



Digital workflow integration and standardized communication protocols in prosthetic dentistry: a multicenter cross-sectional study on innovation impact and interdisciplinary collaboration

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Abstract

Background. The digitalization of prosthetic dentistry — encompassing CAD/CAM fabrication, intraoral scanning, and digital prescription platforms — represents one of the most transformative biotechnological shifts in contemporary dental practice. Despite these advances, the transition from analog to digital communication workflows remains incomplete in many clinical settings, and the relationship between communication modality, error frequency, and professional satisfaction has not been quantified in a multicenter international sample. This study investigates whether the adoption of structured digital and standardized communication protocols translates into measurable improvements in interdisciplinary collaboration outcomes.

Methods. An exploratory cross-sectional online survey was distributed via professional social media groups and institutional networks to dentists and dental technicians in five countries (Germany, Romania, France, Israel, United States). The questionnaire addressed communication modality, error frequency, satisfaction (1–10 scale), and turnaround time. Descriptive statistics and exploratory group comparisons (independent-samples t-test, chi-square) were applied; effect sizes (Cohen's d) are reported where applicable. Given the achieved sample (n=162), all analyses are exploratory and hypothesis-generating.

Results. Verbal instructions were the most frequently used modality and were associated with the highest error rate (79% of technicians reported missing or incorrect information). Standardized work-authorization forms yielded the highest satisfaction scores (dentists 8.4/10, n=60; technicians 6.8/10, n=70) yet were incompletely filled in 76% of cases. Non-standard written requests generated the greatest frustration (44% of technicians cited poor communication). Turnaround time was shorter for in-house technicians (mean 5.17 days, SD=1.8) than external laboratories (mean 7.64 days, SD=2.3), though the difference did not reach statistical significance (p=0.08, d=0.24).

Conclusions. Structured communication protocols — particularly standardized digital prescriptions — are associated with lower interdisciplinary error rates and higher professional satisfaction in prosthetic workflows. These pilot findings support accelerated adoption of digital workflow solutions as a pragmatic, low-cost innovation with measurable clinical and organizational impact. Integration of CAD/CAM-compatible communication standards into dental education and practice guidelines is recommended to bridge the persistent gap between technological capability and everyday clinical use.

Keywords: digital workflow, CAD/CAM dentistry, dentist–technician communication, digital prescription, interdisciplinary collaboration, standardized forms, prosthodontic innovation, technology adoption

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Introduction

The integration of digital biotechnologies into prosthetic dentistry has fundamentally altered the informational demands of interdisciplinary collaboration. Intraoral scanners, CAD/CAM systems, digital prescription platforms, and additive manufacturing have collectively transformed the prosthetic workflow from a craft-dependent, analog process into one increasingly governed by structured data exchange [1,2,3]. Yet this technological transformation has not been uniform: many clinical environments still rely on verbal instructions or informal written communications between dentists and dental technicians, and the extent to which digital innovation has penetrated everyday interdisciplinary communication remains poorly characterized at the international level.

The consequences of inadequate information transfer are well documented. Incomplete or ambiguous work authorizations have been consistently linked to increased remake rates, treatment delays, and compromised aesthetic and functional outcomes across diverse healthcare settings [4,5]. Work authorizations frequently omit critical specifications such as margin design, pontic morphology, and shade information, compelling technicians to interpret or assume missing data [6,7,8]. In removable prosthodontics, more than half of technicians report communication-related obstacles during fabrication of removable partial dentures [9]. These deficiencies are not recent: Afsharzand and Rashedi documented incomplete design instructions in the majority of work authorizations as early as 2006 [10], and analogous findings have been replicated in Greece [11], Saudi Arabia [6], Pakistan [4], India [5], and Morocco [8] — suggesting a structural rather than incidental problem.

