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**Air Force Dental Laboratory Services: Survey of Current Capabilities and Anticipated Need**

**Short title: USAF Dental Labs: Current Capability and Anticipated Need**

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**Structured Summary:**

**INTRODUCTION:** The adoption of digital dentistry, including computer-aided design (CAD) software and computer-aided manufacturing (CAM), has led to faster, safer, and more reliable treatments, and digital implant planning with the use of cone-beam computed topography (CBCT) scans and printed surgical guides has improved accuracy and precision while decreasing complications. There is an increasing trend towards outsourcing laboratory services overseas due to the rapid transition to digital dentistry and the costs associated with acquiring technology and training technicians in new procedures.

**MATERIALS & METHODS:** This study aims to assess the demand for dental laboratory services in an Air Force and identify any existing gaps. The study involved gathering dental laboratory-supported codes from 2019-2020, and a survey was conducted among active-duty Air Force dental providers. The survey was distributed electronically, and responses were collected and analyzed using descriptive statistics.

**RESULTS:** Overall, 55% of respondents felt that laboratory support positively affected their productivity, while 31% felt it limited it. Satisfaction with available technology was high, with 69% of respondents satisfied with CBCT, digital scanners, CAD/CAM, and digital planning software. The majority of respondents felt laboratory technicians have inadequate training. Only 39% of providers credentialed in implant placement felt comfortable teaching digital implant planning, and 80% of credentialed providers would be willing to use a remote implant planning service if it was instituted. When observing coding data active-duty patients were 65% less likely to receive a complete denture than non-active-duty patients. In addition, bases without a prosthodontist account for 85% of off base referrals. Bases with prosthodontists average a savings of roughly \$78,000 in referrals of CBCT, fixed prosthodontics, implant services, removable prosthodontics, and other surgical procedures.

**CONCLUSION:** In relation to the objective of this paper, the following gaps were identified: inadequate laboratory technician training, competence/confidence in the use of implant planning software, the need for non-active-duty patients for maintenance of competence in removable procedures, and ADDP expenditures at some bases that could be avoided with the purchase of a CBCT machine. Air Force dental providers are generally satisfied with the level of lab support and technology available at local labs, but less satisfied with regional and area dental laboratories. There is a consensus that lab technicians lack adequate training, and if dental laboratories are consolidated, there should be an emphasis on technical competence and increased training opportunities. Dentists' freedom to treat non-active-duty patients is reported as necessary to maintain competency, especially in removable procedures. A laboratory-based implant planning and surgical guide service is a potential unmet need in the Air Force dental laboratory service that could increase efficiency in care. Overall, the Air Force dental laboratory service has done well in keeping up with the needs and technological advancements.

**Data Availability Statement:** The data underlying this article were provided by the USAF Dental Research and Consultant Service in accordance with USUHS IRB guidelines. Data will be shared on request to the corresponding author with permission of the Defense Health Agency.

**Keywords:** Laboratories, Dental; Dental Care Team; Dental Clinics; Dental Facilities; Dental Health Services; Dental Implantation; Dental Offices; Dental Staff; Dental Technician; Dental Group Practice; Dental Practice Management; Dental Specialties

## INTRODUCTION

Dental laboratories are an indispensable adjunct to the practice of modern dentistry. As of 2019, there are approximately 9,600 dental labs in the United States, and 13 Commission on Dental Accreditation (CODA) accredited dental technician programs (1). According to the U.S. Bureau of Labor Statistics, there are roughly 4.4 dentists for every one dental lab technician in the United States (2, 3). As of 2019 (the last year of data collected for this article) there are 998 dentists and 416 lab techs for a ratio of 2.4 dentists for each dental lab technician in the USAF. The DOD shares one CODA-accredited program for active-duty dental laboratory technician trainees.

