

# Worldwide Differences in Surgeon Intraoperative Practices for Cochlear Implantation

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## INTRODUCTION

Cochlear implantation is an increasingly performed procedure, with an estimated prevalence of 1 million users worldwide. This number is predicted to increase rapidly as indications continue to expand amongst a highly underpenetrated consumer market.

Although cochlear implantation benefits most recipients with limited aided speech perception abilities, there is considerable variability in word perception improvement among implantees (8.2 to 53.9%). Part of this variability in cochlear implant performance may be due to individual differences in intra-cochlear positioning. Placement complications due to extracochlear electrodes, electrode array kinking, tip roll-over, and translocation across scalae may impart a deleterious effect on clinical outcomes.

Despite published evidence demonstrating that intra-operative functional or radiologic tools may be helpful for hearing preservation and determining final electrode position, there is considerable practice heterogeneity among surgeons. Geographic differences in payment models and healthcare systems may further amplify these differences.

Thus, this study aimed to survey surgeons worldwide to determine intraoperative practice patterns in assessing cochlear implant placement. Study findings better inform professional societies whether there is an unmet need for clinical guidelines for intraoperative measures during cochlear implantation and may help justify payer and governmental coverage for these services.

## METHODS

An anonymous, online, cross-sectional survey was distributed among otolaryngologists actively performing cochlear implantation between 3/1/23-5/6/23. Ninety-seven of the 125 invited participants (78%) completed the survey.

Region	Years in Practice (mean [SD])	Number of Implants per Year by Category (mean [SD])
<b>Africa (n=1)</b>	<b>6.0 [NA]</b>	<b>1.00 [NA]</b>
Algeria (n=1)	6.0 [NA]	1.00 [NA]
<b>Asia (n=23)</b>	<b>19.8 [31.0]</b>	<b>1.95 [0.67]</b>
India (n=3)	13.0 [7.9]	2.00 [0.00]
Iran (n=2)	9.0 [8.5]	2.50 [0.71]
Iraq (n=1)	20.0 [NA]	1.00 [NA]
Israel (n=7)	12.1 [10.2]	2.14 [0.69]
Jordan (n=1)	18.0 [NA]	2.00 [NA]
Malaysia (n=1)	7.0 [NA]	2.00 [NA]
Pakistan (n=2)	12.0 [11.3]	2.00 [0.00]
Tajikistan (n=1)	10.0 [NA]	3.00 [NA]
Thailand (n=1)	15.0 [NA]	1.00 [NA]
Turkey (n=3)	22.5 [11.3]	1.00 [0.00]
United Arab Emirates (n=1)	20.0 [NA]	2.00 [NA]
<b>Europe (n=45)</b>	<b>17.8 [10.2]</b>	<b>2.09 [0.78]</b>
Austria (n=1)	12.0 [NA]	2.00 [NA]
Belgium (n=6)	18.3 [9.4]	2.33 [0.82]
Bulgaria (n=1)	28.0 [NA]	1.00 [NA]
Croatia (n=3)	7.7 [6.4]	1.67 [0.58]
Finland (n=1)	5.0 [NA]	2.00 [NA]
France (n=4)	20.3 [10.5]	2.75 [0.50]
Germany (n=3)	29.3 [5.1]	3.00 [0.00]
Italy (n=4)	25.0 [13.5]	1.50 [1.00]
Latvia (n=1)	15.0 [NA]	1.00 [NA]
Lithuania (n=1)	25.0 [NA]	2.00 [NA]
Netherlands (n=4)	17.0 [12.0]	2.25 [0.50]
Norway (n=1)	10.0 [NA]	2.00 [NA]
Portugal (n=4)	20.0 [10.1]	2.00 [1.15]
Serbia (n=1)	8.0 [NA]	2.00 [NA]
Spain (n=5)	18.2 [12.7]	2.00 [0.84]
Switzerland (n=3)	8.3 [4.9]	2.00 [1.00]
United Kingdom (n=2)	17.5 [6.4]	2.50 [0.71]
<b>North America (n=24)</b>	<b>9.3 [11.5]</b>	<b>1.83 [0.70]</b>
Canada (n=1)	1.0 [NA]	1.00 [NA]
United States (n=23)	9.7 [11.6]	1.87 [0.69]
<b>Oceania (n=3)</b>	<b>14.3 [3.8]</b>	<b>1.67 [0.58]</b>
Australia (n=2)	13.0 [4.2]	1.50 [0.71]
New Zealand (n=1)	17.0 [NA]	2.00 [NA]
<b>South America (n=1)</b>	<b>19.0 [NA]</b>	<b>2.00 [NA]</b>
Uruguay (n=1)	19.0 [NA]	2.00 [NA]