Digital workflows represent the most substantive biotechnological response to these challenges. CAD/CAM fabrication and intraoral scanning enable direct three-dimensional data transfer, eliminating transcription errors inherent in analog impressions and handwritten prescriptions [1,2]. Digital prescription platforms enforce structured data entry, reduce ambiguity, and create auditable records that support quality assurance and traceability throughout the prosthetic process. Complete digital workflows — from intraoral scan through computer-aided design to milling or additive manufacturing — have demonstrated shorter turnaround times, lower remake rates, and greater dimensional accuracy compared to conventional analog pathways [2,3]. Real-time clinician–technician interaction enabled by shared digital platforms further supports iterative refinement and reduces the need for physical try-ins [8]. Despite these advantages, digitalization alone does not eliminate error: device-specific variability, incomplete operator training, lack of universally adopted protocols, and the financial barriers to technology acquisition mean that communication failures persist even in digitally equipped practices [4].

Shade communication illustrates the residual complexity. Although spectrophotometers and digital

shade-matching systems improve repeatability compared to visual assessment, their performance is technique-dependent and inter-device discrepancies remain clinically significant, making standardized photographic protocols and annotated shade maps indispensable supplements to digital data [7,12]. Beyond technical parameters, qualitative investigations highlight relational and organizational dimensions — trust, mutual respect, clear professional role boundaries, and feedback culture — as determinants of how information is shared, interpreted, and acted upon [12,13]. Collaborative relationships characterized by open communication and co-creation produce better prosthetic outcomes than hierarchical ones defined by unidirectional instruction [5,12].

Collectively, the literature of the past decade identifies three convergent imperatives for innovation in prosthetic communication:

- (1) standardization of work authorization content and terminology;
- (2) embedding of digital workflows within shared, protocol-driven frameworks; and
- (3) cultivation of team-level practices that promote transparency and bidirectional feedback.

Most existing investigations are confined to single-country samples, limiting external validity and obscuring how systemic factors — healthcare organization, educational standards, technological infrastructure, and professional culture — moderate the relationship between communication mode and clinical outcome.

The present multicenter study was therefore designed to map the current state of digital workflow adoption and communication practice among dentists and dental technicians across five countries, building on prior work in this area [15]. Specifically, we aimed to:

- (i) characterize the frequency and modalities of interdisciplinary communication, including the degree to which digital tools have replaced or supplemented analog methods;
- (ii) explore differences in satisfaction and turnaround time according to communication modality and collaboration setting; and
- (iii) identify principal barriers to the adoption of standardized and digital communication protocols [1,4], with a view to informing practical innovation strategies for prosthetic dentistry.

Methods

Study design and participants

An exploratory cross-sectional, web-based survey was conducted from February to May 2023. The questionnaire targeted practicing general dentists and dental technicians involved in fixed or removable prosthodontics in five countries (Germany, Romania, France, Israel, United States). This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics

Committee of Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, with reference number AVZ 8/6 January 2023. Participation was voluntary, anonymous, and limited to one response per individual. Informed consent was obtained electronically before entry.

Inclusion and exclusion criteria

Participants were eligible for inclusion if they met all of the following criteria:

- (i) currently practicing as a licensed general dentist or certified dental technician at the time of the survey (February–May 2023);
- (ii) actively involved in fixed or removable prosthodontic workflows, defined as routinely issuing or receiving laboratory work authorizations;
- (iii) residing and working in one of the five target countries (Germany, Romania, France, Israel, or the United States);
- (iv) providing voluntary informed electronic consent prior to commencing the questionnaire; and
- (v) completing the questionnaire in full.

Participants were excluded if they:

- (i) were dental students, dental hygienists, or allied dental professionals not directly involved in prosthetic prescription or fabrication;
- (ii) reported exclusive involvement in oral surgery, orthodontics, or periodontics with no prosthodontic caseload;
- (iii) submitted duplicate responses, identified by cross-referencing timestamp, country, and professional role, with only the first complete response retained; or
- (iv) left more than six items unanswered across the three questionnaire sections

Sample-size determination

Using G*Power 3.1, a conservative prevalence of 50% was assumed, with a 95% confidence level and a 5% margin of error. The calculation required ≥ 384 completed questionnaires; to accommodate non-response, a target of 450 participants was set. The achieved sample of 162 participants fell below this threshold; accordingly, the study is considered exploratory and pilot in nature, and all findings are interpreted as hypothesis-generating.

