Impact of the University of Colorado's Advanced Clinical Training and Service (ACTS) Program on Dental Students' Clinical Experience and Cognitive Skills, 1994–2006

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Abstract: The University of Colorado Denver School of Dental Medicine has operated a community-based dental education program for all of its students since 1985. A database of student productivity has been maintained in a standardized format, capable of multiyear compilation, since 1994. This study utilizes twelve years of these data to profile the type and amount of clinical treatment that can be provided by a typical fourth-year dental student during a 100-day community-based training experience. Between 1994 and 2006, the school's 423 graduates provided a mean of 922 treatment procedures per student at a mean of 498 patient visits per student. During a typical four-week clinical affiliation, each student provided a mean of approximately twenty-seven restorations on permanent teeth, sixteen restorations on primary teeth, and twenty-four oral surgery procedures (extractions). Students also gained considerable experience in periodontics, fixed and removable prosthodontics, and endodontics. Self-assessed competency ratings tended to increase after completing the program, as did willingness to treat underserved populations after graduation. About 16 percent of graduates reported planning to practice in the public sector after completing dental school. A community-based experience such as this appears to offer an opportunity to substantially augment dental students' clinical training experiences.

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Because interest in providing community-based clinical experiences to dental students remains high, it is increasingly important for the literature to provide specific information about the amount and depth of clinical experience available in these settings. Relevant indicators for the nature of the experiences available include the amount of time that students are assigned to practice, the number of patient visits, and the mix of services provided in community settings. Because time spent in the community often displaces time spent in school-based clinics, these clinical outcomes may be of great interest to dental educators.

Cognitive outcomes are of course extremely important as well. More is involved in a high-quality community-based education program than clinical outcomes. Numerous reports indicate that such programs can result in positive attitudinal changes

toward treating people who are culturally or physically different.[1-4] Another valuable outcome measure may be found in observation of changes in student self-assessments of competence. Both improvement in confidence and reduction of overconfidence have been cited as positive outcomes of experience and feedback.[5]

The literature currently provides a greater depth of information on cognitive outcomes than on clinical outcomes. Although some clinical information is becoming available, the literature does not currently provide detailed, multiyear information about dental students' clinical experiences in a long-duration community-based program. This report is designed to increase the depth of such information on clinical and cognitive outcomes of community-based clinical experiences for dental students.

Community-Based Clinical Dental Experiences

The amount of time that students spend practicing in the community varies considerably among North American dental schools. A 2002 survey of academic deans at North American dental schools found that 64.3 percent of schools required some amount of community-based clinical treatment experience.[6] This survey specifically excluded community experiences other than provision of dental treatment. The duration of community-based treatment experiences during senior year varied from one to five weeks (excluding the University of Colorado, which required twenty weeks). Only 17.9 percent of responding schools required all of their students to complete six weeks or more in the community during their final year. More than half of the respondents reported that their institution planned to increase the amount of patient care provided by their students at community-based sites in the future.

Holmes et al.[7] surveyed dental schools' clinical affairs administrators at about the same time, but used a definition for community-based experience that may not have been as explicitly limited to provision of clinical treatment. They reported that 94 percent of schools had a required extramural program in which students spent between three and 100 days (Colorado included), with a median of twenty days. Thirty-eight percent of these respondents indicated that community-based experiences occurred primarily within the final year of the curriculum.

In 2001, the Robert Wood Johnson Foundation, the W.K. Kellogg Foundation, and The California Endowment committed resources to the Pipeline, Profession, and Practice: Community-Based Dental Education program aimed at creating sixty-day, non-elective community-based dental education programs at fifteen dental schools in the United States.[8] A comprehensive evaluation of the Pipeline program was published in February 2009 as a special supplement to the *Journal of Dental Education*. That 358-page publication provided considerable detail on outcomes among the Pipeline program participants. In that supplement, Gutierrez et al.[9] from the Pipeline program's National Evaluation Team provided a summary of several key structural measures describing experiences at those fifteen schools. For example, they reported that between eighteen and sixty days per student were spent providing treatment in community-based dental clinics (a mean of forty-one days per student). The experiences were rated as "positive" or "very positive" by 50 to 87 percent of participating senior dental students (mean of 69 percent).

