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Patient satisfaction using handheld ultrasound at emergency department in Jordan University Hospital

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Abstract

Introduction The use of portable ultrasound equipment in emergency medicine has shown the capacity to greatly improve patient care in the swiftly changing field. This research evaluates the influence of the Butterfly POCUS device on patient contentment in the Emergency Department at Jordan University Hospital.

Materials and Methods We conducted a cross-sectional survey of 98 patients to examine their satisfaction levels after undergoing an ultrasound examination. We then evaluated these levels in relation to demographic and clinical characteristics.

Results Seventy eight percent of the patients expressed a high level of satisfaction with their evaluation. This satisfaction level was consistent across all patient demographics, with no notable differences. Significantly, there was a clear correlation between greater satisfaction levels and higher first pain ratings, indicating that the technology effectively addresses patient concerns and enhances the diagnostic experience.

Conclusion The findings of our study support the wider use of portable ultrasound technology in emergency care settings, emphasizing its ability to greatly enhance patient satisfaction and outcomes. Further investigation should include multicenter trials to authenticate these results and investigate the long-term effects on clinical practice.

Keywords Handheld Ultrasound, Patient Satisfaction, Emergency Medicine, Point-of-Care Ultrasound (POCUS), Butterfly POCUS

Introduction

Point-of-care ultrasound (PoCUS) enhances diagnostic accuracy [1, 2], expedites diagnosis, consultation, and final therapy [3, 4], and reduces complication rates when used for procedural guidance [5, 6]. PoCUS is a cost-efficient diagnostic tool [7, 8] that may eliminate the need for more invasive and costly procedures [9, 10]. It has been shown useful when used by different healthcare practitioners in various clinical environments [11, 12]. PoCUS is well-suited for resource-limited environments where alternative imaging methods may not be accessible, feasible, or costly, and transferring patients for radiological services may be difficult or impossible. PoCUS use has significantly risen in resource-constrained environments in the last ten years [13–15].

Technological advancements contributed to the introduction of true handheld ultrasound (HHU) devices into the POCUS industry [16]. The devices' wide popularity is evident due to their compact size, user-friendly

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interfaces, and affordable prices. Yet, like many new technologies in healthcare, the introduction of HHU devices presents several clinical and academic opportunities along with new challenges and intricate inquiries over patient data management [16]. The prospective applications of newly introduced HHU devices, such as the Butterfly iQ, in resource-limited settings (RLS), emergency departments (EDs), and critical care units (CCUs), have generated considerable interest. The iQ offers advantages such as compact size, reduced expenses, compatibility with the user's mobile device, and use of silicon-chip technology which eliminates the need for several transducers [17]. There has been little critical assessment of the device, especially in the context of RLS. We discuss our use of the Butterfly iQ in regular clinical activities in a fast-paced, high-acuity JUH ED and evaluate its effectiveness and suitability for RLS.

Materials and Methods

Study design and setting

This research used a cross-sectional design to assess patient satisfaction with the utilization of portable ultrasound equipment (Butterfly POCUS) in the Emergency Department (ED) of Jordan University Hospital, a prominent tertiary care center in Amman, Jordan. The decision to use a cross-sectional design was based on its appropriateness for evaluating the immediate viewpoints of a varied group of patients during a certain period, therefore offering a comprehensive summary of patient satisfaction levels and associated variables. Spanning a duration of three months, the research aimed to document the encounters of patients receiving ultrasound scans in diverse clinical situation, including trauma assessments as well as diagnostic evaluations for abdominal discomfort. All scans were performed by a single Emergency Medicine consultant who is also an assistant professor in the general surgery department, school of medicine in the University of Jordan who happen to be the owner of the Butterfly US probe.

Population and sampling

The research cohort included of patients who visited the Emergency Department and had ultrasonography tests utilizing the Butterfly POCUS equipment, the ultrasound exam performed included at least one of the following ultrasound modes according to each patient complaint and to the ultrasound mood which is being installed in the Butterfly machine (1. Soft tissue/Musculoskeletal. 2. Ophthalmic/Eyes. 3. Lungs. 4. Cardiac/Heart. 5.Abdomen/Pelvis. 6. Obstetric/Pregnancy. 7.Gynaecology. 8. Scrotal. 9. Doppler/Vascular. 10. US guided procedure). A comprehensive sampling method was implemented to guarantee a diverse and accurate representation of the emergency department's patient population, including individuals of all ages, genders, and with various clinical conditions. The sample frame consisted of patients selected at certain time intervals throughout the day and night to account for fluctuations in emergency department operations and patient movement, these US scans were done during the clinical shift of the working consultant so the US scan would be a continue on top of the clinal exam, time interval were random and depending on the patient complaint and the availability of the ED consultant who performed all the US scans. These factors have the ability to impact the ultrasound procedure and subsequent satisfaction. A non-probability convenience sample strategy was used, enrolling patients in a sequential manner when they arrived at the Emergency Department and fulfilled the criteria for inclusion This method enabled effective participant recruitment, which is crucial in the dynamic ED setting. The inclusion criteria were intentionally broad, including patients of all ages, both genders, and diverse therapeutic reasons for ultrasonography. This was done to achieve a thorough comprehension of patient satisfaction across a wide range of clinical situations.

