remaining #1 for outcomes. Given our goal to perform 100 transplants per year over the next 5 years, our protocol to reduce unnecessary radiation exposure from CXRs can have major impact on patient care, cost, and resource utilization. Importantly, it can serve as a model for other services on how to change historically ingrained “*standard procedures*”.

Results:

In calendar year 2022 (CY 22), 78 lung transplants were performed.

During the first half of CY 22, 753 CXRs were performed in 38 lung transplants recipients, resulting in an average of 19.82 CXRs per lung transplant case, and a median chest x-ray per patient per day post-transplant of 1.0 (i.e., each patient received one chest x-ray per day).

Each CXR costs $115 resulting in an overall cost of $86,595 for the first half of CY 22 (Table 1).

*After* instituting the new CXR reduction protocol, in the last six months of CY 22, 568 CXRs were performed in 40 lung transplants recipients, translating into an absolute reduction in the total number of CXRs of ≈25%. The median chest x-ray per patient per day post-transplant was 0.69 (31% reduction adjusted for acuity). The implementation of the new protocol led to cost savings of $21,675 in just six months. The reduction in the number of CXRs and the costs is particularly remarkable, considering the significant increase in complexity, acuity, and length of stay during this period, with 8 of the 40 transplants (20%) coming out of the OR with an open chest and 15 of the 40 requiring ECMO (37.5%). In comparison, during the first 6 months of CY 22, only 4 of the 38 patients required open chest (10.5%) and 8 required ECMO (21%).

**Table 1:** Surgical Advanced Lung Disease CXR Reduction in Calendar Year 2022 at UCSF

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | # Transplants | Total # CXRs | Median CXR/patient | Cost ($115/CXR) |
| CY 22 (Jan-Jun)Pre-intervention | 38 | 753 | 1 | $86,995.00 |
| CY 22 (July-Dec)Post-intervention | 40 | 568 | 0.69 | $65,320.00 |

**GAPS:** Routine dailychest x-rays have been a “*standard procedure*” following cardio-thoracic procedure at UCSF for decades. Our initiative to reduce the number of CXRs exposed a major gap in knowledge in need of urgent addressing: *What is the clinical value of routine daily CXRs in patients after cardio-thoracic procedure and even more importantly what should be the indication to perform CXR in such populations?* Despite its obvious relevance, there are no national guidelines with the current practices stemming primarily from an educational and convenience gap.

In addition, the preparation of this proposal exposed a second major gap in knowledge. This time within other surgical and medical UCSF services with many having identified the need to reduce the number of CXRs, but *lacking the knowledge and experience to successfully embark on such project*.

Therefore, this project will try to address these issues by

* Expanding the CXR reduction protocol to 3 additional services: ALD medicine, post-surgical cardiac and thoracic surgery patients, while
* Establishing a robust logistical system allowing
	+ Development and dissemination of protocols, educational materials with the goal to develop guidelines and implement CXR reduction protocol for each individual service, including CXR protocol into an Apex order set.
	+ Expanding the initiative by providing updated results as well as allow for hypothesis-generating grant application; publication, abstract, etc.

As such, the impact of this project has the potential to have tangible hospital-wide effects not only on patient care, but also on overall financial bottom-line especially for fixed rate cases.

**INTERVENTION:** The Surgical Advanced Lung Disease service chest x-ray reduction initiative served as a pilot program, confirming the ability to reduce unnecessary CXRs in a specific cohort of hospitalized patients. Overall,

1) daily CXRs did not lead to a change in the management of the patient,

2) routine post chest tube removal CXR very rarely resulted in a subsequent procedure or intervention

3) we frequently would await a radiology technician and/or a radiologist report –much needed resources that could be diverted elsewhere in the hospital.

Specifically, for surgical ALD patients, the CXRs outside the ICU on the hospital wards were over utilized and redundant.

Based on our initial success, our goal is to expand the imaging reduction protocol to include other patients populations and services, starting with other CT-services. Ultimately, the plan would be a broader sharing of this practice throughout the hospital.