Other valuable indicators of the amount of experience available are the number of patient visits and the mix of services provided. During multiple two-week (ten-day) community-based assignments at the University of Alberta,[10] each dental student was graded on a mean of 36.4 (first assignment) to 43.2 (subsequent assignments) patient "cases" or visits (means of 80.8 and 86.4 procedures, respectively). During the first and subsequent assignments, some of the treatment included a mean per student (respectively) of 12.0 and 15.2 examinations, 10.1 and 14.8 amalgam restorations, and 11.9 and 18.9 tooth-colored restorations, as well as 7.0 and 9.7 extractions per two-week assignment.

A study published in 2005 reported clinical experiences for students who participated in a community-based program at the University of Medicine and Dentistry of New Jersey over an eight-year period.[11] Comparisons were made between those sixty-three students and the experience of 572 graduates of the same school who were not in the program. In place of the actual numbers or types of procedures in each category, the authors utilized the institution's "relative value unit" point-scale to measure volume and grouped experiences into eight clinical categories to measure service mix.

Although those data cannot be directly related to specific types and numbers of procedures, they are instructive. The greatest mean number of relative value units among community-based students was

reported to be in general dentistry and oral diagnosis. Community-based students had twice the number of relative value units in operative dentistry as their school-based counterparts. The smallest means were in the categories of oral surgery and prevention, but the mean numbers of relative value units in these categories were 3.3 and 2.8 times greater, respectively, than these means for school-based students.

Another study reported the actual numbers of patient visits and specific procedures provided in the Pipeline program experience at The Ohio State University during a single academic year.[12] Those data described periods of community-based practice for 102 students, with mean duration of 46.4 days. These students' productivity in community-based clinics was twice their productivity in their school clinic. They had a mean of 116 patients and 264 treatment procedures during their community-based experiences. The most frequently provided treatments in that program were sealants, extractions, and one-surface posterior resin restorations. The least frequently provided treatments were pulpotomies and four-surface anterior resin restorations. In that program's community-based clinics, students performed fourteen of the twenty-five procedures that were most frequently provided at their school clinic.

University of Colorado Denver Program

The University of Colorado Denver (UCDenver) data reported here describe a twelve-year period of implementation and monitoring for a community-based treatment program. During this time, each of more than 400 fourth-year dental students completed 100 days of community-based treatment during their senior year. Among the outcomes that will be presented are the number of patient visits and specific treatment procedures provided, as well as selected subjective and cognitive measures. The data summarize the community-based practice experiences of all dental graduates of the UCDenver School of Dental Medicine between 1994 and 2006.

History of the Program

In 1975, the state legislature's intent in creating a dental school at the University of Colorado was to educate dental graduates who would reduce access barriers, particularly geographic barriers, for oral health care in the state. To that end, a tuition policy was designed to ensure that most graduates would practice in Colorado's underserved communities for at least four years after receiving their degrees.[13] Dental tuition was to be set at the full cost of education, which was determined to be $16,089 per year for state residents in 1978–79.

This tuition rate was extremely high for the time. Excluding Colorado, the highest resident student tuition that year among all U.S. state-supported dental schools was reported by Pearlman et al. to be $4,000 annually.[13] As an integral part of the policy, Colorado's dental students were eligible to receive tuition forgiveness that lowered tuition by a statutorily determined 87.5 percent, to $2,011 in 1978–79. This reduced amount was still high, reportedly 150 percent of the U.S. median resident student tuition at the time. In return for each year of tuition forgiveness received, a student agreed to practice in an underserved community within Colorado for one year.

