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Original Article

Bedside inoculation accelerates detection and improves microbiological diagnosis efficiency compared to delayed inoculation

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Abstract: Objective: To evaluate the differences in effects between bedside inoculation and traditional delayed inoculation methods in diagnosing wound infections, focusing on positivity rates, diagnostic cycles, and therapeutic outcomes. Methods: This prospective interventional study was conducted at the Wound Treatment Center of West China Hospital, Sichuan University, from April 2023 to July 2024. Patients were randomly assigned to a bedside inoculation group (n=132) or a delayed inoculation group (n=132). The effectiveness of the two methods was compared based on wound culture outcomes, bacterial species identified, detection of rare bacteria, wound healing rates, and patient satisfaction. Results: The bedside inoculation group had a significantly shorter detection report time compared to the delayed inoculation group (P<0.001). It also demonstrated a higher rate of detecting complex microbiomes (P=0.003). After 4 weeks, wound area reduction was significantly greater in the bedside group (P<0.001), and this difference remained significant at 8 weeks. The bedside group also had higher Barthel index scores (P<0.05), better wound healing scores (P<0.001), and greater patient satisfaction (P<0.001) than the delayed group. Conclusion: Bedside inoculation enhances wound infection diagnosis by accelerating result turnaround, reducing overtreatment, and promoting faster healing, ultimately improving patient care.

Keywords: Bedside inoculation, wound infection, diagnostic efficiency, wound healing, patient satisfaction

Introduction

Wound infection occurs when pathogenic microorganisms invade and proliferate within a wound, triggering responses that range from local inflammation to systemic illness [1]. Such infections are a major contributor to delayed or impaired wound healing [2]. In China, recent data indicate that approximately 36% of wounds become infected [3], which can significantly hinder recovery and, in severe cases, even threaten patient survival [4].

To determine optimal treatment strategies - whether topical or systemic - clinicians typically rely on microbial analysis of wound samples [5]. Common sampling methods include biopsy, curettage, exudate aspiration, and collection of viable tissue following sharp debridement [6]. Among these, wound swabbing is the most widely used in clinical practice due to its simplicity, non-invasiveness, and cost-effectiveness [7]. However, a persistent challenge is the discrepancy between clinical signs of infection and negative culture results. The reliability of wound cultures is influenced by several factors: sample collection, transportation, inoculation, and incubation. Errors at any of these stages, such as delayed transport, temperature fluctuations, or improper inoculation, can lead to mismatches between laboratory findings and the actual microbial state of the wound [4]. Minimizing these variables is therefore essential for improving diagnostic accuracy.

Bedside inoculation involves directly transferring collected samples onto culture media at the patient's bedside, thereby reducing the time between sample collection and processing. Emerging evidence suggests this approach improves the reliability of microbial cultures in clinical settings [8]. For example, Brendefur et

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al. observed a significant increase in positive culture rates for both symptomatic urethral and asymptomatic pharyngeal specimens using bedside inoculation [9]. Similarly, Lyer et al. reported a consistent 2% improvement in detection rates for pleural fluid cultures with this method [10]. While most existing research has focused on bedside inoculation for blood, peritoneal fluid, and urethral samples [9], its use for wound specimens remains underexplored. Investigating whether this technique enhances microbial detection in wound cultures could have important clinical implications: more accurate diagnoses may facilitate earlier infection identification, guide targeted treatment, and accelerate patient recovery.

Timely diagnosis and treatment of wound infections are critical for promoting healing, as early intervention can limit infection spread and improve patient outcomes [11]. However, traditional wound culture methods often involve delays and low bacterial detection rates, leading to diagnostic uncertainty and suboptimal treatment [12]. To address this, the Wound Treatment Center of West China Hospital of Sichuan University launched this stud, in collaboration with the Department of Experimental Medicine's Bedside Inoculation New Technology Task Force. The aim was to compare the efficacy of this novel technique with conventional methods by analyzing final culture outcomes.

Materials and methods

Study design

This study utilized a prospective interventional design to evaluate the impact of bedside inoculation compared to the traditional delayed inoculation technique on wound culture positivity rates, bacterial species, and the detection of rare bacteria. The study was conducted at the Wound Treatment Center of West China Hospital, Sichuan University, from April 2023 to July 2024. Patients were randomly assigned to either the bedside inoculation group (n=132) or the delayed inoculation group (n=132). The effects of the two inoculation techniques on wound culture outcomes were then compared. The study was approved by the Medical Ethics Committee of West China Hospital, Sichuan University (Ethical Approval No. 2023. examine. No. 532), and conducted in accordance with the principles of the Declaration of Helsinki. All participants provided written informed consent. To ensure the protection of patient privacy, all research data underwent two independent reviews.