Data collection instrument and procedure

The data collecting tool used was a structured and validated questionnaire to measure patient satisfaction (American Institute of Ultrasound in Medicine (AIUM). (2017). "Patient satisfaction surveys in diagnostic ultrasound: development, testing, and results." Journal of Ultrasound in Medicine with added questions specific to handheld ultrasound use. which included both closed and open-ended questions to get comprehensive input on patient experiences with portable ultrasound exams. The questionnaire was developed in a cooperative approach that engaged specialists in emergency medicine, radiology, and patient care quality. A focus group discussion guaranteeing its validity and reliability.. The pilot testing used a select sample of patients to improve the clarity and comprehensibility of the questions. A semi-structured interviews with a subset of patients to gain deeper insights into their experiences and satisfaction with the use of handheld ultrasound. Patients were recruited consecutively as they receive handheld ultrasound in the ED. Obtain informed consent from each participant.

The questionnaire covered several key areas:

- Demographic and Clinical Profile: The factors to consider are age, gender, education level, clinical presentation, and history of prior ultrasound tests.
- Ultrasound Examination Experience: Body type was determined through self reporting body mass index (BMI), a question about if the patient had a previous

US scan, if there are any associated trauma, if there is any pain we asked about the pain score, the onset and the location of the pain, the US mode of exam, and if there are any other related images being done during that visit.

- Satisfaction and Perception: The questionnaire consists of Likert-scale and open-ended inquiries designed to assess the patient's degree of satisfaction with the examination, their perception of the quality of treatment received, and the influence of the ultrasound findings on their comprehension of their medical condition. The overall satisfaction with the Butterfly probe exam was rated by answering a single question by the volunteers to choose one of the following answers (1. Extremely unsatisfied, 2. Unsatisfied, 3. Average, 4. Satisfied, 5. Extremely satisfied).
- Comparative Assessment: The study evaluated the experiences of patients who had previous ultrasound procedures, focusing on the comfort, speed, and overall satisfaction with standard ultrasound machines against handheld ultrasound devices. Data collection was promptly carried out after the ultrasound examination to record initial feelings and sensations. Patients used electronic tablets to complete the questionnaire, which allowed for immediate data collection and reduced the potential for memory bias. This technique also enabled a high rate of completion and ensured the confidentiality of replies.

Statistical analysis plan

The statistical analysis was designed to provide a thorough assessment of the gathered data. The dataset's integrity was verified by initial data cleaning and validation methods. Descriptive statistics, including measures such as mean, median, mode, standard deviation, and range, were used to provide a concise summary of demographic factors, clinical features, and satisfaction ratings. The categorical data were shown as frequencies and percentages. Demographic and clinical factors were analyzed using inferential statistics to investigate their relationship with patient satisfaction levels. Chi-square tests were used to analyze categorical variables, whilst t-tests and one-way ANOVA were applied for continuous variables. The choice between t-tests and one-way ANOVA depended on the data distribution and the number of groups being compared. A multivariate logistic regression analysis was performed to determine the independent factors that predict high satisfaction with the portable ultrasound examination, while taking into account any confounding variables. The threshold for statistical significance was established at a p-value of less than 0.05. The studies were conducted using Python version 3.12.2, and the findings were presented in tables and figures to facilitate straightforward dissemination.

Results

Participant demographics and clinical characteristics

The research included 98 subjects who had ultrasound tests using the Butterfly POCUS equipment in the Emergency Department at Jordan University Hospital. The cohort had a marginal male majority, with 55 (56%) male and 43(44%) female participants, and included a wide age range from 1 to 90 years (mean age = 54.8 years). The participants exhibited a range of educational attainment, with the largest proportion (57%) having completed high school or less. Following this, 22% of participants had a bachelor's degree, while a lesser fraction possessed advanced academic degrees (see Table 1). For a visual representation of the gender distribution, refer to Fig. 1, and for the age distribution, refer to Fig. 2.