***Proposed Intervention Project Plan:***

1. During the first project year, we plan to expand the CXR reduction protocol to 3 additional services that are high utilizers of ‘daily routine CXRs’:
* ALD medicine
* Adult cardiac and
* Thoracic surgery Services
1. We have met with leadership of each service: Dr Tom Nguyen, Chief, Adult Cardiothoracic Surgery Division, Dr David Jablons, Chief, Section of Thoracic Surgery as well as Dr. Steve Hays, Medical Director of Lung transplant. All have offered their full enthusiastic support for this project.
2. With the help of Senior analyst, Mr. John Hillman, we have collected and reviewed the CXR data for both Cardiac and Thoracic Surgical services. The next step is to review this data at their respective quality improvement meetings and identify project champions, who we will collaborate with to develop CXR reduction protocols for their service specific goals/needs and set targets.
3. We will individually meet with the clinical team of APPS, physicians, and educate on the new processes.
	1. ALD Medical Service:
		1. Director: Steve Hays
		2. APP Director: Lori Coleman
		3. Target population to implement CXR reduction protocol:
			1. *Pre-lung transplant patients waiting for transplant.* This constitutes a significant amount of the ALD Medical census. These patients have routinely lived on 10CVT tele ward for weeks to months. It is common practice to obtain weekly CXRs on these patients to document progression of disease. However, these X-rays typically do not alter patient’s clinical course leading up to transplant.
			2. *Post-lung transplant patients admitted for myriad of conditions*. Due to the nature of being a lung transplant recipient, CXRs are over utilized in this population.
	2. Cardiac Surgery Service:
		1. Director: Tom Nguyen
		2. APP Lead: Lisa Tanimune
		3. Target population to implement CXR reduction protocol:
			1. Routine CABG, Valve, and combined CABG/Valve surgeries. Similar to the lung transplant patients, there are 3 aspects of CXR reduction that can be implemented
				1. Post-operative, in the ICU, focusing on every other day instead of daily
				2. Post-operative, out of the ICU, focusing on twice weekly while admitted
				3. Post-chest tube removal CXR elimination
			2. The Cardiac Surgery CXR reduction protocol is attached at the end of the proposal
	3. Thoracic Surgery:
		1. Director: David Jablons
		2. APP Lead: Lisa Tanimune
		3. Target population to implement CXR reduction protocol:
			1. Lobectomies, wedge resections, esophagectomies, pneumonectomies, and pleurodesis will be the surgeries targeted for reduction of CXRs. Similar to the lung transplant patients, there are 3 aspects of CXR reduction that can be implemented:
				1. Post-operative, in the ICU, focusing on every other day instead of daily
				2. Post-operative, out of the ICU, focusing on twice weekly while admitted
				3. Post-chest tube removal CXR elimination
			2. The Thoracic Surgery CXR reduction protocol is attached at the end of the proposal

**PROPOSED EHR MODIFICATIONS:** There are two EHR modifications that can be implemented:

1. The first is to flag an order in APEX on a patient who has had 3 CXRs already during their hospital stay, to ask the provider whether an additional CXR would alter the course of patient’s treatment. And/or
2. The second EHR modification is to add a ‘slow down’ warning if a patient has had a CXR within the last 24 hrs. Analogous to ordering a C Diff test if the patient has received laxatives within a certain time frame. A slowdown warning can be displayed to have the provider pause and reflect whether an additional CXR is indicated. If it is clinically warranted, they can close the warning and proceed.

**COST:**

The cost will include development of a robust structure allowing:

* Working with various teams to develop guidelines and implementing CXR reduction protocol for each individual service as well as educating staff.
* Support from Senior analyst, Mr. Hillman to collect and analyze data prospectively in biweekly meetings.
* Building the chest x-ray protocol into an Apex order set.

The projected savings would reflect a 25% CXR reduction. Such a decrease in the number of CXRs will significantly reduce unnecessary radiation exposure to the patient, family, and staff. Using the observed cost savings of $21,675 for just 40 lung transplant recipients in 6 months, an extrapolation to multiple services could lead to profound savings for the medical center in direct costs for CXR (at $115/CXR) as well as in indirect costs (less wear and tear of radiology machines, radiological technicians and radiologist time). For example, in fiscal year (FY) 2022 (Table 2),

* Cardiac Surgery service alone utilized 6,081 CXRs for 697 patients amassing 6,470 patient days. This was an average of 0.94 CXR per day per patient at a cost of $697,787 ($115/CXR). **A 25%-reduction in CXRs would lead to a cost saving of $174,446 per FY**.
* Thoracic Surgery service alone utilized 1,590 CXRs for 238 patients amassing 1,138 patient days. This was an average of 1.40 CXRs per patient per day, i.e., higher utilization than both Cardiac surgery and Surgical ALD service, at a cost of $182,460 ($115/CXR). **A 25%-reduction in CXRs would lead to cost saving of $45,615 per FY.**