Study participants and data handling for dropout

Inclusion criteria: 1) Age ≥18 years [13]; 2) Presence of infection signs or suspected biofilm, with no healing trend after conventional wound treatment and evidence of low-level chronic inflammation [14, 15].

Exclusion criteria: 1) Patients who received systemic or local antibiotic treatment within 1 week before sample collection [16]; 2) Specimens with confirmed or suspected contamination [17].

Data Dropout Handling: For data analysis, patients with missing data due to loss to follow-up, withdrawal, or incomplete records were managed using the intention-to-treat (ITT) approach [18]. This method includes all randomized patients in the final analysis and appropriately handles missing data (e.g., via imputation), thereby minimizing potential bias in study conclusions caused by dropout.

Grouping and intervention methods

Grouping: Participants were randomly assigned to one of two groups using computer-generated randomization.

Bedside inoculation group: Both groups used the Levine technique for collecting wound secretions: the wound bed was cleaned with saline, excess moisture was blotted dry, and a sterile swab was gently pressed onto the wound surface to obtain samples. In this group, samples were immediately streaked onto blood agar plates at the bedside, which were then promptly transported to the microbiology laboratory for incubation and analysis.

Delayed inoculation group: Collected samples were placed into transport tubes and sent to the laboratory per standard protocols, resulting in a brief delay between collection and inoculation due to conventional handling and transportation. All specimens reached the laboratory within 30 minutes, followed by incubation at 35°C with 5% CO_2 for 18-24 hours. After incubation, plates were examined for bacterial growth; robustly growing colonies were select-

ed, heat-fixed, and subjected to Gram staining for preliminary identification. Randomization was performed using specialized software to ensure balanced allocation based on predefined inclusion criteria.

Observational indicators

Primary outcome indicators: (1) Detection report time [19]: Time from sample collection to generation of the laboratory report. (2) Bacterial detection positive rate [20]: Proportion of samples with detected bacterial growth relative to the total number of samples. (3) Detection of complex microbial communities [21]: Identification of complex microbial communities in wound samples via bacterial culture. (4) Number of treatment prescriptions [22]: Total prescriptions issued during hospitalization. (5) Types and counts of detected wound bacteria [23]: Identification and enumeration of bacterial species (including common/rare pathogens) and their loads. (6) Wound area healing rate [24]: Percentage reduction in wound area at specific time points (4 weeks, 8 weeks), calculated as [(Initial area - Final area)/Initial area] ×100%. (7) α-Diversity and Relative Abundance via 16S rRNA Sequencing [25]: Microbial diversity assessed using α-diversity indices (e.g., Chao, Shannon, Simpson) and relative abundance of bacterial species identified by 16S rRNA sequencing.

Secondary outcome indicators: (1) Wound treatment duration [26]: Total time from initiation of wound care to stable wound healing. (2) Barthel index [27]: Measures independence in daily activities (e.g., eating, bathing, walking) via 10 items, scored 0-100 (higher scores indicate greater independence). (3) Wound healing score (WHS) [28]: Evaluates wound healing based on size, new tissue growth, exudate, and infection signs, scored 0-10 (higher scores indicate better healing). (4) Patient satisfaction [29]: Assessments of satisfaction with treatment process, outcomes, and overall experience. The Barthel Index, WHS, and patient satisfaction were evaluated at 8 weeks after admission.

Sample size estimation

To detect meaningful differences in positive culture rates between the two groups, sample size was calculated using PASS software. Based on previous studies [8], the positive culture rates were 81% for bedside inoculation and 52% for delayed inoculation. Using the "Two Proportions" module in PASS, with a significance level of 0.05, power of 80%, and equal group allocation, the calculated sample size was ~47 participants per group, yielding a total of 94 participants. This sample size provides sufficient statistical power to detect significant differences in positive culture rates between the two methods.