**Table 1. Respondents' Basic Practice Information.**

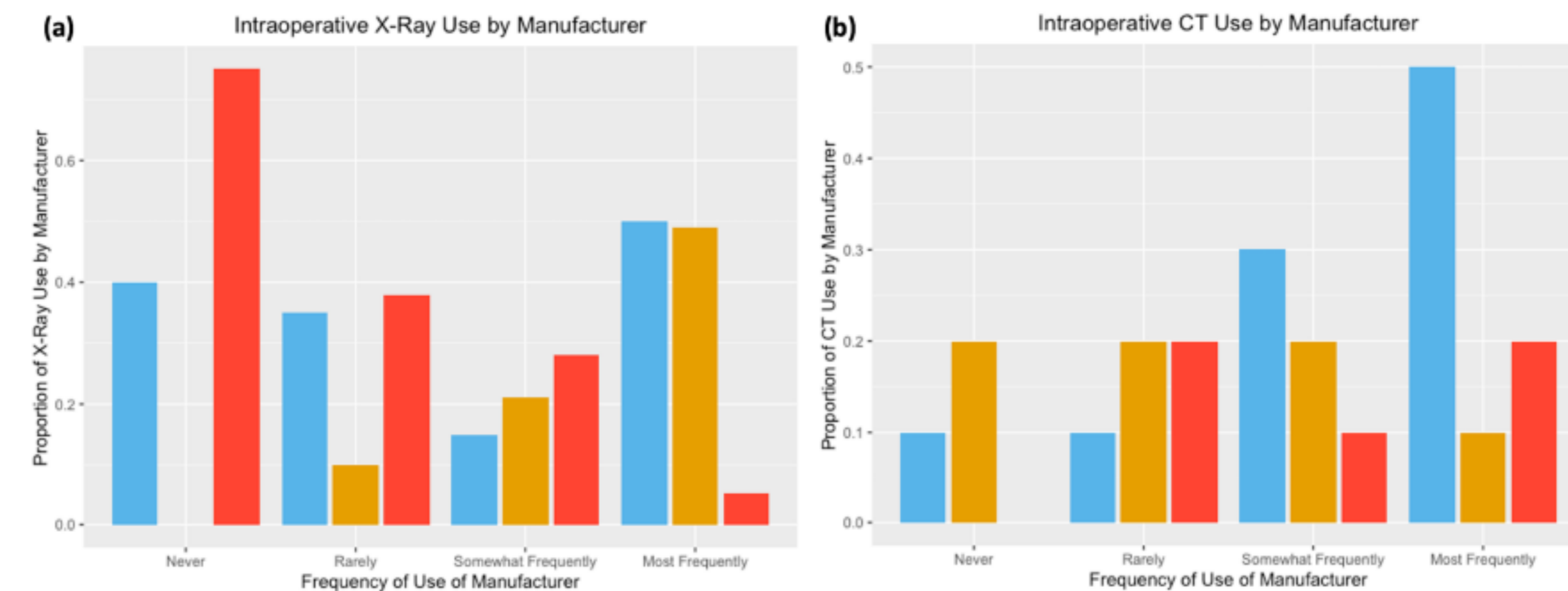
Participants were asked whether they perform less than 20 cochlear implants a year (coded as "1"), 20 to 50 cochlear implants a year (coded as "2"), or more than 50 cochlear implants a year (coded as "3"). Abbreviations: NA – Not Applicable; SD – Standard Deviation.

