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# **Nurse and physician perceptions of working with Goal-Directed Therapy in the perioperative period**

## **Abstract**

*Purpose:* To explore nurse and physician perceptions of working with and collaborating about arterial wave analysis for Goal-Directed Therapy (GDT) to identify barriers and facilitators for use in anesthesia departments, post anesthesia care units (PACUs) and intensive care units (ICUs).

*Design:* A qualitative study drawing on ethnographic principles in a field study using the technique of non-participating observation and semi-structured interviews.

*Methods:* Data collection occurred using semi-structured interviews with nurses (n=23) and physicians (n=12) and field observations in three anesthetic departments. An inductive approach for content analysis was employed.

*Findings:* The results showed one overarching theme “Interprofessional collaboration encourage and impede” based on three categories: 1) Interprofessional and professional challenges; 2) Obtaining competencies; 3) Understanding optimal fluid treatment.

*Conclusions:* Several barriers identified related to interprofessional collaboration. Nurses and physicians were dependent upon each other’s skills and capabilities to use arterial wave analysis. Education of nurses and physicians is important to secure optimal use of GDT.

## **Keywords**

Early Goal-Directed Therapy, Fluid Therapy, Interdisciplinary communication, Patient safety, Physician-nurse relation, Qualitative research

## Introduction

Hemodynamic optimization to maintain adequate tissue perfusion in critically ill surgical patients is one of the most crucial tasks to accomplish for nurses and physicians in the operating room (OR), post anesthesia care unit (PACU) or intensive care unit (ICU).<sup>1</sup> Inadequate tissue perfusion can lead to postoperative complications and increased length of stay in the hospital.<sup>1</sup> In 1970, the pulmonary artery catheter were introduced for the measurement of cardiac output (CO) using the thermodilution method.<sup>2</sup> Today, CO and stroke volume (SV) are easily accessible through use of minimally invasive monitors, like arterial wave analysis for Goal-Directed Therapy (GDT).<sup>3,4</sup> The guidelines of GDT pertain to high-risk perioperative patients, sepsis and septic shock.<sup>5,6</sup> Local guidelines used in this study are based on these recommendations. Clinicians' compliance to GDT guidelines is often less than 50% due to following reasons: time consuming, labor intensive, and benefits from optimization are latent and limiting for patients who have atrial fibrillation or are spontaneous breathing.<sup>1,7</sup>

Evidence-based knowledge is intended to provide a stronger scientific foundation for professional practice and has been identified as a central competency for all health professionals by the Institute of Medicine of the United States.<sup>8</sup> It was originally conceived as a problem solving process comprising of five steps to be undertaken by the practitioner.<sup>9</sup> These steps require considerable skills and time.<sup>10</sup> Clinical guidelines and synthesizing the best available evidence in specific areas, are thought to help clinicians and ensure that decisions about patient care rely on evidence.<sup>11</sup> However, many factors influence the impact of guidelines on care. For example the acceptance of evidence, transparency of guidelines and the perceived adoptability.<sup>12</sup> Contextual, organizational, and cultural factors can also impede or limit guideline implementation.<sup>12</sup> Commonly used strategies in guideline implementation are education and printed material.<sup>13</sup> Nilsen et. al.<sup>14</sup> suggested low adherence to best practice is not necessarily caused by lack of knowledge, but that everyone, including health professionals, is prone to develop efficient and automatically activated habits. Therefore, different kinds of strategies are needed to disrupt unwanted habits and promote desired habits.<sup>14</sup>

Studies of nurses and physicians administration of intravenous (IV) fluid indicated current practice seems to be arbitrary, not evidence based, and potentially harmful.<sup>15,16</sup> To increase patient safety and reduce perioperative complications related to inadequate or excessive administration of fluid perioperatively, nurse and physician adherence to GDT guidelines and their experiences of using GDT in the clinical setting needs to be explored to guide the development of initiatives for improved adherence.

The aim of this study was to describe certified registered nurse anesthetists (CRNAs), PACU nurses, ICU nurses, and physician perceptions of arterial wave analysis in GDT in an attempt to identify barriers and facilitators for use in daily clinical practice.

## Method

### Design

This was a qualitative multicenter study drawing on ethnographic principles in a field study using the technique of non-participating observation (Spradley)<sup>17</sup> and semi structured interviews as described by Kvale and Brinkmann.<sup>18</sup> Non-participating observation made it possible to observe what happened in the departments when arterial wave analysis was used and explore situations that had become so routine-like that it could be difficult to put into words.<sup>17</sup> Semi-structured interviews elucidated nurses' and physicians' perceptions of their work with arterial wave analysis. The point of using data triangulation was to gain a good understanding from different perspectives about the phenomenon under investigation.<sup>19</sup> To ensure explicit and comprehensive reporting of the study, the Consolidated Criteria for Reporting Qualitative Research (COREQ) was applied.

### Setting

Data was collected at Departments of Anaesthesiology located at three university hospitals in Denmark. All departments had emergency surgical centers. Each department used arterial wave analysis for measuring CO in patients undergoing high-risk abdominal surgery and/or elective colorectal surgery. Only one department used arterial wave analysis in the PACU and ICU. In the ICU, arterial wave analysis was primarily used for unstable patients diagnosed with sepsis. The departments had 16, 27, and 13 operating rooms, respectively. The PACU had 15 beds and the ICU had 15 beds.

### Participants

A purposive sample of nurses and physicians with experience in working with GDT were invited to participate.<sup>19</sup> This was done to explore and describe the phenomenon from a varied perspective. The ward managers helped identify eligible participants with varying age, seniority and experience in using GDT (see Table 1).