The patient group had a wide range of clinical features, with body types classified as follows: 34% overweight, 29% slim, 21% average, and 16% slightly overweight. Figure 3 illustrates the distribution of body types.

Ultrasound examination details

The majority of ultrasound tests were performed for abdomen/pelvis (67%), cardiac/-heart (36%), and lung evaluations (24%). Further information on the distribution of ultrasound modes employed is provided in the discussion section. Participants provided diverse pain levels before the evaluation, with 28% expressing no pain (score of 0) and 14% reporting the maximum pain score of 10.

Patient satisfaction

The Butterfly POCUS equipment yielded an overwhelmingly positive response from the majority of participants, with 78% being"Extremely satisfied" with their ultrasound examination. Additionally, 12% expressed being"Satisfied" and 9% deemed their satisfaction level to be"Average". Merely a minuscule proportion (1%) expressed" Extremely unsatisfied" sentiment. The degrees of satisfaction are shown in Table 2 and Fig. 4.

Statistical analysis

Chi-square tests indicated that there were no statistically significant variations in satisfaction levels across various demographic categories ($p > 0.05$). This suggests that patient satisfaction with the handheld ultrasound equipment remained consistently high, regardless of age, gender, or education level. In addition, a one-way

Table 1 Distribution of participants by: Gender, level of education, and the US mode

Distribution of Gender with Pain Onset				
Gender	**Gradual**	**Sudden**	**Unknown**	**Grand Total**
Female	19	13	11	43
Male	16	23	16	55
Grand Total	**35**	**36**	**27**	**98**
Level of education			**Count of Level of education**	
High school or less			57.14%	
Bachelor's degree			22.45%	
diploma degree			14.29%	
Phd, or equivalent			3.06%	
Master degree			3.06%	
Grand Total			**100.00%**	
Ultrasound mode			**Count of Ultrasound mode**	
Abdomen/pelvis			47	
Abdomen/pelvis | Cardiac/heart | Lungs			3	
Abdomen/pelvis | Gynaecology			1	
Abdomen/pelvis | Lungs			2	
Abdomen/pelvis | Soft tissue/MSK			1	
Cardiac/heart			14	
Cardiac/heart | Abdomen/pelvis			3	
Cardiac/heart | Abdomen/pelvis| Lungs			2	
Cardiac/heart | Lungs			1	
Cardiac/heart | Lungs | Abdomen/pelvis			1	
Doppler/vascular			1	
Doppler/vascular | Cardiac/heart			1	
Lungs			5	
Lungs | Cardiac/heart			4	
Lungs | Cardiac/heart | Abdomen/pelvis			6	
Scrotal			1	
Soft tissue/MSK			5	
Grand Total			**98**	

analysis of variance (ANOVA) revealed that there was no statistically significant variation in satisfaction ratings among individuals with different body types ($p > 0.05$). Nevertheless, a noteworthy association was seen between patient satisfaction and the pain score before the test ($p < 0.01$), indicating that patients with higher pain ratings expressed higher levels of pleasure with their ultrasound experience (see Table 3).

Discussion

The objective of this research was to assess the level of patient satisfaction about the use of portable ultrasound equipment (Butterfly POCUS) in the emergency department at Jordan University Hospital. The results indicate a significant degree of contentment among patients, with 78% expressing great satisfaction with their ultrasound examination. The findings emphasize the capacity of portable ultrasound devices to improve patient experiences in emergency care environments. This aligns with previous studies that emphasize the advantages of point-of-care ultrasound (POCUS) in enhancing diagnostic precision, speeding up decision-making, and promoting communication between patients and healthcare providers [18, 19].

The high levels of satisfaction seen in our research may be ascribed to many aspects that are intrinsic to the use of portable ultrasound equipment. Devices like the Butterfly POCUS provide ultrasound readings that are immediate and clear, which may greatly reduce patient anxiety, particularly in high-stress settings like the emergency room [20]. Moreover, the mobility and user-friendliness of these devices allow healthcare personnel to do exams at the patient's bedside, decreasing the need for patient transportation and thereby lowering pain and waiting periods. These characteristics are crucial in ensuring patient satisfaction. Our research also found