## RESULTS

Region	% Confirm Placement with Imaging					% Confirm Placement with Electrophysiology				
	X-Ray	Fluoroscopy	CT	Other	None	Impedance	ECAP	ECOG	Other	None
Africa (n=1)	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
Asia (n=23)	9.1%	0.0%	13.6%	4.5%	72.7%	81.8%	90.9%	18.2%	9.1%	0.0%
Europe (n=45)	19.6%	8.7%	17.4%	13.0%	56.5%	87.0%	87.0%	30.4%	23.9%	4.3%
North America (n=24)	70.8%	4.2%	8.3%	0.0%	20.8%	58.3%	70.8%	4.2%	4.2%	25.0%
Oceania (n=3)	33.3%	33.3%	0.0%	0.0%	33.3%	100.0%	100.0%	0.0%	0.0%	0.0%
South America (n=1)	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%
<b>Fisher test (p-value)</b>	<b>&lt;0.001</b>	<b>1</b>	<b>1</b>	<b>0.6</b>	<b>0.02</b>	<b>0.3</b>	<b>1</b>	<b>1</b>	<b>0.7</b>	<b>0.5</b>

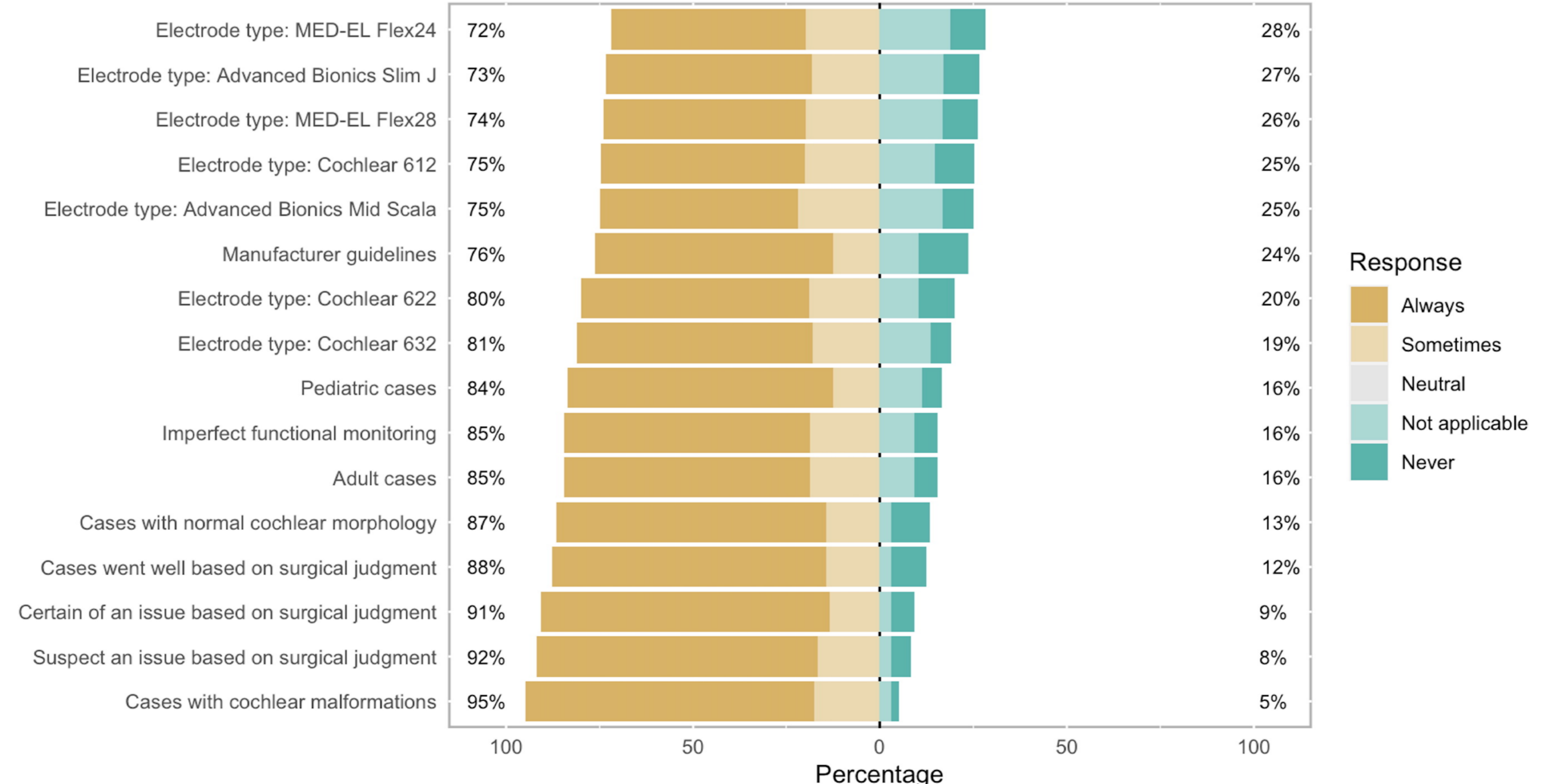
**Table 2. Use of Intraoperative Imaging Equipment and Electrophysiology Tools during Cochlear Implant Surgery.**