For those who did not want to establish a rural practice, an alternative arrangement was offered. Choosing that option, a graduate could provide unreimbursed dental care within a non-shortage area of Colorado. The total value of unreimbursed care was monitored by the school for each graduate until it equaled the total amount of tuition forgiveness received. This amount was reported by Pearlman et al. to be about $48,000 for each of the school's 1979 graduates.[13]

Implementation of the tuition policy was complicated by the limited market for dental services in many of the state's sparsely populated underserved areas. In 1980, thirty-two of Colorado's sixty-three counties had population densities of fewer than seven people per square mile; fifty-seven counties had densities of fewer than eighty people per square mile.[14,15] In their report, Pearlman et al. concluded that many underserved communities in the state simply did not have a large enough population base within a reasonable geographic area to support a private dental practice.[13]

The policy's federal tax consequences further complicated its implementation. The Internal Revenue Service considered Colorado's tuition forgiveness to be taxable personal income. Thus, a 1979 graduate moving to a rural community would have immediately owed federal income tax on $48,000 of income, at a time when the average annual income of dentists nationally was approximately $53,000.[16] The Pearlman et al. report detailed numerous strategies employed to change this policy at a national level, none of which were successful.

A major change in the Colorado tuition policy was enacted in 1985. The school's dean at the time, Dr. Lawrence Meskin, and the school's chairman of the Department of Applied Dentistry at the time (RLC), negotiated with the state legislature to replace the tuition policy with a new initiative, the Advanced Clinical Training and Service (ACTS) Program. State funding was increased so that dental tuition could be reduced to levels comparable to peer institutions in the region. In return, all dental graduates were required to complete the ACTS Program, providing care to underserved populations in Colorado before receiving a degree.

Program Timeline

The ACTS Program has evolved over the subsequent two decades. During the time period represented by the data presented here, ACTS required each graduating dental student to practice in underserved community-based settings for 100 days. This took place primarily during the final semester of the curriculum. Since 2006, the school has begun modifying the program's structure and timing to more fully integrate the ACTS Program within the overall curriculum.

Between 1994 and 2006, ACTS was made up of twenty weeks of practice. A one-week transitional affiliation took place at a nearby community health center during the fall semester. Before a student could progress beyond that transitional week, all school-based, discipline-specific clinical standards for competence were required to be completed. Following completion of all school-based experiences, each student embarked on a series of full-time, four-to-five-week affiliations for the remaining ninety-five days of community-based practice. The affiliations were separated in the spring semester by three week-long classroom education sessions at the campus.

Some students were able to complete school-based requirements and begin full-time ACTS in December, which led to completion by the school's commencement date. More commonly, students began ACTS in January and completed their final three weeks of ACTS after the school's commencement ceremony. The latter students participated fully in all graduation-related ceremonies and activities, but their degrees were withheld until they completed the ACTS Program. In such cases, an "in progress" grade was used to maintain student status and professional liability coverage until ACTS was completed. After completing ACTS, usually without any additional tuition or fee charges, these students received diplomas carrying the original commencement date.

A "banked time" option allowed students to accumulate up to three weeks of early credit prior to beginning ACTS by practicing at ACTS clinics during vacation breaks or participating in health fairs. Banked time credit could be applied toward the post-commencement time commitment or any voluntary absences during the program.

Curriculum, Faculty, and Staffing

The program was represented in the curriculum at the time by four clinical courses graded on a pass/fail basis, totaling 14.8 semester hours of credit and 711 clinical contact hours. ACTS students practice dentistry, defined as diagnosis and the cutting of hard or soft tissue, only under direct supervision of community-based faculty members or "preceptors." The community-based ACTS faculty at any given point in this time period has included approximately seventy dentists, for an average dentist-to-student ratio of approximately 1.9 to 1. Each preceptor is licensed to practice dentistry in the state and holds a faculty appointment in the UCDenver School of Dental Medicine's Department of Applied Dentistry. Though they are volunteers, preceptor faculty appointments are held to the same processes and standards as all other faculty appointments at the school.

These community-based faculty members practice at approximately forty different locations throughout the state, making about 150 dental operatories available for student training and preceptor practice. During this time period, about sixteen of the dental clinics were in Federally Qualified Health Centers (FQHCs), fourteen were in other not-for-profit health centers, six were private dental practices, and four were federal or state government-operated dental facilities. Most of the preceptors were salaried staff dentists at community not-for-profit clinics. Each clinic was typically staffed with at least one dental assistant for each dentist or dental student. Additional staff members filled roles in reception, patient records, billing, and administration at these clinics.