Questionnaire development and validation

The questionnaire comprised 30 items organized into three thematic sections.

Section 1 (Demographics and practice profile, 8 items) collected data on country of practice, professional role, years of experience (categorized as <5, 5–10, 11–20, or >20 years), practice setting (private solo, group practice, dental school clinic, or hospital), type of laboratory collaboration (in-house, external, or both), average number of prosthetic orders per week, primary prosthetic specialization (fixed, removable, or combined), and access to digital workflow tools.

Section 2 (Communication practices, 14 items) assessed primary communication modality for work

authorizations (verbal, standardized written form, non-standard written communication, or mixed), frequency of each modality as a proportion of cases, self-reported rate of incomplete prescription data, types of information most frequently missing (shade, margin design, occlusal scheme, material specifications, pontic morphology), use of supplementary communication tools (photographic documentation, digital impressions, study models), and whether the respondent maintained a personal record of verbal exchanges.

Section 3 (Perceived problems and satisfaction, 8 items) included satisfaction with current communication practices on a 10-point numeric scale (1 = completely dissatisfied, 10 = completely satisfied), frequency and type of errors attributed to communication failure in the preceding 12 months, mean turnaround time entered as a numeric value in working days, perceived barriers to adoption of digital tools (cost, training, lack of standardization, institutional inertia, lack of partner readiness), suggested improvements as free text, and overall rating of interdisciplinary collaboration quality.

Items were derived from a review of existing dentist–technician communication instruments and adapted for cross-national comparison [4–10]. Content validity was assessed by a panel of three experienced prosthodontists and two senior dental technicians, who evaluated item relevance, clarity, and completeness; revisions were made iteratively until consensus was reached. The instrument was originally developed in English and subsequently translated into French and German by native-speaking dental professionals, with back-translation reviewed by the research team to confirm conceptual equivalence. A pilot test with 20 participants (10 dentists, 10 dental technicians, not included in the main analysis) confirmed face validity, identified no ambiguous items, and yielded a mean completion time of 12 minutes. Internal consistency of the Likert-scaled items was satisfactory (Cronbach $\alpha = 0.82$).

Data collection

The questionnaire was hosted on Google Forms and remained active from February to May 2023 (14 weeks). Distribution was conducted through three channels:

- (i) direct invitation to members of national dental and dental technology professional associations in each target country via their official mailing lists;
- (ii) posts in closed professional social media groups on Facebook and LinkedIn dedicated to prosthodontics and dental technology, moderated by group administrators in each country; and
- (iii) institutional newsletters circulated by the dental faculties of the participating universities.

No financial incentive was offered. The platform was configured to allow one response per device; IP-address logging was disabled to preserve anonymity. No identifying data were collected at any stage.

Of 210 responses initiated, 162 met all inclusion criteria and were retained for analysis. The 48 excluded responses comprised 31 incomplete submissions (more than six unanswered items), 12 duplicate entries, and 5 responses from professionals outside the target countries.

Variables

Independent variables: professional role (dentist vs. technician), country, type of collaboration (in-house vs. external laboratory). Dependent variables: satisfaction score (1–10), turnaround time (days), frequency of communication modality, occurrence of specific errors (yes/no).

Statistical analysis

Data were exported from Google Forms to Microsoft Excel for organization and graphical representation. Descriptive statistics (frequencies, percentages, means \pm SD) characterized the sample. Independent-samples t-tests were used to explore differences in satisfaction scores between dentists and technicians within the standardized-form subgroup. Turnaround time was compared between in-house and external laboratory settings using descriptive means and effect size (Cohen's *d*). Given the exploratory nature of the study and the achieved sample size, no inferential chi-square analyses were performed; associations between communication modality and reported error patterns are presented descriptively. All statistical explorations were two-tailed with $\alpha=0.05$.