The progression of digital dentistry is evolving quickly, and dental professionals who adopt these scientifically tested and proven advancements may be able to offer superior care than in the past (5). Many of these advances have led to faster, safer, more comfortable, and more reliable treatments (5,7). On the other hand, commercial dental companies' data-gathering hardware (intraoral and laboratory optical scanners, CBCT), computer-aided design (CAD) software, and computer-aided manufacturing (CAM) will drive workflows (6). Due to the expense, there are more larger laboratories, fewer small laboratories, and a trend to outsource work where labor is less expensive (4).

Research and technological advances have also laid the foundation for improvements in both surgical technique and success rates of dental implants. In recent years, dental implants have become an integral part of practice (17). The McGill consensus statement on overdentures goes so far as to assert that mandibular overdentures are the standard of care for treatment of edentulous mandibles (10).

This shift required the support side of implant dentistry to evolve to accommodate the increase in implant placement. Advances such as digital implant planning with the use of cone-beam computed topography (CBCT) scans and printed surgical guides have increased accuracy and precision while decreasing complications (13-15). Among the many benefits of digital advancements, the use of a guided system allows for flapless implant placement with advantages such as: shorter procedure time, minimal bleeding, no need to place or remove sutures, lower patient morbidity, and a reduction in the incidence of surgery-related bacteremia (14).

Some civilian dental laboratories have developed remote digital implant planning services. The laboratory collects data files from providers, including CBCT scans and patient records. With the lab work authorization, the technician completes the setup and schedules a virtual consultation with the provider to discuss specifics of the case. When the plan is finalized, surgical guide design and 3D printing begins (16, 18). This service allows providers a guided implant surgery experience without the loss of chair time typically associated with digital planning and surgical guide fabrication.

The Air Force has its share of larger labs. The Area Dental Laboratory (ADL) at Peterson AFB Colorado has three Cerec MCX5 milling units, three Cerec MCXL milling units, seven Sirona inEos X5 scanners, three Sirona inlab workstation, one Form 2 3D printer, one Form 3 3D printer, one 3Shape Performa, one Imes-CORE Coritec 350I PRO 5-axis wet mill, two 3Shape E4 scanners, three Asiga freeform Pro 3d printer, one DOF UHD Scanner, two Imagine milling technologies, one Coritec 350I Pro 5 axis mill wet/dry, two blue sky bio modules, and one Fujifilm Finepix S3 pro digital as indicated by the director, Lt Col Ryan Sheridan (DMD, MS email communication, March 2023). Certain workflows are centralized at the ADL or Lackland, for instance RPD fabrication. Some bases have 5-axis milling units, but the ADL is the centralized source where base labs can send more complicated prostheses for fabrication. The stereolithography lab at Lackland AFB offers 3D printing of surgical guides and other prostheses and functions as an ad hoc ADL for this purpose.

Within the DOD, the Fort Gordon ADL offers to other services the ability to interface with implant companies Nobel Biocare (Yorba Linda, CA) and Zimmer Biomet (Miami, FL) for fabrication of titanium and zirconia custom abutments and bar prostheses. They have recently begun fabricating titanium bars, and have a Programill PM7 which is capable of milling monolithic dentures (Ivotion, Ivoclar-Vivadent, Amherst, NY) (LTC Sloan McLaughlin, DMD, email communication, July 2021).

In the USAF, laboratories have not only a production mission but also a training mission. In January 2013, the Director of Air Force Dental Operations established eleven training bases where recent dental lab tech school graduates would be stationed to receive additional training. Unique to the USAF, dental technicians must pass written tests and on-the-job training requirements in order to progress in specialty-level and rank and continue serving. There are currently 346 enlisted dental lab technicians in the Air Force at an approximate cost of \$64K per trainee (Mr. Gary Johnson, CDT, TE, BSHCA, Program Director, Medical Education and Training Campus, in-person communication, January 2021).

With this dual mission, dental laboratories offer many services to dentists throughout the Air Force. The purpose of this study is to investigate dentists' coding for clinical practice that involves dental laboratory support, and a survey of their perceived need of dental laboratory services relative to what is currently available. This information may assist Dental Corps leadership in making data-driven decisions and determine whether there is a gap in dental laboratory services offered.