Statistical analysis

Data were compiled in Excel and analyzed using SPSS 24.0. Continuous data with a normal distribution are presented as mean ± standard deviation (Mean ± SD), and between-group differences were assessed using independent samples t-tests. Non-normally distributed continuous data are presented as median and interquartile range [M (Q1, Q3)], with between-group comparisons using the Mann-Whitney U test. Categorical data are expressed as counts and percentages [n (%)], and between-group comparisons were made using Pearson's χ^2 test or Fisher's exact test (for small samples). For within-group comparisons over time, paired t-tests were used for normally distributed data, and the Wilcoxon signed-rank test for non-normally distributed data. Cox regression analysis was used to evaluate the cumulative proportion of wounds under treatment, with hazard ratios calculated to assess time-to-event differences between groups. All tests were two-tailed, with statistical significance set at $P<0.05$.

Results

Comparison of baseline data

As shown in **Table 1**, no significant differences were noted between the groups in gender, age, residence, marital status, income, wound type, wound duration, wound infection severity score, diagnostic category, diabetes, or hypertension (all $P>0.05$).

Comparison of primary outcome indicators

As depicted in **Figure 1A**, the detection report time was significantly shorter in the bedside inoculation group than in the delayed inoculation group (61.76±9.16 vs. 77.61±6.27 hours,

Table 1. Comparison of baseline data between the two groups

Variables	Total (n=264)	Bedside inoculation (n=132)	Delayed Inoculation (n=132)	Statistic	P
Sex, n (%)				χ^2=1.65	0.199
Male	94 (35.61)	52 (39.39)	42 (31.82)		
Female	170 (64.39)	80 (60.61)	90 (68.18)		
Age, n (%)				χ^2=3.34	0.188
≥60	71 (26.89)	42 (31.82)	29 (21.97)		
18-44	103 (39.02)	47 (35.61)	56 (42.42)		
45-59	90 (34.09)	43 (32.58)	47 (35.61)		
Residence, n (%)				χ^2=2.07	0.355
Within the city	153 (57.95)	82 (62.12)	71 (53.79)		
Outside the city but within the province	80 (30.30)	35 (26.52)	45 (34.09)		
Outside the province but within the country	31 (11.74)	15 (11.36)	16 (12.12)		
Marital Status, n (%)				χ^2=0.09	0.763
Unmarried	56 (21.21)	27 (20.45)	29 (21.97)		
Married	208 (78.79)	105 (79.55)	103 (78.03)		
Income (¥), n (%)				χ^2=1.04	0.903
<2001-5000000	86 (32.58)	45 (34.09)	41 (31.06)		
>20000	3 (1.14)	1 (0.76)	2 (1.52)		
10001-20000	18 (6.82)	10 (7.58)	8 (6.06)		
2001-5000	83 (31.44)	39 (29.55)	44 (33.33)		
5001-10000	74 (28.03)	37 (28.03)	37 (28.03)		
Wound Type, n (%)				χ^2=0.17	0.685
Trauma	77 (29.17)	37 (28.03)	40 (30.30)		
Ulcer	187 (70.83)	95 (71.97)	92 (69.70)		
Wound Duration, n (%)				χ^2=0.02	0.898
More than 1 month	97 (36.74)	48 (36.36)	49 (37.12)		
Within 1 month	167 (63.26)	84 (63.64)	83 (62.88)		
Wound Infection Severity Score	6.6±1.85	6.5±1.8	6.7±1.9	t=-0.38	0.880
Diagnosis Type, n (%)				χ^2=2.66	0.103
Initial diagnosis	157 (59.47)	72 (54.55)	85 (64.39)		
Re-diagnosis	107 (40.53)	60 (45.45)	47 (35.61)		
Diabetes, n (%)				χ^2=0.27	0.603
No	225 (85.23)	114 (86.36)	111 (84.09)		
Yes	39 (14.77)	18 (13.64)	21 (15.91)		
Hypertension, n (%)				χ^2=0.20	0.656
No	242 (91.67)	122 (92.42)	120 (90.91)		
Yes	22 (8.33)	10 (7.58)	12 (9.09)		

Note: χ^2: Chi-square test.

P<0.001). The average number of treatment prescriptions also differed significantly (P< 0.001): 4.63±1.66 in the bedside inoculation group versus 6.56±1.98 in the delayed inoculation group (**Figure 1B**). As shown in **Table 2**, the bacterial detection positive rate was significantly higher in the bedside inoculation group (71.21% [94/132]) than in the delayed inoculation group (54.55% [72/132], P=0.005). A significant between-group difference was also observed in polymicrobial detection (P=0.003): 44 cases (33.33%) in the bedside inoculation group versus 31 cases (23.48%) in the delayed inoculation group.