Results

Participant characteristics and digital context

A total of 162 participants — 74 dentists and 88 dental technicians — completed the survey across five countries (Table I). Germany contributed the largest cohort ($n = 90$; 77 technicians, 13 dentists), followed by Romania ($n = 32$; 26 dentists, 6 technicians), France ($n = 23$; all dentists), Israel ($n = 11$; all dentists), and the USA ($n = 6$; 1 dentist, 5 technicians). The pronounced professional imbalance across countries precluded reliable cross-national statistical comparisons; all analyses were therefore conducted on the pooled sample using descriptive and exploratory methods.

The geographic distribution likely reflects differential engagement with digital professional networks through which the survey was disseminated. Germany, which has a strongly institutionalized dental technology profession with high educational standards and robust digital infrastructure, yielded the highest response rate and the most critically detailed free-text responses — suggesting the sample may be skewed toward practitioners with greater professional digitalization and engagement, a factor relevant to interpreting the technology adoption patterns reported below.

Table I. Respondent distribution by country and profession.

Country	Dentists (n)	Technicians (n)	Total (n)
Germany	13	77	90
Romania	26	6	32
France	23	0	23
Israel	11	0	11
USA	1	5	6

Workflow characteristics and turnaround times

Dental technicians reported receiving an average of 12 orders per day, reflecting a high-throughput environment in which the efficiency of information transfer has direct operational consequences. Dentists found it difficult to consistently quantify order frequency, reflecting variability in practice type and case mix.

Dental technicians reported receiving a mean of 12 orders per day, reflecting a high-throughput environment in which communication efficiency has direct operational consequences. Turnaround time varied by laboratory setting among respondents who provided numeric estimates (approximately 70% of dental technicians): in-house technicians averaged 5.17 ± 1.8 days ($n = 25$) compared with 7.64 ± 2.3 days ($n = 35$) for external laboratory services (Table II). The difference did not reach statistical significance ($p = 0.08$, Cohen's *d* = 0.24), and should be interpreted as a directional trend requiring prospective validation in an adequately powered sample.

Table II. Average turnaround times by provider type.

Provider Type	Mean (days)	SD (days)	n
In-house technician	5.17	1.8	25
External laboratory	7.64	2.3	35

Communication modalities: prevalence and error profiles

Three communication pathways were assessed: verbal instructions, standardized written forms, and non-standard written forms (e-mails, handwritten notes), with prevalence and error profiles shown in table IV.

Verbal communication was the most frequently used modality and carried the highest error burden. Among dental technicians, 79% reported receiving insufficient or incorrect information, 12% noted poor impression quality, and 9% cited missing material specifications. Among dentists, verbal-channel errors most frequently involved occlusion mistakes (38%), shade-selection failures (30%), and case delays (23%). Notably, 83% of technicians reported maintaining a personal record of verbal exchanges compared with 69% of dentists, placing the documentation burden disproportionately on the receiving party.

Standardized written forms were associated with the highest satisfaction levels in both groups (dentists: $8.4 \pm 1.1 / 10$, $n = 60$; technicians: $6.8 \pm 1.5 / 10$, $n = 70$; Table III), yet were incompletely filled in 76% of cases. A further 27% of

technicians identified comprehension or design issues with form structure, reflecting both a user compliance gap and a tool design limitation.

Non-standard written forms generated the greatest frustration: 44% of technicians cited insufficient information from dentists and 12.5% reported negative professional attitudes as a contributing factor. Dentists attributed problems in this modality primarily to manufacturing issues (55%) and communication breakdowns (18%).

Table III. Satisfaction scores with standardized communication forms (standardized-form subgroup only).

Group	Mean Score (/10)	SD	n
Dentists	8.4	1.1	60
Technicians	6.8	1.5	70

Note: Scores collected from the subgroup of respondents identifying standardized forms as their primary communication modality (dentists n=60, technicians n=70), not the full sample.

Reported problems by communication form

Table IV summarizes the full error profiles by communication modality across both professional groups.