Survey participants were asked if they employed intraoperative imaging or electrophysiologic monitoring to confirm the placement of cochlear implant electrodes. The frequency of use of these tools is not reflected in this table. Abbreviations: CT – Computerized Tomography Imaging; ECAP – Electrically Evoked Compound Action Potential; ECOG – Electrocochleography.



**Figure 1. Characterization of Intraoperative Imaging Practices during Cochlear Implantation by Manufacturer & Frequency of Use.** Intraoperative (A) X-ray and (B) CT imaging use were characterized accordingly to the cochlear implant manufacturer and the frequency of use by the participating surgeon. Responses were categorized as: never, rarely (1-33%), somewhat frequently (34-66%), and most frequently (67-100%). Key: Blue = Advanced Bionics; Yellow = Cochlear Corporation; Red = MED-EL.

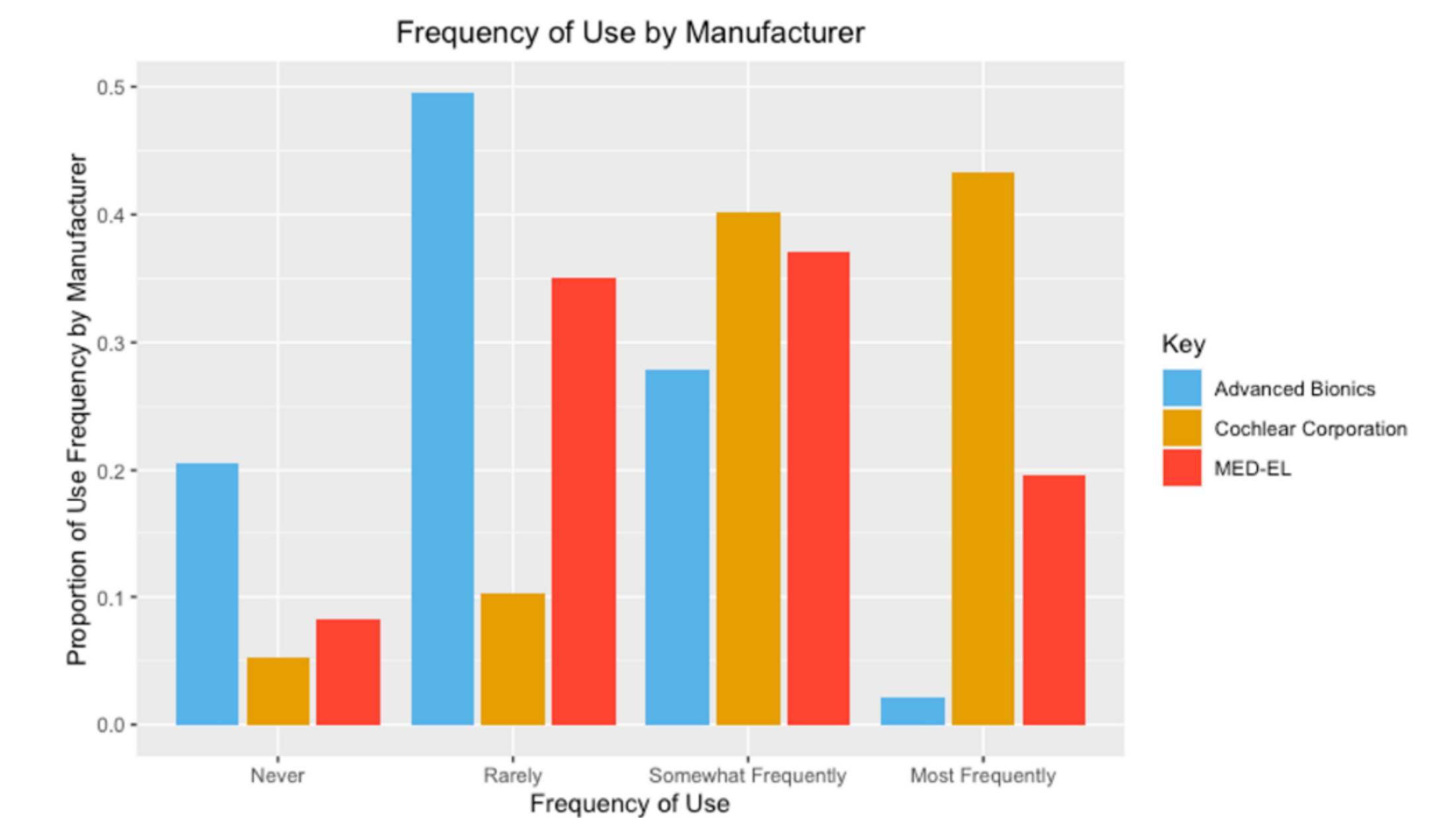
## Indications for Intra-operative Assessment of CI Placement



**Figure 2. Indications for Intraoperative Assessment of Cochlear Implant Placement.**

This Likert Scale plot depicts the respondents' application or lack thereof use of intraoperative imaging and electrophysiologic tools for common clinical scenarios during cochlear implant surgery.

## RESULTS



**Figure 3. Surgeons' Frequency of Use by Cochlear Implant Manufacturer.** Survey participants (n=97) were asked what percentage of the implanted devices consisted of the following three cochlear implant manufacturers. The responses were categorized as: never, rarely (1-33%), somewhat frequently (34-66%), and most frequently (67-100%).