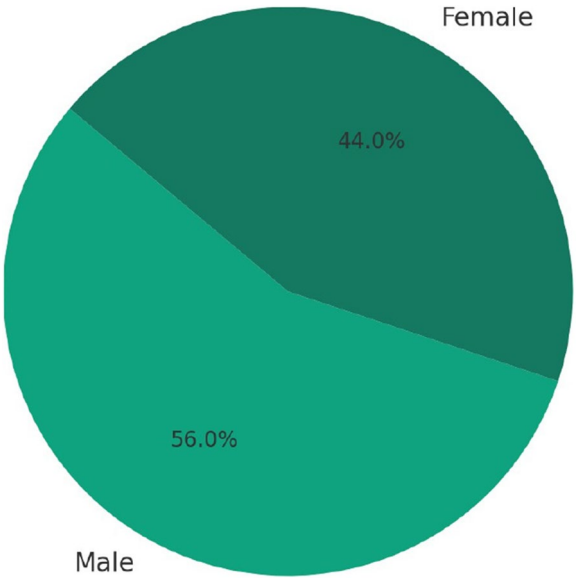

Fig. 1 Participant demographics—gender distribution

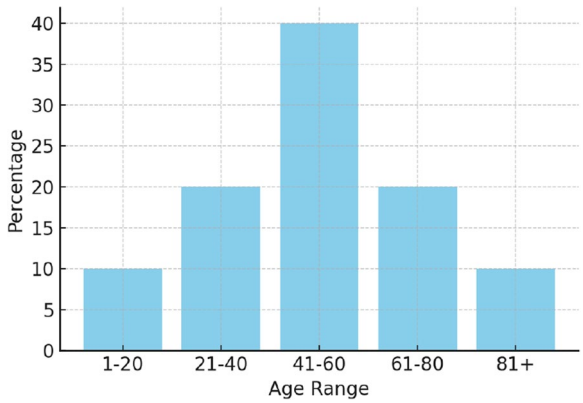

Fig. 2 Participant demographics—age distribution

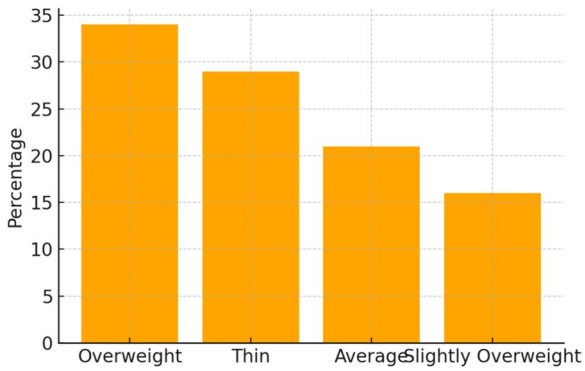

Fig. 3 Clinical characteristics—body types

Table 2 Patient Satisfaction Levels

Satisfaction Level	Total (N = 98)	Percentage (%)
Extremely Satisfied	76	78%
Satisfied	12	12%
Average	9	9%
Extremely Unsatisfied	1	1%

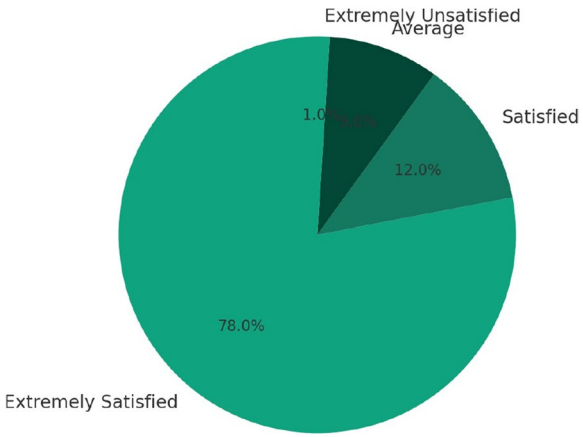

Fig. 4 Patient Satisfaction Levels with the Butterfly POCUS Device

Table 3 Statistical Analysis of Patient Satisfaction with Handheld Ultrasound (HH US)

Variable	Test	*p*-value
Gender	χ^2	0.65
Age Group	ANOVA	0.52
Body Type	χ^2	0.73
Prev. Exam w/ US	χ^2	0.58
US Mode	χ^2	0.49
Pain Score	Pearson	< 0.01

Notes: χ^2 Chi-square test, *Prev. Exam w/ US* Previous Examination with Ultrasound, *US Mode* Ultrasound Mode Used, *HH US* Handheld Ultrasound

that satisfaction levels did not vary significantly based on demographic and clinical variables. This suggests that portable ultrasonography is universally appealing and beneficial for a varied range of patients. A significant association was seen between greater pain ratings and improved satisfaction levels, which may indicate that patients value the quick and non-invasive aspect of ultrasound tests in treating and detecting painful diseases. The study's findings on portable ultrasound demonstrate a strong correlation with previous research, which indicates that POCUS contributes to improved patient satisfaction by providing prompt diagnostic information and individualized therapy [21]. Research has shown POCUS