Bacterial species and quantity detected in patient wounds

As shown in **Figure 2A**, *Staphylococcus aureus* was the most prevalent pathogen in both groups (39 cases in the bedside inoculation group vs. 29 in the delayed inoculation group). *Staphylococcus epidermidis* was the second most common (14 vs. 17 cases). Other notable bacteria included *Escherichia coli* (*E. coli*, 9 vs. 5 cases), *Pseudomonas aeruginosa* (4 cases in the bedside inoculation group), and *Klebsiella pneumoniae* (7 vs. 3 cases). Less common species included *Acinetobacter baumannii*, *En-*

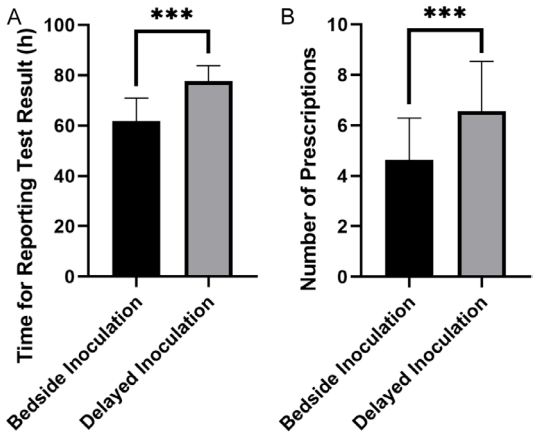

Figure 1. Comparison of diagnostic reporting time and treatment prescription frequency between bedside and delayed inoculation groups. Note: Compared with delayed inoculation group, ***P<0.001.

terococcus faecalis, *Streptococcus constellatus*, and *Clostridium cruzi* in both groups. Rare species such as *Enterobacter cloacae* complex and *Proteus mirabilis* were detected once in the delayed inoculation group, while *Staphylococcus striatum* was identified in 2 cases in the bedside inoculation group.

As shown in **Table 3**, α-diversity analysis of bacterial samples revealed significantly higher Chao, Shannon, Simpson, and Invsimpson indices in the bedside inoculation group, indicating greater bacterial richness and diversity. Specifically, higher Chao (3315.57±2107 vs. 3019.37±843, P<0.05) and Shannon (5.42±0.45 vs. 3.51±0.11, P<0.01) indices in the bedside inoculation group reflected increased species richness, while elevated Simpson and Invsimpson indices indicated a more diverse and balanced microbial Composition (P<0.01).

As illustrated in **Figure 2B**, *Staphylococcus aureus* was the most abundant species in both groups, with slightly higher levels in the bedside inoculation group (P<0.001).

As shown in **Figure 3**, the microbial composition of wound samples differed between groups: data points were more dispersed in the bedside inoculation group, whereas those in the delayed inoculation group (red circles) clustered more tightly, with partial overlap (**Figure 3A**, P=0.042). At the phylum level (**Figure 3B**), *Firmicutes* was the most abundant in both groups, followed by *Proteobacteria*. At the genus level (**Figure 3C**), *Staphylococcus* predominated, with higher abundances of *Pseudomonas* and *Enterococcus* in the bedside inoculation group. At the species level (**Figure 3D**), *Staphylococcus aureus* was the most prevalent, with higher detection rates of *Pseudomonas aeruginosa* and *Enterococcus faecalis* in the bedside inoculation group. Significant differences in microbial composition between the two groups were observed at the species, genus, and phylum levels as well (all P<0.001, chi-square test).

Comparison of prognostic outcomes

As shown in **Table 4** and **Figure 4**, the wound area reduction rate was significantly higher in the bedside inoculation group than in the delayed inoculation group at both 4 and 8 weeks. At 4 weeks, the rate was 65.29%±15.95% in the bedside inoculation group versus 44.15%±17.72% in the delayed inoculation group (P<0.001). At 8 weeks, the rate was 73.94%±10.19% versus 59.18%±20.29% (P<0.001). Both groups showed significant improvements in area reduction rates from 4 to 8 weeks: an absolute improvement of 8.65% in the bedside inoculation group and 15.03% in the delayed inoculation group.

As shown in **Figure 5**, the proportion of wounds still under treatment was significantly lower in the bedside inoculation group (P=0.011).

As depicted in **Figure 6**, the Barthel index was significantly higher in the bedside inoculation group (P<0.05), as was the wound healing score (P<0.001).

As shown in **Table 5**, patient satisfaction was significantly higher in the bedside inoculation group (62.88%) than in the delayed inoculation group (42.42%, P<0.001). Moderate satisfaction was similar between groups (32.58% vs. 36.36%, P>0.05). Additionally, the rate of return visits due to wound-related issues was lower in the bedside inoculation group (6.82%) than in the delayed inoculation group (20.45%, P=0.002).