### Effects by Manufacturer

Across regions, Cochlear Corporation was the most frequently used cochlear implant manufacturer, while Advanced Bionics was the least frequently used cochlear implant manufacturer among our study cohort (Figure 1). There was a significant difference in Cochlear Corporation (p=0.003) and MED-EL (p=0.012) use by region. In pairwise comparisons between regions, this difference was significant between North America and Asia (p=0.003, p<0.001, respectively) and North America and Europe (p=0.02, p=0.04, respectively). North American participants used Cochlear Corporation cochlear implants more frequently with respect to the other two manufacturers than European and Asian participants. European and Asian participants implanted MED-EL more regularly with respect to the other two cochlear implant manufacturers than North American respondents.

## CONCLUSIONS

- There are worldwide differences in the use of imaging and electrophysiologic tools during CI surgery
- North American surgeons used intraoperative X-rays more frequently than European and Asian surgeons
- There were no regional differences in the use of intraoperative electrophysiological monitoring.
- Participants from Europe and Asia used MED-EL more frequently than the study participants from North America, who implanted Cochlear Corporation devices more frequently.
- The most common indication for intraoperative assessment was cochlear malformations, followed by surgical judgment
- There is a need for professional guidelines on indications and evidence-based application of intraoperative tools during CI surgery

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