## **MATERIALS AND METHODS**

### **Dental Coding**

Dental laboratory-supported codes were gathered for all dentists working in an Air Force dental treatment facility. This includes civilian, contract, Air Force, and non-Air Force active-duty. This information was gathered from Corporate Dental Application (CDA) and included the number of implants placed, fixed restorations, and removable prostheses delivered in order to give a more complete picture of the demand for dental laboratory services and potentially be repeated in the future to establish trends as demonstrated by previous studies (11, 19-21).

### **Survey**

A survey comprised of 35 questions was created using the website "www.surveymonkey.com". A current list of active-duty Air Force dental providers was obtained from each respective Specialty Consultant. The survey was distributed electronically via email to all active-duty Air Force Comprehensive Dentists, Oral Surgeons, Periodontists, and Prosthodontists (n = 343). Residents were excluded from the survey. A pilot survey was conducted within the Air Force Post Graduate Dental School in order to discover errors in the survey and/or unclear questions which were revised as needed prior to dissemination to the targeted demographic.

The finalized survey was designed so that it could only be completed once. The survey consisted of two sections: 1. demographics and 2. questions about dental laboratory and implant planning support. It was designed such that progress can be saved and the survey completed at a later time.

Follow-up emails were sent to providers who have not responded at monthly intervals, until the survey closed after a period of three months. Survey responses and data pulled from CDA were collected and input into Microsoft Excel. The accumulated data was analyzed via descriptive statistics.

**RESULTS**

**Survey**

A total of 136 providers responded for a response rate of 39.7%. Not all respondents answered every question. Response rates and demographics are depicted in **Table 1**.

<b>Category</b>	<b>Answer Choices</b>	<b>n</b>	<b>%</b>
<b>Response Rate</b>	<b>Overall (n=343)</b>	<b>136</b>	<b>40</b>
	Comprehensive Dentist (n=200)	52	26
	Oral Surgeon (n=40)	12	30
	Periodontist (n=52)	30	58
	Prosthodontist (n=51)	42	82
<b>In charge of laboratory...</b>	Yes, as OIC (additional duty)	9	7
	Yes, Flight Commander	30	22
	Not currently, but was in the past	30	22
	I am not in charge of a laboratory	67	49
<b>Primary Duty Type</b>	Clinical	67	49
	Teaching	26	19
	Admin w/ Pt Care	31	23
	Admin w/o Pt Care	12	9
<b>Residency Graduation Year</b>	Before 2013	50	39
	2013-2017	43	34
	2018-present	34	27
<b>Residency Program</b>	Air Force	116	86
	Civilian	19	14
<b>Total Years Practicing Dentistry</b>	Median	13	n/a

**Table 1: Depicts response rate and demographics of survey respondents.**

Dental laboratory-related results can be found in Table 2:

Air Force Dental Laboratory Services: Survey of Current Capabilities and Anticipated Need