**Table 2:** Cardiac and Thoracic Surgery CXR Utilization Fiscal Year 2022

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | # Cases | Total # CXRs | Average CXR/patient | Cost ($115/CXR) |
| FY 22Cardiac Surgery | 697 | 6,081 | 0.94 | $697,787 |
| FY 22 Thoracic Surgery | 238 | 1,590 | 1.40 | $182,460 |

**Therefore, the planned 25%-reduction in CXRs for the 3 services (Surgical ALD, Cardiac, and Thoracic Surgery) would lead to combined cost savings of $263,411 per FY. – and this at the current patient volume.** With projected growth for each service line, **the true savings may reach $400,000 and higher.**

**SUSTAINABILITY:**

* Development of a robust logistical support structure is key in ensuring sustainability of this initiative. Such support structure would allow us to “keep the focus” by developing new Apex order adjustments, education of providers as well as creating and implementing financial incentives for reduction of unnecessary radiation exposure
* Robust data collection system would allow us to support, modify and expand the initiative by providing updated results as well as allow for hypothesis-generating grant application

**BUDGET:** Our budgetary focus on development of a robust logistical support structure ensuring:

1) Distribution and extrapolation of our pilot program,

2) Collection and analysis of data from the other three services,

4) Development and implementation of changes in Apex, including time and input from an Apex analyst

5) Creation and dissemination of educational materials, protocols, etc. This includes the time educating other teams about the new project.

6) Development of financial incentive per team for meeting CXR reduction goals

1. $10,000: Apex Analyst. Estimate. Currently our Apex Analyst is pro bono, however with the expansion to multiple teams, would budget for increased analytical workload.
2. $28,080: ALD Surgical Nurse Practitioners non-clinical time for coordination, education, and deployment of reduction protocol as well as analytical time to process the data and confirm results. Budgeting 80 hours per team (ALD Medical, Cardiac Surgery, Thoracic Surgery). This includes pre-intervention meeting, planning and tailoring the protocol to service specific needs ensuring patient safety, time post planning to educate and deploy the new protocols, and additional time for educating new staff, additional support, and analyzing results. $117 (current hourly rate for Nurse Practitioners) x 80 hours = $9,360 per team implementation.
	1. Phase 1 Teams targeted for CXR Reduction:
		* ALD Medical
		* Cardiac surgery
		* Thoracic surgery
3. $3,000: Teambuilding initiatives (max $1,000 per team) such as:
* Free luncheon for educational sessions to keep health care providers motivated and focused on the mission
* Prize for the services that meet the 25% reduction goal each quarter
* Celebrate achieving reduction goal together
1. $6,000: Financial incentive for the entire team ($2,000 per team) to assist, coordinate, and achieve the CXR reduction goal. There is a precedence for this at UCSF with the hand hygiene project where the non-physician providers were financially incentivized to promote hand hygiene.
2. $2,920: Indirect costs: Education materials, distribution costs, unanticipated items

**SURGICAL ADVANCED LUNG DISEASE CHEST X-RAY REDUCTION PROTOCOL**

The new protocol will eliminate obtaining "Screening or surveillance" CXRs after the first 5 days. After this time point, CXRs will be ordered for cause only.

* CXRs will be performed for the first 4 days post-transplant while recipient is in the ICU as this the most critical time when primary graft dysfunction (a form of acute lung injury) of the allograft occurs
* On post-op day 5 and beyond:
	+ If the patient is still in the ICU, then we will obtain every other day CXR until postop day 10.
	+ If the patient has transferred to CVT, then we will order a CXR twice weekly until discharge, preferably on Monday and Thursday so CXRs can be reviewed by the team at Monday sign-out rounds and before team rotates onto the weekend.
	+ The APP who is transferring the patient out of the ICU is responsible for ordering the ‘Routine’ twice weekly surveillance CXRs as individual orders. They will order 4 CXRs which will cover two weeks of surveillance. Subsequent weeks if required would need to be re-established by new orders.
	+ The Routine CXRs will need to have the comment added "Please perform at 07:00am and do not wake up patient prior to this time" to ensure adequate sleep hygiene and minimize interruptions.
* Additional CXRs may be ordered in both ICU and CVT if clinically indicated or there has been a change in clinical condition
* All CXRs that are standard surveillance, both ICU and CVT should be ordered as ‘Routine’ and only utilize ‘STAT’ for clinical emergencies. This will further reduce unnecessary costs.
* A ‘routine’ CXR will be performed prior to discharge from the hospital
* A ‘routine’ CXR will be performed after a chest tube is removed prior to a second chest tube being removed. No “post-pull” CXR is required unless clinically warranted. Example is patient has a chest tube removed Sunday and has a scheduled routine surveillance CXR Monday, that will suffice as their post pull CXR. However, if the same patient had a CXR pulled Tuesday, before a subsequent chest tube is removed, a ‘routine’ post-pull CXR is warranted. Chest tube removal should not be delayed waiting for scheduled twice weekly CXR.