Discussion

When bacteria invade the skin and subcutaneous tissue, they release toxins and proteases that delay collagen synthesis and epitheliali-

Table 2. Comparison of outcome measures between the two groups

Variables	Total (n=264)	Bedside inoculation (n=132)	Delayed Inoculation (n=132)	Statistic	P
Bacterial test, n (%)				χ^2=7.85	0.005
Positive	166 (62.88)	94 (71.21)	72 (54.55)		
Negative	98 (37.12)	38 (28.79)	60 (45.45)		
Complex microbiota detection, n (%)				χ^2=8.84	0.003
No	220 (83.33)	119 (90.15)	101 (76.52)		
Yes	44 (16.67)	13 (9.85)	31 (23.48)		

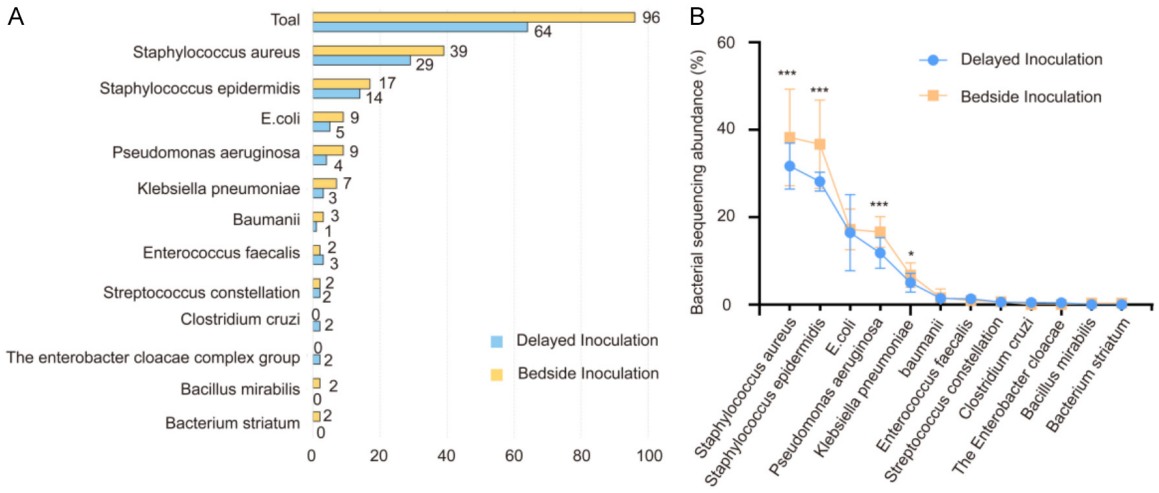

Figure 2. Relative abundance of top 10 bacterial species: number of cases and relative abundance. A. Bar chart of the top 10 strains detected from the wounds of the two patient groups. B. Relative Abundance Values of the Top 10 Bacteria in Bacterial Sequencing. Note: Compared with delayed inoculation group, *P<0.05, ***P<0.001.

Table 3. α-diversity analysis of bacterial samples between the two groups

Group	Chao	Shannon	Simpson	Invsimpson	Coverage
Delayed Inoculation	3019.37±843	3.51±0.11	0.27±0.21	3.18±0.58	1.00
Bedside inoculation	3315.57±2107*	5.42±0.45**	0.34±0.06**	6.52±2.18**	1.00

Note: Compared with Delayed Inoculation, *P<0.05, **P<0.01.

zation [30]. Early detection and monitoring of wound infections are therefore critical for timely healing and functional recovery. Wound infections are typically diagnosed semi-quantitatively when bacterial loads exceed 1×10^5 CFU/mL or per gram of tissue in wound cultures [31]. However, traditional wound swab cultures - primarily designed to identify aerobic bacteria - are often inadequate for detecting anaerobic organisms, which account for approximately 50% of wound-colonizing microorganisms. This limitation is due to their complexity, cost, and restricted clinical utility [32]. In addition, delays between sample collection and laboratory inoculation in traditional methods can reduce bacterial viability, compromising the reliability of culture results. In this study, the bedside inoculation group adopted an alternative approach by directly inoculating samples onto blood agar plates at the patient's bedside before further testing. This method produced higher positive detection rates, shorter turnaround times, and greater bacterial diversity, a shown by higher Chao, Shannon, Simpson, and Invsimpson indices compared to delayed inoculation. Staphylococcus aureus was more frequently detected in the bedside group. Patients in this group also experienced better wound healing, improved pain control, higher treatment satisfaction, and faster recovery at both 4 and 8 weeks.