Question	Answer Choices	n	%
How does your current level of lab support affect your productivity?	Strongly limits	11	8
	Somewhat limits	31	23
	Neither limits nor supports	17	13
	Somewhat supports	40	30
	Strongly supports	36	27
How does your current level of lab support affect your access to care?	Strongly limits	9	7
	Somewhat limits	24	18
	Neither limits nor supports	40	30
	Somewhat supports	29	21
	Strongly supports	33	24
Do you feel laboratory technicians, in general, have adequate training?	Yes	39	29
	No	71	53
	Unsure	25	19
Please rate your level of satisfaction with laboratory support in your local clinic	Strongly dissatisfied	4	3
	Somewhat dissatisfied	21	16
	Neutral	12	9
	Somewhat satisfied	47	35
	Strongly satisfied	46	34
	N/A	5	4
Please rate your level of satisfaction with laboratory support available via regional and area dental labs	Strongly dissatisfied	9	7
	Somewhat dissatisfied	16	12
	Neutral	26	19
	Somewhat satisfied	33	24
	Strongly satisfied	24	18
	N/A	27	20
Please rate your level of satisfaction with currently available technology in your local clinic	Strongly dissatisfied	11	8
	Somewhat dissatisfied	19	14
	Neutral	8	6
	Somewhat satisfied	49	36
	Strongly satisfied	45	33
	N/A	4	3
How often do you send cases to the Peterson ADL?	Never	62	46
	1-10 times per year	45	33
	11-15 times per year	12	9
	16-20 times per year	7	5
	>20 times per year	9	7
How often do you send cases to the Army ADL (Ft Gordon)?	Never	96	71
	1-10 times per year	35	26
	11-15 times per year	3	2
	16-20 times per year	1	1
	>20 times per year	0	0
How often do you send cases to Lackland AFB?	Never	89	65
	1-10 times per year	32	24
	11-15 times per year	3	2
	16-20 times per year	0	0
	>20 times per year	12	9
How often do you send cases to another regional dental lab?	Never	113	84
	1-10 times per year	12	9
	11-15 times per year	1	1
	16-20 times per year	2	1
	>20 times per year	6	4
If you do not utilize services of these regional laboratories now, do you plan to in the future?	Yes	17	13
	No	54	40
	I currently utilize some or all of these services and plan to continue	60	44
	I currently utilize some or all of these services and plan to stop	5	4

**Table 2: Summary of survey questions related to dental laboratories**

## Air Force Dental Laboratory Services: Survey of Current Capabilities and Anticipated Need

When asked about plans to use regional labs, 92% of respondents currently using some or all of the services plan to continue and 8% plan to stop. For respondents not currently using the regional labs, 24% indicated plans to use them in the future while 76% do not.

When asked to elaborate on why they did not use regional labs, 23% reported that their local lab is sufficient, 15% poor work quality, 14% extended turnaround times, 13% inadequate quality control, 12% unaware of services offered, and 11% inadequate training of lab technicians. In addition, 9% reported that they didn't use either local or regional lab at all.

When asked for additional comments regarding lab support, 35% of comments mentioned that laboratory technicians do not receive adequate training, 14% stated that additional duties and/or promotion hinders job proficiency, and 8% referred to the need for updated training as well as inefficiency in the lab. A few comments mentioned that lab technicians often get filtered into one specific area of expertise and aren't well rounded, high turnover rates are detrimental to success, and that civilian presence should be increased or that all positions should be converted to civilian. Other negative sentiments included a perceived lack of incentives for technical excellence, but rather incentives to work outside of the lab to procure promotion opportunities.

When asked an open-ended response to what CAD/CAM capabilities respondents would like to have that is not currently available at the local level, the top responses were digital implant planning and design (34%), full mouth digital sculpting (19%), and digital smile design (14%). Some requested more complex implant restoration design (8%) such as full-arch restorations, angulated screw channel, and non-engaging Ti-bases for screw-retained implant FPDs. By-name requests for software included exocad (8%), inLab (3%), and 3Shape (2%). Some respondents mentioned that they already had what they need (17%), while 8% indicated it took significant effort to obtain what they have, and 10% requested more training for themselves or lab techs. Some requested items already available at other clinics, such as chairside scanning (8%), 3D printing (9%), and 5-axis milling (3%).

The most common comments regarding available technology were concerning the need for standardization between bases (20%), the constant need for upgrade training (14%), problems with DOD computer incompatibility (12%), the need to utilize technology more across the force (10%), the need for more open source options (10%), and the difficulty associated with purchasing or getting technology repaired in the military (8%). Additional comments included how technology has improved turnaround times and readiness and that upkeep and technological retirement need to be considered when purchasing new technology.