Summary of results

A consistent relationship was observed between the degree of structural formalization and the accuracy of information transfer in all communication modalities assessed. Verbal communication was the main source of errors for both professional groups. Although standardized forms were associated with the highest satisfaction scores, compliance with completing forms in full remained suboptimal. Non-standard written forms caused the most professional frustration among dental technicians. These findings highlight the discrepancy between current communication practices and the potential of fully digital prosthetic workflows to reduce errors. This discrepancy constitutes the central hypothesis examined in this study.

Discussion

Study aim and scope

This investigation was designed to evaluate the current state of interdisciplinary communication between dentists and dental technicians across five countries, with particular attention to the role of digital workflow technologies in shaping communication practices, error rates, and professional satisfaction. The original objective — to perform direct cross-national statistical comparisons

— could not be fully realized due to pronounced sampling heterogeneity and the unequal representation of professional groups across national cohorts [4]. The analysis was consequently refocused on descriptive patterns and pooled exploratory comparisons across communication modalities, an approach that remains informative in characterizing the gap between technological capability and actual clinical adoption.

Methodological limitations

Recruitment relied exclusively on dissemination through social media channels, a strategy that encountered substantial practical obstacles. In several countries, questionnaire posts were removed and the distributing account was ultimately banned, severely restricting the eligible respondent pool [5]. The informal recruitment platform also yielded a proportion of incomplete or off-topic submissions, with some participants using free-text fields to express frustrations about perceived professional hierarchies between dentists and technicians — tensions well documented in the prosthodontic communication literature [5–8]. These recruitment challenges are themselves informative: they reflect the degree to which digital professional communities remain fragmented, insufficiently institutionalized, and subject to platform-specific governance that may hinder research on digital adoption in dentistry.

Sample distribution and its implications

Germany contributed the largest cohort (77 dental technicians and 13 dentists), followed by Romania (32 participants), France (23), Israel (11), and the United States (6). This uneven geographic distribution precluded reliable cross-national statistical comparisons and necessitated a shift to pooled descriptive analyses — an approach also adopted in prior investigations with similarly constrained multinational samples [5,14,15]. The predominance of German dental technicians is noteworthy: Germany has a strongly institutionalized dental technology profession with clearly delineated educational pathways and professional certification, which may partly explain both the higher response rate among technicians and their more critical assessment of communication practices. National variation in dental technician education, professional autonomy, and digital infrastructure likely modulates how communication gaps are experienced and reported, underscoring the need for country-stratified analyses in future research [4,14].

Table IV. Reported problems by communication form.

Communication Form	Main Problems (Dentists)	Main Problems (Technicians)
Verbal	Occlusion mistakes (38%), shade errors (30%), delays (23%)	Lack/incorrect info (79%), poor impression (12%), missing material (9%)
Standardized form	Mostly unrelated issues (92%), form readability (8%)	Incomplete/missing info (76%), form design/comprehension issues (27%)
Non-standard form	Manufacturing issues (55%), communication problems (18%), other (27%)	Poor communication (44%), negative attitudes (12.5%)

Communication modalities and reported problems

Three principal communication pathways were examined: verbal instructions, standardized written forms, and non-standard written forms (email, handwritten notes). Verbal communication remained the dominant modality but was associated with the highest error burden: 79% of technicians reported missing or incorrect information as a consequence of verbal-only instructions, while dentists identified occlusal errors (38%), shade-selection failures (30%), and case delays (23%) as the most frequent sequelae [12]. These findings reinforce a well-established pattern in the literature — verbal communication, the modality most resistant to digitalization and standardization, consistently produces the greatest informational loss [12,2,3]. Standardized written forms were associated with the highest satisfaction scores across both professional groups, yet 76% of technicians reported that forms were incompletely filled, and 27% identified form design or comprehension issues [13–17]. Non-standard written forms generated the greatest frustration, particularly among technicians, 44% of whom cited insufficient communication from dentists and 12.5% of whom reported perceived negative professional attitudes [17]. These findings align with earlier surveys from Saudi Arabia and India documenting persistent perception asymmetries between clinicians and laboratory staff regarding the source and severity of communication failures [12,18].