ACTS preceptors interacted with their students daily, but they also conducted more focused discussions on a weekly basis as they signed paperwork that documented treatment provided. These sessions covered not only clinical skills and issues, but also interpersonal and behavioral issues. At the end of an affiliation, the preceptor completed a written assessment of the student's performance. That assessment

provided feedback to the student and the school-based faculty on professionalism, patient care, discipline-specific clinical skills, and practice management skills. Ratings utilized a five-point, Likert-type scale.

Preceptor calibration has been accomplished through an ongoing process of periodic discussions with school-based faculty members, punctuated by an annual training conference. The periodic discussions are based on recent preceptor assessments of students and recent feedback from students. A major feature of each annual preceptor conference is a series of town hall-style meetings of school- and community-based faculty members. These case-based sessions focus on student assessment strategies, clinical decision making, and new developments in clinical disciplines.

ACTS program administration includes student interviewing/mentoring, faculty/site development, clinical/educational quality assurance, community outreach/liaison efforts, lecture/clinical instruction, student evaluation, program evaluation, scheduling, and data management. At the end of the program, after receiving a final clearance signature for graduation, each student meets individually with the ACTS director for an exit interview. This session typically lasts twenty to thirty minutes and is intended to gain feedback on the program, the clinics, and the preceptors from the unique perspective of a student learner.

Matching of students with preceptors and sites is based on the student's interests, skill/experience levels, type of supervision needed, personal issues such as care of family members, program logistics, and availability. When students are assigned to sites located more than one hour's driving time from the campus, local housing and assistance are arranged for them by the ACTS Program, in collaboration with four regional Area Health Education Centers (AHECs).

The years between 1994 and 2006 saw no major structural modifications in the program. Clinical experiences for twelve consecutive graduating classes are presented here and contrasted with the volume and service mix of selected school-based clinical experiences during the most recent academic year at the UCDenver School of Dental Medicine.

Because these twelve years of ACTS data include all community-based experiences of all graduates of this school, they offer insight into such a program's sustainable impact upon a "typical" student. Based on published reports, it appears that no other North American dental school has ever required all of its graduates to practice in community-based clinics for as long a portion of their predoctoral training as the University of Colorado Denver School of Dental Medicine. The analysis presented here will detail the community-based clinical experiences of 423 of those dental students.

Methods

Data for all community-based clinical experiences of all UCDenver dental students graduating between 1995 and 2006 were collected by the students' self-report, using paper forms. This encompasses a period in which a single standardized data collection instrument was utilized, from the 1994–95 through 2005–06 academic years, after which the ACTS Program went through substantial restructuring aimed at greater integration with school-based clinical training. The "production summary" form was completed weekly and signed by the supervising preceptor.

This form contains a condensed list of seventy-six of the most commonly reported clinical procedures. Similar procedures, e.g., all types of crowns, are combined for ease of reporting on the single page form. Students make tally marks beside procedure descriptions while completing patient progress notes, then sum each procedure at the end of the week. A section of this form is devoted to open-ended reflection, but that material was not included in this study's dataset. Manual data entry of clinical procedures by university staff members utilized dBase3 (dataBased Intelligence Inc., Vestal, NY). These files were subsequently merged into a single database. Analyses by the authors utilized SPSS 16.0 (SPSS Inc., Chicago, IL).

Signed weekly forms for 100 eight-hour days of practice were required for graduation, and each form was required to be submitted within two weeks of completion. There was no programmatic incentive for overreporting of productivity, since ACTS requirements were based not on productivity, but on the number of days completed. In order to limit program administrative costs, treatments were not linked to individual patient characteristics. Because offsite electronic data collection was not possible, patient-level data would have required more than 20,000 hard-copy patient encounter documents per year.