The vast majority (88%) (120/136) of respondents reported being involved in dental implant planning and/or placement, with 90% (90/117) being fully credentialed in the surgical placement of dental implants. When asked to rate their "level of confidence using implant planning software to make surgical guides," the majority (65%) are able to work independently; 39% of them felt confident enough to teach, whereas 26% needed occasional help, 8% direct supervision, and 2% were not sure where to start. When asked if they would "let a lab technician propose implant position on straightforward cases for me to change as needed and approve," 80% (93/117) said yes, with 52% (62/116) reporting they would either complete more cases or the same amount but would be interested in the service. Many are interested in implant planning of multi-unit or full-arch cases; 60% (69/115) would use such an Air Force concierge service, and approximately 12% (14/117) of surveyed providers are currently using civilian lab concierge services such as nSequence, Blue Sky Bio, Nobel Biocare, Bellatek/3i, Anatomage, Implant Concierge, and Smile-in-a-box. Half (50%) report these costs as <\$1000 per year, but 42% report they are unsure of the cost and some (7%) report these costs up to \$10,000 per year.

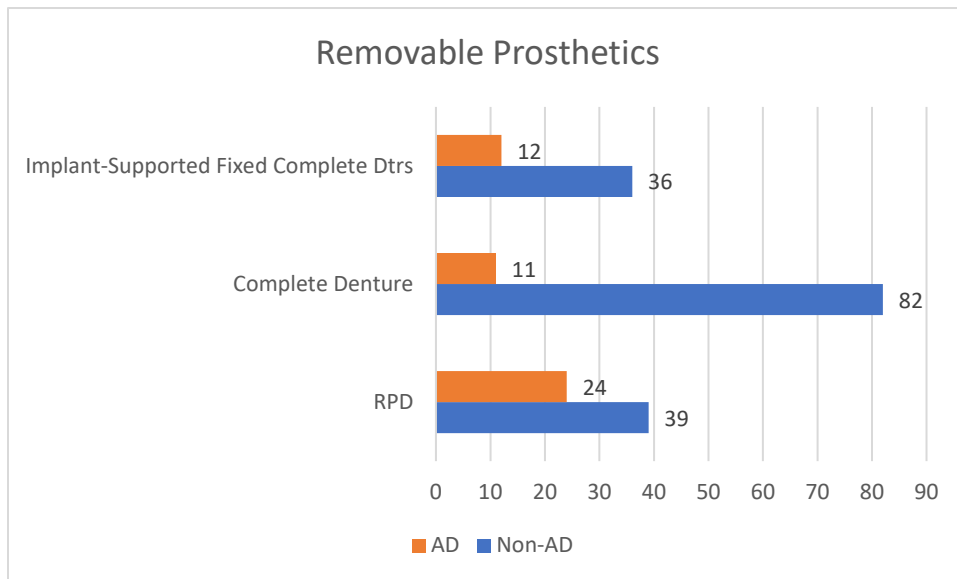
In terms of dental laboratory supporting the ability to provide implant treatment, 58% reported a positive effect, 12% reported a negative effect, 25% were neutral, and 5% stated “N/A.” Logistics support was reported as 45% positive, 33% negative, 20% neutral, 2% N/A. A slight majority (55%, 65/117) agreed with the statement: “The restorative dentist is often a limiting factor for how many implants can be placed and restored in my clinic.” In addition, 67% (79/117) agree that the treatment of non active duty patients is required in order to be able to plan and restore implant-supported fixed complete dental prostheses. If they had access to implant concierge services, 38% (44/117) of respondents reported that they would perform more full-arch implant-supported fixed restorations.

**Dental Coding**

In the data acquired from CDA, the following dental laboratory supported procedures were performed by Air Force dental providers in fiscal year 2019, on active duty (AD) and non-active duty (non-AD) patients.