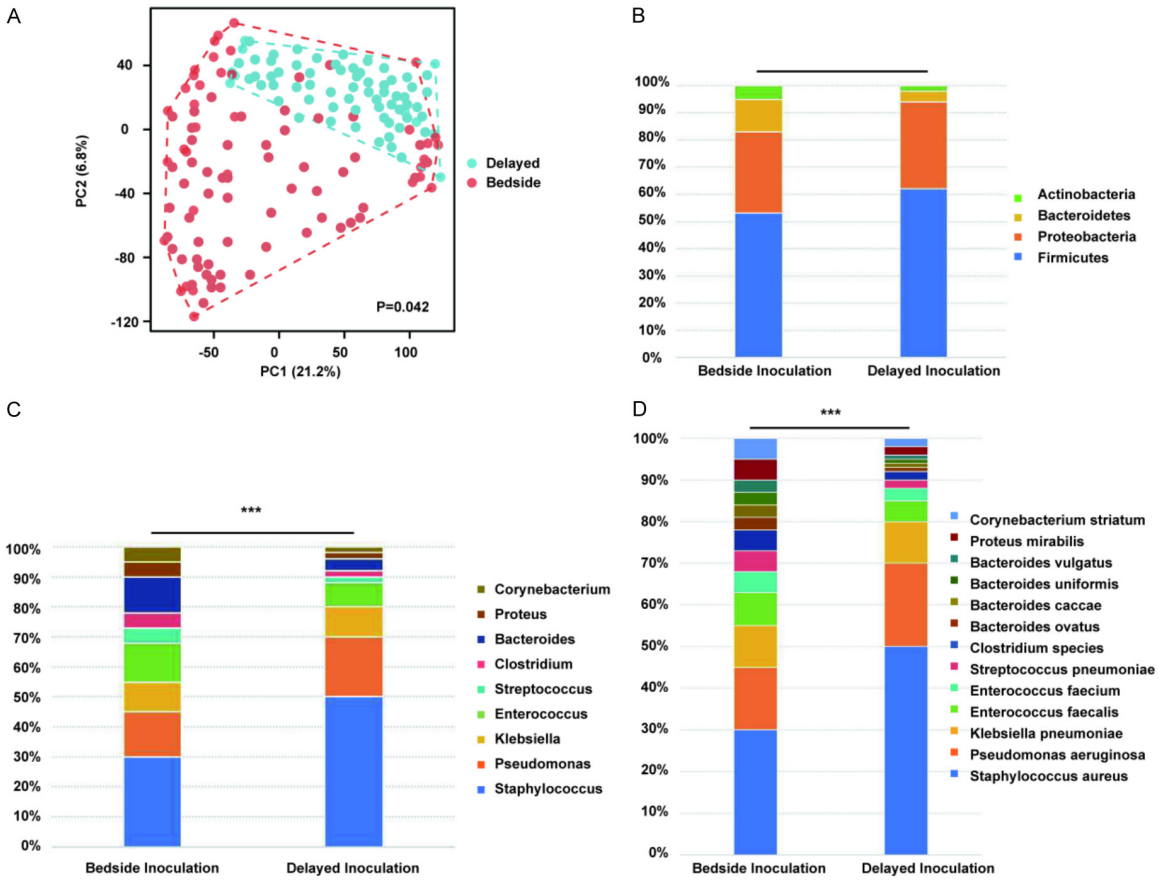

Figure 3. Comparison of microbial composition in wound samples between bedside and delayed inoculation groups. A. Principal Component Analysis (PCA) Scatter Plot. B. Phylum-Level Relative Abundance Bar Chart. C. Genus-Level Relative Abundance Bar Chart. D. Species-Level Relative Abundance Bar Chart. Note: Compared with delayed inoculation group, ***P<0.001.