Supplemental data from preceptor assessments, pre-/post-program student questionnaires, and school-based clinical productivity were utilized for additional analyses. At the end of each affiliation, preceptors completed written assessments of their students. That assessment form contained five

"Personal skills" items, nine "Clinical skills" items, and six "Professional growth" items. Prior to beginning ACTS, each student completed questionnaires about attitudes regarding underserved populations, postgraduation plans, and self-assessed competencies. The same questionnaires were also completed six months later by all students during a mandatory exit interview after completion of ACTS. This study utilized preceptor assessments and pre-/post-ACTS student questionnaire data for the graduating classes of 1995 and 2006.

Reliable school-based clinical productivity information was not available for the period 1994–2006 because electronic records were not fully implemented until 2007. For this study, a summary of student-career clinical data for the graduating class of 2009 from the school's axiUm record system (Exan Academic Software, Port Coquitlam, BC, Canada) was utilized. This summary does not include any data for school-based pediatric experiences, which occur in a separate hospital-based setting.

Results

The mean graduating class size during this twelve-year period was thirty-five students (range thirty-one to forty). While practicing at ACTS clinics, these students provided a total of 389,879 treatment procedures at 210,706 encounters (patient visits). Each student provided a mean of approximately 922 treatment procedures at 498 patient visits. The mean number and percentage of procedures provided per student in ACTS clinics are summarized by treatment category in Table 1.

This table also provides a similar summary for experiences of the 2009 graduating class in the school-based clinics. Those students spent a mean of 138 days in "open clinic," exclusive of block rotation assignments. For more accurate comparison between the two settings (school-based data do not include pediatrics), a separate column reports the percentages of ACTS procedures with primary teeth data excluded.

During their clinical careers at UCDenver, the 1994–2006 students provided more care at ACTS clinics than did the 2009 students in school-based open clinic. Excluding primary teeth procedures, the ACTS students provided a mean of 840 procedures, and students in the school clinic provided a mean of 640 procedures (not including care for pediatric patients). The three most common procedure groups (diagnostic/preventive, oral surgery, and operative) were the same for both ACTS clinics and the school-based clinic. ACTS clinics provided more treatment experiences in diagnostic/preventive, operative, endodontics, and oral surgery. The school-based clinic provided more treatment experiences in periodontics, fixed prosthodontics, and removable prosthodontics.

Means for ACTS and the school-based clinic were calculated for the most commonly reported specific treatments in each procedure group (Tables 2 and 3). The patterns noted for relative frequencies

Table 1. Procedures per student-career by category, in school-based clinic and ACTS clinics

	School-Based Clinic[a]		ACTS Clinics[b]		
Treatment Category	Number of Procedures Per Student	Percent of Procedures	Number of Procedures Per Student	Percent of Procedures	Percent of Procedures, Excluding Primary Teeth
Diagnostic/preventive	442.4	69.1%	530.9	57.6%	63.2%
Operative (permanent teeth)	54.3	8.5%	133.6	14.5%	15.9%
Pediatrics (primary teeth)	n/a	n/a	81.6	8.9%	
Periodontics	29.2	4.6%	13.2	1.4%	1.6%
Fixed prosthodontics	13.2	2.1%	6.6	0.7%	0.8%
Removable prosthodontics	19.4	3.0%	18.3	2.0%	2.2%
Endodontics	6.6	1.0%	16.0	1.7%	1.9%
Oral surgery	75.1	11.7%	121.5	13.2%	14.5%
Total	640.2		921.7		

[a]School-based clinic: class of 2009, 2007–09
[b]ACTS clinics: 1995–2006

Note: Percentages may not total 100% because of rounding.