**Removable**

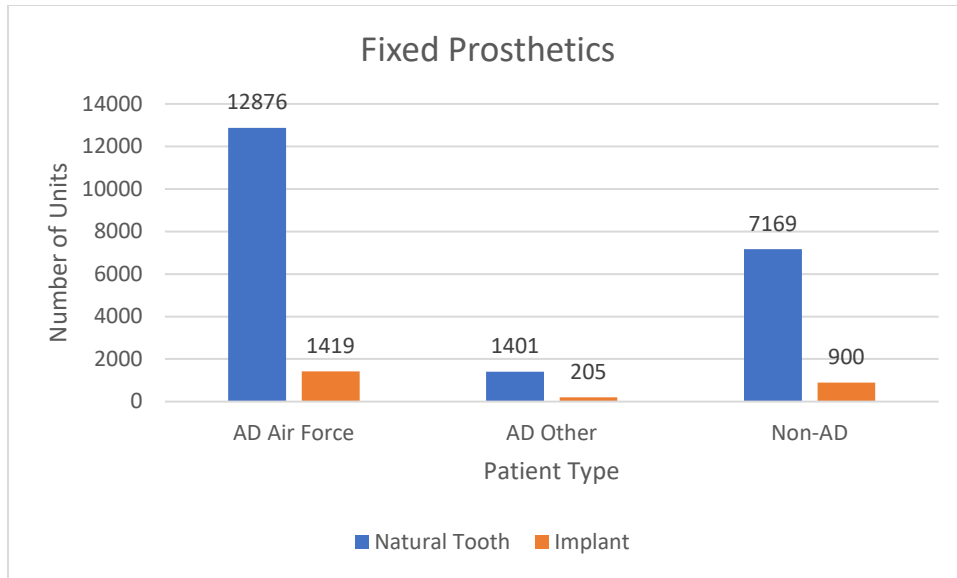
Approximately 5.13% (8/158) of removable cases included implants. Of the implant supported full arch prostheses, 91% (40/44) were fixed with only 9% (4/44) removable. Of these 44 full arch restorations on implants, 73% (32/44) were on non-AD patients. When looking at removable partial dentures with and without implants, 62% (39/63) were completed for non-AD patients, with 6.3% (4/63) including implants. In terms of statistically significant results, a Poisson Regression was performed to examine differences in incident-rate ratios for receiving a complete denture between AD and Non-AD patients. AD patients were 65% less likely to receive a complete denture than non-AD (P=0.003).



**Figure 1: Removable prostheses completed on AD and non-AD patients**

**Fixed**

When observing natural tooth fixed units completed by Air Force dental providers, 60.04% (12,876/21,446) were completed on AD Air Force service members, 6.53% (1,401/21,446) on AD Army or Navy servicemembers, and 33.43% (7,169/21,446) were completed on non-AD patients.



**Figure 2: Fixed prostheses completed on AD Air Force, AD other, and non-AD patients.**

**Implant**

Similar statistics were noted with implant fixed units, with 56.22% (1,419/2,524) completed on AD Air Force, 8.12% (205/2,524) on AD Army or Navy, and 35.66% (900/2,524) on non-AD patients.

A total of 3094 implants were placed by Air Force providers in FY19. Prosthodontists represent 12.2% (42/343) of providers in the Air Force with the ability to place implants, and placed 3.17% (98/3094) of all implants. A Poisson Regression was also performed to examine the number of CDT D6010 codes reported between prosthodontists and non-prosthodontists. Prosthodontists were found to report D6010 31% less than non-prosthodontists (P=0.004).

**ADDP Data**

When comparing the 40 bases without prosthodontists to the 11 bases with prosthodontists, the 40 bases without totaled 25,215 procedures and \$8,200,000 in ADDP expenditures per year while the 11 bases with prosthodontists totaled 5,748 procedures and \$1,400,000 in ADDP expenditures. This translates to an average of 630 procedures and \$205,000 per base without a prosthodontist versus 523 procedures and \$127,000 per base with a prosthodontist. Bases without a prosthodontist account for 85% of off base referrals and average \$16,000 per base per fiscal year in off base CBCT imaging costs.

## **DISCUSSION**

Prosthodontists had the highest response rate (82%), possibly because of their higher level of involvement and dependence on quality lab work. The respondents surveyed appear represent a reasonable cross-section of surgical and restorative specialists and advanced general dentists across clinical, admin, and teaching roles, many of whom have been responsible for dental laboratories.