Table 4. Comparison of the area healing rate at different time points between the two groups

Variables	Total (n=264)	Bedside inoculation (n=132)	Delayed Inoculation (n=132)	Statistic	P
The area reduction rate at 4 weeks, (%)	54.72±19.88	65.29±15.95	44.15±17.72	t=10.19	<0.001
The area reduction rate at 8 weeks, (%)	58.37±22.74	73.94±10.19	59.18±20.29	t=7.47	<0.001
Statistic	t=-7.24	t=-5.25	t=-6.41		
P	<0.001	<0.001	<0.001		

While prior studies recommend evaluating novel diagnostic techniques through withinsubject pre-post comparisons [33], this study employed a randomized controlled trial design to assess prognostic indicators linked to timely treatment. Baseline characteristics were comparable between the two groups, minimizing confounding variables and supporting the reliability of the results. The bedside inoculation group exhibited significantly shorter detection times. This aligns with the with rationale that immediate inoculation reduces delays between sample collection and culture initiation. In contrast, traditional delayed inoculation method requires transporting samples to the laboratory, which prolongs the time to detection. Bouscambert et al. similarly found that bedside inoculation shortened infection detection time by approximately 12 hours in critically ill patients and improved the accuracy of antibiotic selection [34]. This advantage is particularly valuable in high-risk environments like intensive care units (ICUs), where patients are immunocompromised and rapid infections can

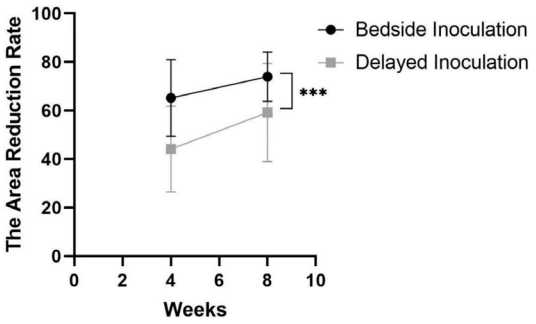

Figure 4. Comparison of wound area reduction rate over time between bedside and delayed inoculation groups. Note: Compared with delayed inoculation group, ***P<0.001.

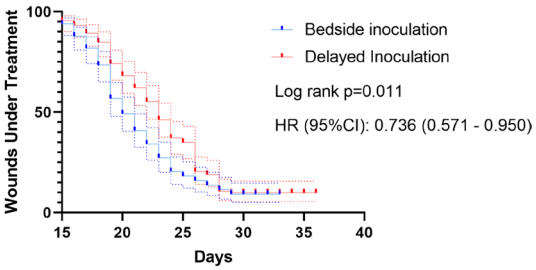

Figure 5. The impact of different inoculation timings on wounds under treatment: A comparison between bedside inoculation and delayed inoculation.

spread rapidly. In such cases, spread demand timely microbiological results are essential to guide treatment decisions and improve outcomes [35].

Primary outcomes revealed a significantly higher bacterial detection rate in the bedside inoculation group, indicating greater sensitivity for identifying infections. These findings gained supported by Blondeau et al., who observed higher positivity rates in bedside-inoculated peritoneal effluent samples from peritonitis patients [36]. Species distribution also differed between groups. Staphylococcus aureus, a common pathogen in skin and device-related infections, was more frequently detected in the bedside group, likely due to better viability preservation through immediate inoculation. Delays in processing may reduce the viability of growth of such pathogens. Staphylococcus epidermidis (17 vs. 14 isolates) and Escherichia coli (9 vs. 5 isolates) were also more abundant in the bedside group. Notably, less common species such as Bacterium striatum were uniquely identified in this group.there. Leegaard et al. reported similar findings in sexually trans-

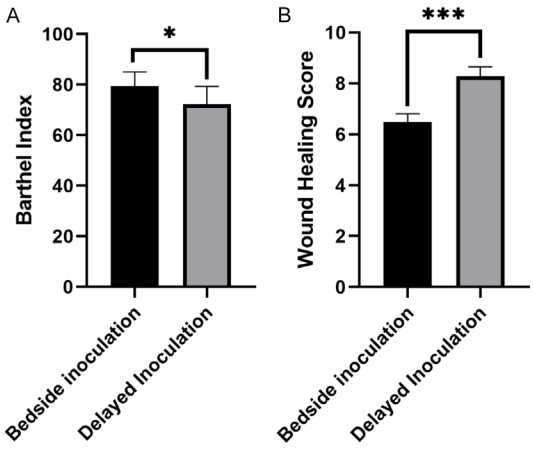

Figure 6. The impact of bedside inoculation versus delayed inoculation on functional status and wound healing. A. Barthel Index: The bedside inoculation group showed significantly higher scores than the delayed inoculation group (P<0.05). B. Wound Healing Score (WHS): The bedside inoculation group had significantly higher WHS scores than the delayed inoculation group (P<0.001). Note: Compared with delayed inoculation group, *P<0.05, ***P<0.001.

mitted infection clinics. In their study, bedside inoculation of Neisseria gonorrhoeae samples yielded a 57% positivity rate, compared to 41% with delayed laboratory processing. The improvement was attributed to reduced viability loss caused by transport delays and temperature fluctuations [9]. Van der Vyver et al. further demonstrated that enriching peritoneal dialysis fluid cultures with blood culture bottles enrichment to increased positivity rates from 23% to 51% [37, 38]. Collectively, these studies highlight that optimized inoculation methods, particularly bedside approaches are more effective at preserving fastidious pathogens.