Table 2. Procedures per student in school-based clinic and ACTS clinics: selected diagnostic/preventive, operative, pediatrics, and periodontics procedures

	School-Based Clinic[a]	ACTS Clinics[b]	
Treatment Provided	Mean Number Per Student-Career	Mean Number Per Student During ACTS	Mean Number Per Student Four-Week ACTS Affiliation
Diagnostic and preventive			
Examination (all types)	87.6	271.36	54.27
Screening	15.1	59.81	11.96
Radiograph	316.6	121.18	24.24
Prophylaxis	18.0	39.95	7.99
Operative (permanent teeth)			
Amalgam, 1 surface	1.9	26.44	5.29
Amalgam, 2+ surfaces	5.3	42.44	8.48
Composite, anterior	18.1	36.66	7.34
Composite, posterior 1 surface	10.7	9.33	1.87
Composite, posterior 2+ surfaces	8.1	5.78	1.16
Pediatric (primary teeth)	n/a		
Amalgam, 1 surface		14.22	2.84
Amalgam, 2+ surfaces		16.41	3.28
Composite, anterior		4.29	0.86
Composite, posterior 1 surface		7.61	1.52
Composite, posterior 2+ surfaces		3.17	0.63
Pulpotomy		17.02	3.40
Stainless steel crown		14.34	2.87
Periodontics			
Scaling and root planing	14.0	8.14	1.63
Maintenance visit	14.8	2.49	0.50

[a]School-based clinic: class of 2009, 2007–09
[b]ACTS clinics: 1995–2006

among procedure groups were also evident when specific procedures were considered. Because it has been a policy of the ACTS faculty that four weeks' duration is the shortest appropriate length for a clinical affiliation, means that are intended to illustrate student experiences during such an affiliation were also calculated.

Assessments by preceptors utilized a three-point Likert-type scale. Compliance with submission of these assessments by the preceptors to the school was irregular during the time period reported here. For the graduating class of 1995, 87 percent of these forms were recorded and filed at the school. For the graduating class of 2006, only 49 percent of these forms were recorded and filed. Preceptors generally gave very high ratings to their students. The median score throughout the period was 1 ("greatly exceeds expectations"), and no more than five students received a score of 3 ("needs considerable growth") during the 2005–06 year.

Selected information from the student questionnaires provides additional outcome data. Because students completed these questionnaires during required one-on-one meetings with school-based faculty members during this period, data are available for 100 percent of the students. One component of the pre-ACTS and post-ACTS instruments asks the student to rate his or her own competence on twenty-six important clinical skills, using a five-point scale ranging from 1 (low) to 5 (high).

Upon completion of ACTS, the lowest percentage of students rating themselves above average (4 or 5) was for "Order and interpret appropriate clinical laboratory tests" (50.9 percent). The highest percentages scoring themselves at 4 or 5 were for "Develop confidence, respect, and trust in patient relationships," "Utilize local anesthesia techniques," and "Utilize patient management and interpersonal skills" (96.5 percent). For twenty of the twenty-six skills, a larger percentage of students rated themselves at 4 or

Table 3. Procedures per student in school-based clinic and ACTS clinics: selected fixed and removable prosthodontic, endodontic, and oral surgery procedures

Treatment Provided	School-Based Clinic[a] Mean Number Per Student-Career	ACTS Clinics[b] Mean Number Per Student During ACTS	ACTS Clinics[b] Mean Number Per Student Four-Week ACTS Affiliation
Fixed prosthodontics			
Preparation of tooth for coverage	11.3	5.65	1.13
Removable prosthodontics			
Complete denture (max or mand)	5.2	3.90	0.78
Rem partial denture (max or mand)	2.5	2.10	0.42
Denture repair or reline	1.1	5.40	1.10
Endodontics			
Anterior RCT	2.1	3.29	0.66
Premolar RCT	1.5	1.79	0.36
Molar RCT	3.0	4.27	0.85
Oral surgery			
Nonsurgical extraction	62.3	101.60	20.32
Surgical extraction or root recovery	8.2	10.61	2.12
Removal of impacted tooth	1.2	3.16	0.63

[a]School-based clinic: class of 2009, 2007–009
[b]ACTS clinics: 1995–2006

5 after ACTS than before ACTS. For sixteen of the skills, the proportion of students rating themselves with scores of 4 or 5 increased by 5 percent or more (Table 4).

A small number of students reported post-ACTS decreases in some areas of self-assessed competence. This was observed most frequently (15.9 percent of students) for "Obtain/interpret medical/social history, review of systems, and dental history." These students reduced their own scores on this item either from 5 to 4 (45.5 percent) and from 4 to 3 (54.5 percent) after completing ACTS.