### **Survey Results**

#### *- General Dental Laboratory Satisfaction*

Survey respondents in general were satisfied with the level of support they had at their local clinic (69%). Many indicated that their laboratory positively affected productivity (55%). However, satisfaction with regional and area dental labs was lower at 42%. Some (24%) reported that their current level of lab support limits their access to care, indicating a possible need for improvement in turnaround times from local base laboratories. A contributing factor to delayed turnaround times may be the skill level of laboratory technicians, as 53% of survey respondents thought laboratory technicians did not have adequate training. This indicates a potential need to revisit and update the training curriculum or enhance training opportunities. Currently at Fort Sam Houston, supplemental training is offered on a regular basis in implant (23), porcelain (24), and removable (25) workflows. Low manning was also a concern noted among 5% of those surveyed, and 4% answered "N/A" indicating they might have no local lab support.

Another means to increase efficiency is to increase the use of technology (27). While several respondents reported satisfaction with available technology, a significant minority reported the need for better technology or better-trained lab techs and assistants to facilitate the use of technology. Several reported local barriers including IT, funding, time investment, and lack of knowledge of how to procure equipment.

Regarding utilization of area and regional dental labs, the majority (54%) use the Air Force (Peterson) ADL. A majority (71%) do not use the Army (Ft Gordon) ADL; however, 3% use it over 10 times per year. Although it is not a regional laboratory, 35% of respondents also reported sending cases to Lackland AFB laboratory, with 9% reporting usage over 20 times per year. This is more than any other regional laboratory available to Air Force personnel. This supports the current push to convert it into a regional laboratory. Of the 21 additional comments on the subject, 12 mentioned either Ramstein or Kadena Regional Dental Laboratories, 4 utilized other CONUS base labs, and 4 mentioned use of civilian lab services.

The main reason (23%) reported for disuse of area of regional labs was that the local lab support was sufficient, corroborating higher satisfaction values with local labs. In addition, providers seem to be satisfied with the current level of technology available at their local bases, which reflects well on the Air Force's ability to provide the best treatment and technology for its patients and providers. Any future changes to dental laboratories should keep in mind that local dentists may wish to maintain local control in order to keep up satisfaction and quality.

#### *- Implant Planning*

The survey results concerning digital implant planning capabilities of providers indicate an unmet need for more training of providers to increase the utilization of guided surgery and so that they may train others under them, both provider and technician. The incorporation of a remote laboratory service could potentially alleviate this issue allowing for surgical providers to place more implants. Despite placing a low percentage of all implants, prosthodontists are involved in the restoration and/or planning of a much higher percentage of implant restorations. Most survey respondents felt restorative providers are the

limiting factor to completing more implant cases (or more quickly), which indicates a need for increased efficiency in restorative based implant planning as well as implant restoration. With the prosthodontists spending less time creating restoratively driven implant plans, they could complete an increased number of implant restorations again increasing overall productivity.

Saving thousands each year on implant planning services could be another benefit to creating an Air Force based implant planning service. The Air Force currently uses Blue Sky Bio; the software is free but each surgical guide costs \$20 per export. Exoplan's commercial cost is \$575 per year plus a \$3,425 sign-up fee. Depending on the number of cases being completed, it may be beneficial to switch from a cost-per-export program to a different software with a flat fee at base(s) that house the concierge service or plan more than 200 cases per year, or 29 per year to cover the yearly fee only. While an in depth, per base cost-analysis would be necessary to fully assess the financial benefits, it could be possible to establish multiple concierge services at regional labs and maintain the Blue Sky Bio capabilities at local laboratories. In addition, 12% (14/117) of providers surveyed reported spending government funds to purchase civilian implant planning services for some cases with 8% (9/110) reporting spending more than \$1,000 per year on these services. With 3,094 implants placed by Air Force personnel in the year studied, this change has the potential to yield significant cost savings with no loss of capability.