α-Diversity analysis confirmed higher species richness in the bedside inoculation group. This aligns with Mahnic et al., who reported that traditional methods often underestimatethe complexity of wound microbiota [23]. β-diversity analysis showed greater dispersion in bedside samples, indicating richer microbial variability. In contrast, delayed inoculation samples clustered more tightly - likely due to the loss of sensitive species such as anaerobes during transport, leaving primarily robust, dominant taxa. Consistent with previous studies [39], Staphylococcus, particularly S. aureus, was the predominant genus in both groups. However, its relative abundance was higher in the delayed group likely due to reduced detection of other

Table 5. Comparison of patient satisfaction between the two groups

Variables	Total (n=264)	Bedside inoculation (n=132)	Delayed Inoculation (n=132)	Statistic	P
Patient satisfaction, n (%)				χ^2=19.75	<0.001
Satisfied	139 (52.65)	83 (62.88)	56 (42.42)		
Average	91 (34.47)	43 (32.58)	48 (36.36)		
Dissatisfied	34 (12.88)	6 (4.55)	28 (21.21)		
Return Visit Rate, n (%)				χ^2=9.73	0.002
Return Visit	36 (13.64)	9 (6.82)	27 (20.45)		
No Return Visit	228 (86.36)	123 (93.18)	105 (79.55)		

species, which led to more homogenous samples. Bedside inoculation not only preserved these dominant species but also revealed a broader range of genera, including *Pseudomonas* and *Enterococcus*. This confirms its superiority in capturing complex, polymicrobial communities by better maintaining microbial viability [40].

Beyond enhancing detection, bedside inoculation also accelerated clinical decision-making. Patients in the bedside group received fewer treatment prescriptions. This was likely due to earlier access to culture results, which enabled more targeted therapy and reduced unnecessary antibiotic use [41]. They also showed higher wound healing rates at 4 and 8 weeks, along with shorter hospital stays. These findings indicate that timely diagnosis contributed to faster recovery. Further benefits includedimprovements in Barthel index scores, wound healing scores, and overall patient satisfaction. The bedside group also had lower revisit rates, These outcomes highlight the clinical value of bedside inoculation, likely driven by reduced wound inflammation, optimized antimicrobial strategies, and a more favorable perceived prognosis [42].

Both methods have distinct advantages. Delayed inoculation benefits from established laboratory infrastructure and standardized workflows, making it suitable for high-volume processing. However, it risks the loss of fastidious pathogens due to transport and processing delays. In contrast, bedside inoculation is particularly effective in managing acute or severe infections - such as those in ICU patients or individuals with chronic wounds, by enabling rapid therapeutic adjustments. That said, it requires trained personnel, sterile materials, and strict contamination controls, which may be challenges in resource-limited settings. Therefore, selecting the appropriate inoculation method based on patient acuity and available resources is key to optimizing clinical outcomes.

This study has several limitations. Patient heterogeneity, such as differences between chronic and. acute wounds [43], could introduce bias, despite the use of randomization and intention-to-treat analysis. Future studies should incorporate robust subgroup analyses to better account for these variables. Additionally, the absence of detailed data on antimicrobial regimens and adjunct therapies limits our ability to fully assess their impact on clinical outcomes. Further refinement of bedside inoculation techniques, especially through the integration of advanced diagnostics such as electronic noses [44], may enhance precision of wound infection management.

In conclusion, bedside inoculation significantly reduces detection time, improves microbiological diagnostic efficiency, and enables earlier targeted treatment compared to delayed inoculation. Although overall bacterial positivity rates did not differ markedly between groups, bedside inoculation more effectively captured complex microbial communities, reduced unnecessary antibiotic prescriptions, accelerated wound healing, and enhanced patient satisfaction. These findings support its clinical value as an effective strategy for optimizing wound infection management.

Disclosure of conflict of interest

None.

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