Another questionnaire asked students to rate the amount of change in confidence they experienced as a result of the ACTS Program within four broad skill areas. On this five-point scale, the percentages of students indicating moderate (4) or large (5) positive changes in confidence were diagnosing and treating dental emergencies (90.0 percent); diagnosing, evaluating, and treating handicapped or geriatric patients (83.3 percent); interpersonal skills for patient and staff management (85.0 percent); and overall confidence in clinical skills (96.7 percent).

That questionnaire also asked students to indicate their willingness to provide care to certain patient populations, using a five-point Likert-type scale. For willingness to treat low-income people, 85.5 percent reported being "generally" or "very" willing (scores of 4 or 5) after completing ACTS. Percentages for the other groups were pediatric patients (74.5 percent), handicapped patients (72.7 percent), medically compromised patients (83.6 percent), and geriatric patients (89.1 percent).

Finally, students were asked to indicate their plans following graduation. About 54 percent planned to pursue postdoctoral training. Almost 30 percent planned to practice in the private sector. Approximately 16 percent planned to practice in the public sector after graduation from dental school.

Discussion

The ACTS Program represents a considerable commitment of curriculum time to community-based education by the UCDenver School of Dental Medicine. At 100 days of practice, ACTS students received five times the 2002 median community-based experience for North American dental schools reported by Holmes et al.[7] ACTS also exceeded the mean experience duration reported for Pipeline program dental schools by nearly 70 percent.[9] ACTS students experienced about 2.5 times the number of patient visits reported for Ohio students,[12] but ACTS students provided somewhat fewer procedures (1.9

versus 2.3) per visit. Given the availability of dental auxiliaries in the ACTS community-based clinics, this level of clinical productivity per patient visit is lower than might be hoped. It is consistent, however, with experiences at the University of Alberta[10] of between 2.0 and 2.2 procedures per visit in community-based clinics.

These levels appear similar to clinical productivity per patient visit in Colorado's school clinic. Assuming two patients per day, UCDenver's 2009 graduating class provided approximately 2.3 procedures per visit in the school's open clinic. The higher productivity of students in community-based clinics appears to result from differences in the number of patients seen, rather than the number of procedures per patient. Students in the school clinic provided a mean of 4.6 procedures per day. In contrast, ACTS students provided twice as many procedures (a mean of 9.2) during nearly five patient visits per day.

None of the estimates discussed here account for the unknown rates of failed appointments and unscheduled time. It is interesting to note, however, that with substantially different levels of auxiliary support and available time, students provided approximately the same number of procedures per patient visit in both settings. This suggests the possible existence of some sort of target expectation for productivity per patient, shared by a large number of dental students. It is conceivable that such a target expectation might develop during closely supervised practice in a school clinic and be carried over into the community-based environment.

Perhaps because of financial limitations typical of a community-based safety-net clinic, a considerably greater proportion of treatment experiences in higher-cost disciplines, such as provision of complete and partial dentures, were seen at the school clinic than in ACTS clinics. Similar to data reported at the University of Illinois at Chicago,[17] student experiences in community health clinics were weighted toward lower cost procedures such as operative dentistry and oral surgery (exodontia). Still, ACTS students were not without experience in the higher-cost areas of patient care. Over a student-career, more than half of a typical student's endodontic cases, nearly half of complete denture cases and removable partial denture cases, about one-third of crowns, and over a third of scaling/root planing cases were experienced in ACTS clinical sites.