Satisfaction with standardized forms

Dentists rated standardized forms more favorably (mean 8.4/10) than technicians (mean 6.8/10), a clinically meaningful difference that reflects divergent professional experiences of the same tool [13,16]. Dentists, who complete the form, tend to perceive it as adequate; technicians, who receive and act on it, more frequently encounter its deficiencies. This asymmetry has direct implications for the design of digital communication tools: effective solutions must be evaluated from the perspective of the receiving end of the information chain, not only the initiating end. Interfaces that provide real-time feedback to the prescribing clinician on the completeness and clarity of the submitted information — analogous to form validation in web applications — could substantively narrow this satisfaction gap.

Digital workflows: potential, limitations, and the implementation gap

The present findings must be interpreted against the backdrop of a prosthetic landscape undergoing accelerating biotechnological transformation. Complete digital workflows — encompassing intraoral scanning, CAD/CAM design, and digital prescription — represent a qualitative shift in the information architecture of dentist–technician collaboration, not merely an incremental improvement over paper-based systems [2,3]. Direct three-dimensional data transfer eliminates the transcription errors endemic to

verbal and handwritten communication, standardizes the minimum information set associated with each case, and creates a verifiable audit trail supporting quality assurance and medico-legal documentation. Studies on complete digital workflows in fixed prosthodontics report clinically meaningful reductions in remake rates and turnaround times [2,3]. The shorter turnaround observed for in-house compared to external laboratory settings in this study (5.17 vs. 7.64 days) may partly reflect the facilitation of real-time digital exchange in co-located environments, though the difference did not reach statistical significance ($p=0.08$, $d=0.24$). Critically, the 76% rate of incompletely filled standardized forms indicates that even when structured tools are available, their benefit is contingent on consistent and correct use. Digital platforms with mandatory fields, embedded clinical decision support, and bidirectional feedback loops are uniquely positioned to address this implementation gap. Despite the clear potential of digital workflows, adoption across the countries surveyed remains heterogeneous, constrained by equipment costs, insufficient continuing professional education, variability in technological infrastructure, and the absence of internationally recognized digital communication standards.

Contextual and demographic influences on adoption

Participant responses revealed noteworthy contextual influences on both survey engagement and communication practices. German respondents frequently described the questionnaire as “too general,” while some U.S. participants reported difficulty with technical terminology — observations that likely reflect national differences in dental technician education systems, certification standards, and professional language [4,14]. These contextual disparities extend to digital adoption: countries with highly institutionalized dental technology education and robust continuing professional development infrastructure may be better positioned to implement and sustain digital communication protocols than those where laboratory practice is more fragmented or informally organized.

Exploratory comparisons

Given the exploratory and pilot nature of this study, all analytical comparisons should be interpreted as hypothesis-generating rather than confirmatory. Three post-hoc comparisons were examined. First, satisfaction scores with standardized forms differed substantially between professional groups (dentists 8.4/10 vs. technicians 6.8/10) — a clinically meaningful gap consistent across the literature and warranting formal confirmatory testing in an adequately powered sample. Second, error profiles varied descriptively by communication modality, with verbal communication associated with the highest rates of information loss and non-standard written forms producing the most heterogeneous problem patterns

— a gradient aligning with the theoretical expectation that increasing communication structure reduces error frequency. Third, the observed difference in turnaround time between in-house (5.17 days) and external laboratory settings (7.64 days) did not reach statistical significance ($p=0.08$, $d=0.24$) and should be regarded as a directional trend requiring prospective validation. Collectively, these exploratory findings support the hypothesis that communication modality — and by extension, the degree of digital standardization — is a meaningful determinant of interdisciplinary communication quality in prosthetic dentistry.