**CARDIAC SURGERY CABG, VALVE, AND CABG VALVE CHEST X-RAY REDUCTION PROTOCOL**

The new protocol will eliminate obtaining "Screening or surveillance" CXRs after the first 2 days. After this time point, CXRs will be ordered for cause only.

* CXRs will be performed for the first 2 days post-transplant while recipient is in the ICU. This includes immediate post-operative and 24 hrs later on postop day 1.
* On post-op day 2 and beyond:
	+ If the patient is still in the ICU, then we will obtain every other day CXR until postop day 10.
	+ If the patient has transferred to CVT, then we will order a CXR twice weekly until discharge, preferably on Monday and Thursday so CXRs can be reviewed by the team at Monday sign-out rounds and before team rotates onto the weekend.
	+ The APP who is transferring the patient out of the ICU is responsible for ordering the ‘Routine’ twice weekly surveillance CXRs as individual orders. They will order 4 CXRs which will cover two weeks of surveillance. Subsequent weeks if required would need to be re-established by new orders.
	+ The Routine CXRs will need to have the comment added "Please perform at 07:00am and do not wake up patient prior to this time" to ensure adequate sleep hygiene and minimize interruptions.
* Additional CXRs may be ordered in both ICU and CVT if clinically indicated or there has been a change in clinical condition.
* All CXRs that are standard surveillance, both ICU and CVT should be ordered as ‘Routine’ and only utilize ‘STAT’ for clinical emergencies. This will further reduce unnecessary costs.
* A ‘routine’ CXR will be performed after a chest tube is removed prior to a second chest tube being removed. No “post-pull” CXR is required unless clinically warranted. Example is patient has a chest tube removed Sunday and has a scheduled routine surveillance CXR Monday, that will suffice as their post pull CXR. However, if the same patient had a CXR pulled Tuesday, before a subsequent chest tube is removed, a ‘routine’ post-pull CXR is warranted. Chest tube removal should not be delayed waiting for scheduled twice weekly CXR.

**THORACIC SURGERY CHEST X-RAY REDUCTION PROTOCOL**

**Lobectomies, Wedge resections, Pneumonectomies, Esophagectomies, Pleurodesis**

The new protocol will eliminate obtaining "Screening or surveillance" CXRs after the first 2 days. After this time point, CXRs will be ordered for cause only.

* CXRs will be performed for the first 2 days post-transplant while recipient is in the ICU. This includes immediate post-operative and 24 hrs later on postop day 1.
* On post-op day 2 and beyond:
	+ If the patient is still in the ICU, then we will obtain every other day CXR until postop day 10.
	+ If the patient has transferred to CVT, then we will order a CXR twice weekly until discharge, preferably on Monday and Thursday so CXRs can be reviewed by the team at Monday sign-out rounds and before team rotates onto the weekend.
	+ The APP who is transferring the patient out of the ICU is responsible for ordering the ‘Routine’ twice weekly surveillance CXRs as individual orders. They will order 4 CXRs which will cover two weeks of surveillance. Subsequent weeks if required would need to be re-established by new orders.
	+ The Routine CXRs will need to have the comment added "Please perform at 07:00am and do not wake up patient prior to this time" to ensure adequate sleep hygiene and minimize interruptions.
* Additional CXRs may be ordered in both ICU and CVT if clinically indicated or there has been a change in clinical condition.
* All CXRs that are standard surveillance, both ICU and CVT should be ordered as ‘Routine’ and only utilize ‘STAT’ for clinical emergencies. This will further reduce unnecessary costs.
* A ‘routine’ CXR will be performed after a chest tube is removed prior to a second chest tube being removed. No “post-pull” CXR is required unless clinically warranted. Example is patient has a chest tube removed Sunday and has a scheduled routine surveillance CXR Monday, that will suffice as their post pull CXR. However, if the same patient had a CXR pulled Tuesday, before a subsequent chest tube is removed, a ‘routine’ post-pull CXR is warranted. Chest tube removal should not be delayed waiting for scheduled twice weekly CXR.