Although direct comparison cannot be made between these data and the relative value unit data published by DeCastro et al.,[11] it is possible to contrast multiples between community-based and school clinics at the two institutions. In both New Jersey and Colorado, community-based practice provided more operative dentistry experience than school clinics (twofold and nearly fourfold, respectively). For oral surgery, the multiple was much higher for

Table 4. Percentages of students with pre- and post-ACTS self-assessment scores of 4 or 5

Outcome	Pre-ACTS (percent)	Post-ACTS (percent)
Examine and evaluate patient	79.1	86.4
Identify and record patient's oral problems	77.6	83.1
Prescribe sequential treatment plan and be able to provide majority of required care	74.6	86.4
Provide/supervise preventive services and education	80.6	91.5
Make appropriate referrals and coordinate care by others	68.7	86.4
Understand indications/contraindications for contemplated treatment and recognize when scope is beyond capability	74.6	83.1
Assess and diagnose patient	80.6	88.1
Conduct appropriate clinical and radiographic examination; distinguish hard and soft tissue abnormalities	70.1	77.2
Order and interpret appropriate clinical laboratory tests	43.3	50.9
Interpret findings from history and clinical/radiographic examination, formulate treatment plan, and establish prognosis	74.6	82.5
Recognize/understand pathologic physiology and systemic disease and influence on oral health	44.8	64.9
Evaluate data, develop appropriate sequence of treatment, and make appropriate modifications	74.2	80.7
Educate patients on etiology and control of oral diseases/conditions	83.6	91.2
Utilize local anesthesia techniques	86.6	96.5
Utilize prescription drugs relevant to dentistry	73.1	82.5
Utilize patient management and interpersonal skills	91.0	96.5

New Jersey (3.3 times greater) than for Colorado (1.6 times greater).

Though data on patient visits and clinical procedures represent outcomes that are relatively straightforward to quantify, consideration of cognitive outcomes is also necessary. The ACTS data on growth in cognitive clinical skills show substantial gains for students. Similar to data from University of Kentucky field experiences at the end of the third year,[18] some of the greatest growth was reported by students in knowledge and decision-making skills.

Among the skills enhanced by ACTS was the ability to recognize when the scope of planned care is beyond one's capabilities. A substantial proportion of students in 2006 reported gains related to this skill. If a central goal of dental education is to produce clinicians who are safe beginners, this area of improvement is a critically important accomplishment of the ACTS Program.

Improvement in realistic self-appraisal could also be potentially inferred from the skill areas in which gains were not observed. Practicing in a one-on-one setting with an experienced dentist may offer a greater opportunity than school clinics for a student to experience personal feedback. Feedback in a community-based clinic may be conducive to a form of feedback known as social comparison,[19] whereby the student may directly compare his or her own efforts with those of an experienced clinician.

It has been suggested that learners who are unable to recognize high levels of expertise portrayed by others are unable to accurately identify their own deficiencies.[5] The vital task of recognizing another person's expertise may be facilitated for a student when the preceptor is practicing in an adjoining operatory. Working closely with preceptors should have given these students an opportunity to make direct, real-time comparisons of expert and beginner performance.

Activities aimed at reducing access barriers are increasingly being considered central to the long-term viability of dental education programs.[1] History shows that at the UCDenver School of Dental Medicine, ACTS is closely linked to institutional viability. The intent expressed on the post-ACTS questionnaire by 16 percent of graduates to practice in the public sector addresses a core institutional goal of serving underserved communities. The high level of willingness to treat specific underserved populations is another indication of the intangible benefits offered by programs. These ACTS outcomes regarding care of the underserved confirm findings reported elsewhere, indicating the effects of community-based dental education on reducing some access barriers to care.[1,20-22]

Conclusion

Community-based dental education programs offer significant advantages, including practice in these smaller scale settings with personalized supervision and use of auxiliaries. Students provide a large amount of high-quality care to underserved populations and report large positive changes in their abilities. Additionally, students' exposure to diverse cultural settings, clinical care delivery systems, and managerial environments help to more fully prepare them for clinical practice.

In this model, school-based facilities are devoted to the faculty-intensive process of developing a student's initial skill-set. Subsequent learning experiences in the community yield far more experience than a dental school clinic, resulting in enhanced clinical decision-making skills. The advantages of community-based education have been gained through faculty preceptors and clinical facilities available at no cost through community partners. Future research should assess the long-term trade-offs in educational costs that such a model makes possible for dental schools, as well as the attitudes and career choices of dental graduates several years after participating in such programs.

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