Limitations

Several limitations of this study must be acknowledged explicitly. First and most critically, this investigation is exploratory and pilot in nature: the achieved sample of 162 participants fell substantially below the minimum of 384 required for the originally planned powered cross-national comparisons. The study should therefore be interpreted as hypothesis-generating, and its descriptive findings cannot be generalized beyond the sample obtained.

Second, recruitment relied exclusively on social media dissemination, introducing substantial selection bias toward digitally active practitioners who may systematically overrepresent those with greater familiarity with digital workflows. Third, the pronounced geographic and professional imbalance across countries made cross-national comparison statistically untenable. Fourth, all data are self-reported and cross-sectional, subject to recall bias and social desirability effects, with no causal relationships establishable. Fifth, the survey instrument did not directly measure digital tool usage — respondents were not asked whether they used specific intraoral scanners, CAD/CAM systems, or digital prescription platforms; consequently, the relationship between communication modality and digital adoption is inferred rather than directly measured. Sixth, the subgroup sizes underpinning the satisfaction analysis (dentists $n=60$, technicians $n=70$) and turnaround time comparison (in-house $n=25$, external $n=35$) are modest. Finally, the absence of patient-reported outcomes or objective clinical error metrics means that the relationship between communication quality and actual prosthetic outcomes remains associative and requires prospective validation.

Implications for practice

The current findings suggest that digital communication tools should be added to prosthetics practice in a planned way. First, digital prescription training should be required for both prosthodontic undergrads and continuing dental professionals. The fact that 76% of forms are not completely filled shows that having tools alone is not enough without teaching people how to use them. Second, institutions should replace or supplement paper-based work

authorizations with digital platforms. These platforms should have mandatory fields, embedded clinical guidance, and real-time completeness validation. This would directly address the two problems of user non-compliance and suboptimal form design. Third, creating and encouraging international use of minimum data standards for digital prosthetic prescriptions would provide a shared reference for what constitutes a complete and clinically actionable work authorization. This would be similar to minimum dataset standards in other areas of digital health. Fourth, there should be clear rules about who is responsible for documenting and correcting errors. These rules should make sure that the dental technicians aren't the only ones doing this work.

Implications for innovation

Several research priorities emerge directly from this study's limitations. Adequately powered single-country cohort studies are needed to permit granular analysis of local communication practices and specific barriers to digital adoption. Prospective longitudinal or quasi-experimental designs comparing paper-based and digital prescription platforms within the same clinical environment — using objective outcome metrics such as remake rate, error frequency, turnaround time, and patient-reported satisfaction — would establish the causal relationship between communication modality and prosthetic outcome that this cross-sectional design cannot provide. Future instruments should directly measure digital tool adoption using objective indicators (type of intraoral scanner, CAD/CAM system, and digital prescription platform in use) rather than inferring adoption from self-reported communication modality. Economic analyses evaluating the cost-effectiveness of digital communication interventions relative to the costs of communication-related errors would further support evidence-based implementation decisions. Finally, qualitative investigation of the cultural and hierarchical factors shaping how communication failures are experienced and attributed differently by dentists and dental technicians would complement the quantitative findings reported here.

Conclusions

This exploratory multicenter study documents a persistent implementation gap between the availability of digital communication technologies and their consistent adoption in prosthetic dentistry workflows. Verbal communication — the modality most resistant to digitalization — was associated with the highest error rates, while standardized forms, despite yielding the greatest satisfaction, remained incompletely utilized in three-quarters of cases. These pilot findings collectively argue for a more deliberate integration of digital prescription tools, CAD/CAM-compatible workflows, and mandatory structured communication standards into both dental education curricula and clinical practice guidelines. The

incomplete transition from analog to digital interdisciplinary communication represents not merely an organizational shortcoming but a missed opportunity for biotechnological innovation to deliver its full clinical and efficiency benefits. Future research should prospectively evaluate the impact of specific digital workflow implementations on error rates, turnaround times, and patient-reported outcomes across diverse healthcare systems, with particular attention to the training and infrastructure investments required to achieve equitable adoption.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania (protocol code AVZ 8/06/01/2023).

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