### ***Clinical Data***

#### **Removable**

Services least required were for removable and total edentulous situations: less than 1 in 10,000 members require complete dentures (11), implant-supported fixed complete dentures (12), or RPDs (24). This can be attributed to DHA dental disqualification criteria for new recruits as well as a generally young and healthy active-duty population. The low number of removable prosthodontic cases among the active-duty population indicates an increased need for non-active-duty patient treatment to be completed to allow prosthodontists and laboratory technicians to maintain their clinical competency.

#### **Fixed Prosthesis**

With a total active-duty population of 329,000 Airmen in the fiscal year 2019, one can estimate the utilization of dental services per year per member. Fixed units on natural teeth predominate at 3.9 units per 100 members (12,876/329,000). This number is lower than the 1.7 per new recruit projected by Knudson et al (26). The needs of new recruits can be expected to be higher than active-duty members who have had consistent quality dental care and mandated annual exams.

#### **Implant**

Next is implant fixed units at 4.3 units per 1,000 members (1419/329,000). This service may not be available at all bases, and ADDP requires pre-approval. The total ADDP expenditure cost from 2019-2020 was \$1.2M for implant placement. The implementation of an implant concierge service, as mentioned above, could potentially make it possible to decrease the number of implant placements referred off-base.

#### **ADDP Data**

Prosthodontists offer a unique capability to the Dental Corps, having been trained in both advanced restorative techniques, and the dental laboratory techniques required to support them. The value may be difficult to quantify, but it is interesting to note ADDP expenditures were on average 38% lower at bases with versus without a prosthodontist. While it's not feasible or practical to have a prosthodontist at every

base, a possible cost savings was identified with the purchase of CBCT imaging machines for bases with high ADDP expenditures in this category.

According to Asset Management in Radiology (22) CBCT scanners should be replaced approximately every 8 years. With the cost of CBCT imaging machines to be \$108,450, it would take 6.6 years for a CBCT machine to pay for itself on average given these statistics. This indicates a potential unmet technology need and a potential long term cost savings to purchase CBCT machines for bases without prosthodontists on the higher end of the average CBCT expenditures. Assuming an 8-year lifespan of a CBCT machine, a total of \$920,584 in ADDP expenditures could be saved across all non-prosthodontist bases. With further evaluation of the data, targeting CBCT purchases for bases with higher ADDP referrals would yield a higher return on investment.

## **CONCLUSION**

In relation to the objective of this paper, the following gaps were identified: inadequate laboratory technician training, dentist competence/confidence in the use of implant planning software, implant concierge service, the need to treat non-active-duty patients for maintaining competence in certain procedures such as removable prosthetics, and ADDP expenditures at some bases that could be avoided with the purchase of a CBCT machine.

In general, most Air Force dental providers in the specialties surveyed are satisfied with the level of lab support and technology available at local labs. Despite this, satisfaction with regional and area dental laboratories was considerably lower. There seems to be a consensus that laboratory technicians, at both local and regional/area labs, do not have adequate training to complete their duties and generate acceptable final products. If dental laboratories are consolidated, there should be an emphasis on technical competence and increased training opportunities.

A large percentage of providers credentialed in implant placement are not competent in the use of digital implant planning and guide fabrication software, which tends to place the burden on the restorative provider, often the prosthodontist. A laboratory-based implant planning and surgical guide service is a potential unmet need in the Air Force dental laboratory service that could increase efficiency in care. In addition, dentists' freedom to choose to treat non-active-duty patients appears necessary to maintain competency in removable procedures for both prosthodontists and laboratory technicians.

Overall, the Air Force dental laboratory service has done well in keeping up with the needs and ever advancing technology, but there is always room for continuous process improvement. The individuals surveyed - clinical dentists, residency faculty, and local/regional dental lab leaders - have first-hand knowledge on appropriate use and training of current and future technology. These individuals should have key input to committees and other decision-making bodies about incorporating future technology and training platform requirements for dentists, assistants, and laboratory technicians. Centralizing purchasing and standardized training on hardware and software across the enterprise may overcome some of the local hurdles to acquiring technology. If the unmet needs identified in this study are further investigated and addressed it will benefit patients, providers, and technicians while potentially bringing a cost savings to the Air Force as well.

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