has a substantial effect on how patients are treated in emergency situations, resulting in faster diagnosis and the start of therapy [18, 19, 22]. The results of our study add to the existing data, emphasizing the need of incorporating portable ultrasound technology into the practice of emergency care [16]. The consequences of our discoveries are many and varied. Initially, they emphasize the need for emergency departments to include and use portable ultrasound equipment as a customary component of patient treatment [23]. This is not only due to their diagnostic capabilities but also because of their favorable influence on patient satisfaction. It is crucial to prioritize training and proficiency in the use of these devices, so that all emergency medicine practitioners are skilled in providing this high level of care. Furthermore, the favorable response from patients creates opportunities to extend the use of portable ultrasonography beyond the emergency room. This technology may be utilized in primary care and distant medical services to address limitations in diagnostic resources. Although our research offers significant insights, it does have limits. The use of a single-center design may restrict the applicability of the results to other healthcare settings and demographics. Furthermore, due to the cross-sectional design of the research, it is not possible to evaluate the long-term satisfaction and results related to the use of handheld ultrasonography. In order to overcome these constraints, future research should focus on performing multicenter, longitudinal studies to investigate patient satisfaction and clinical outcomes over an extended period of time. Moreover, qualitative research has the potential to provide more profound understanding of the particular elements of portable ultrasound exams that have the greatest impact on patient satisfaction.

Conclusion

Our study's results demonstrate that the introduction of portable ultrasound equipment, namely the Butterfly POCUS, in the emergency department at Jordan University Hospital has received significant patient acceptance. A staggering 78% of the patients who were assessed expressed a high level of satisfaction, highlighting the potential of these gadgets to not only speed up diagnostic procedures but also greatly improve the patient experience in acute care environments. This research adds to the growing body of data that confirms the benefits of POCUS technology in enhancing clinical outcomes and patient-centered treatment. The widespread contentment across various patient demographics and clinical situations highlights the adaptability and efficacy of the Butterfly POCUS device. The results of this research support the idea of incorporating POCUS more extensively into emergency care procedures. This would include using its skills to provide quick, precise, and comforting diagnostic assessments immediately at the patient's bedside. The link identified between increased patient satisfaction and acute pain presentations underscores the crucial significance of POCUS in addressing immediate patient concerns and enabling prompt treatment choices.

Although the findings are positive, it is important to exercise care when applying the results generally due to the study's restricted scope, which is constrained by its single center design and cross-sectional approach. In order to confirm these results in a wider range of healthcare settings and assess the long-term effects of using handheld ultrasound on patient satisfaction and clinical efficiency, future research should focus on conducting multicenter, longitudinal studies. In addition, doing qualitative research to investigate the viewpoints of patients and healthcare providers may provide detailed and subtle understandings of how POCUS (Point-of-Care Ultrasound) is accepted and used in emergency medicine. Ultimately, the introduction of portable ultrasound technology represents a noteworthy progression in emergency medical treatment, holding the capacity to revolutionize both patient encounters and results. The study's findings on the high patient satisfaction ratings emphasize the need for healthcare systems to adopt and incorporate these innovations. This will provide a more flexible, attentive, and patient-focused approach to emergency treatment. As the medical field deals with the challenges of contemporary healthcare delivery, the integration of technologies such as the Butterfly POCUS demonstrates the ability of medical technology to improve patient care and happiness. Although further studies need to be done to compare the handheld US probes with the bedside machines, the Butterfly IQ is a cheaper US machine with a high level of patient satisfaction.

Authors' contributions
I.A collected the data and supervised the whole research, Y.A, S.J, F.A, H.M, and N.A, all worked together to write the article.

Funding
No funding was received.

Availability of data and materials
All data are available on forms.app and can be sent upon request

Data Availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The research was carried out in full compliance with the ethical principles outlined in the Declaration of Helsinki and received approval from the Institutional Review Board (IRB) at Jordan University Hospital. Consent was acquired from all subjects participating in the research. Every participant

received comprehensive information on the objectives, procedures, expected advantages, and possible hazards of the research.
In addition, they were duly advised of their entitlement to resign from the research at any point, without any implications for their medical treatment. Permission was obtained by the administration of a permission form, which participants were required to sign before being included in the study. This process ensured that their involvement was voluntary and that they had a clear knowledge of the research being undertaken. A written informed consent was obtained from all participants or, if participants are under 16, from a parent and/or legal guardian. Written informed consent was obtained from the patient for publication of this study and accompanying images.

Consent for publication
Written informed consent was obtained from the patient for publication of this study and accompanying images.

Competing interests
The authors declare no competing interests.

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