<b>Table 1. Characteristics on participants</b>					
<b>OBSERVATIONS</b>	<b>Anaesthesia 1</b>	<b>Anaesthesia 2</b>	<b>Anaesthesia 3</b>	<b>PACU</b>	<b>ICU</b>
<i>Female/male</i>	12/1	7/1	6/0	4/1	12/2
<i>Age, median (range), years</i>	41 (35-45)	39 (37-46)	47 (33-53)	52 (39-63)	37 (26-65)
<i>Seniority<sup>a</sup>, median (range), years</i>	16 (7-33)	11 (7-17)	21 (8-26)	28 (12-40)	14 (3-41)
<b>INTERVIEW NURSES</b>					
<i>Female/male</i>	3/1	4/0	4/0	5/0	5/1
<i>Age, median (range), years</i>	50 (39-48)	44 (37-49)	43 (35-49)	46 (33-52)	40 (29-47)
<i>Seniority<sup>a</sup>, median (range), years</i>	26 (14-35)	19 (11-25)	19 (10-24)	22 (10-40)	12 (4-17)
<b>INTERVIEW PHYSICIANS</b>					
<i>Female/male</i>	1/3	2/2	2/2		
<i>Age, median (range), years</i>	43 (38-48)	44 (33-59)	45 (35-60)		
<i>Seniority<sup>a</sup>, median (range), years</i>	13 (2-34)	15 (4-30)	14 (2-34)		

<sup>a</sup>Seniority is defined as years of clinical experience postgraduate.

### *Data collection*

Observations were carried out from December 2016 to April 2017. Some of the observed situations were during emergent surgery. The observer was present during day-time and on call several times during evening and night shifts to obtain observations at different hours of the day. Observations of elective patients were carried out during day time. In ICU, the use of arterial wave analysis was rare. Therefore, the first author was present in the ICU in the morning to see if there were any patients connected to arterial wave analysis. Nineteen observations occurred in OR, five in PACU, and nine in the ICU. The median length of the observations were 3 hours in OR, 0.9 hours in PACU, and 1.5 hours in ICU. An observation guide was written by the authors: however, pilot field observations and research by Spradley<sup>17</sup> guided its developmental process. Observations involved an interplay between grand tour seeking (physical environment), and minitours (specific actions and events) relevant to elucidate the study aim.<sup>17</sup> Condensed field notes were taken during observations. Because it is impossible to write down everything that goes on or is said during an observation, these notes consist of phrases, single words and unconnected sentences<sup>17</sup>. Immediately after the observation, notes were expanded with details not recorded on the spot.

Semi-structured interviews using an interview guide were performed by the first author<sup>18</sup>. The interview guide was developed by the authors based on literature reviews related to implementation in healthcare, experience from field observations and discussions among the research team. The interview guide addressed four overall themes: (1) Working with GDT in everyday practice; (2) Perception of using the guideline for GDT; (3) Confidence in using GDT; (4) Cooperation with other health professionals when GDT is used. The interviews were performed during day time in an undisturbed room in the department where the participants were employed and at a time that suited nurses and physicians. Open ended questions were supported with “please elaborate” and “did I understand you correct when you said...”. A total of 35 interviews occurred: 23 nurses and 12 physicians. The median length of the interviews were 18 minutes. All interviews were audio recorded and transcribed verbatim. Data collection was continued until saturation was reached. Assessment of when saturation was reached were settled via discussions in the research group.

### *Data analysis*

To the best of our knowledge, no similar studies exist. Therefore we chose an inductive approach.<sup>20</sup> Data was analyzed using content analysis.<sup>21</sup> The analysis was conducted by the first and last author. The analysis was performed on a manifest level. A manifest analysis is the descriptive level at which the surface structure of the text close to the phenomenon and the study aim is described.<sup>21</sup> In the first part of the analysis, observations and interviews were analyzed separately. Data was divided in OR/PACU and ICU. Interviews with nurses and physicians were also divided in the analysis. Field notes and transcribed interview text were read through multiple times to be familiar with the data and acquire an overview of the texts. The texts were divided into meaning units that contained insight to answer the question set out in the study aim. Each identified meaning unit was condensed into text near descriptions and labelled with a code (see Table 2). The authors individually coded the text. After coding eight interviews, they met to compare codes, and discussed details in the texts to ensure a common understanding of the content. Then the rest of the material was individually coded and discussed until consensus was reached. Codes were then abstracted into subcategories individually by the authors and later discussed until consensus was reached on all subcategories. After subcategories were formulated, data was merged and three categories

were created. Subcategories were discussed, and consensus was reached to formulate three categories. In this part of the analysis, a second co-author (AB) was involved to increase the study's credibility.

## Ethical considerations

The study was registered within the Danish Data Protection Agency, file number: AHH-2015-061. The Danish National Ethical Committee on Health Research waived the need for consent, file number: 15012245. The study was approved by the head physician and head nurse of each center. Nurses and physicians were informed about the study and participation. Verbal and written consent were obtained from the participants prior to observations and interviews according to The Ethical Principles of the Declaration of Helsinki.<sup>22</sup> Participants were informed that they could withdraw from the study at any time. One participant withdrew after being observed because she felt the situation was not a representation of her work.

Meaning unit	Condensed meaning unit	Code
Nurse: I believe it helps with the fluid mostly. When do we begin and when do we stop	Believes it helps administer the right amount of fluid	Arterial wave analysis guides fluid administration
Physician: If you forget that the patient has atrial fibrillation, there are some of these parameters you can't use, or if it isn't validated well, they might not be responding on fluid bolus, but you can see stroke volume is decreasing. Then you must think. It is not to blame the nurse, but these things they don't see it.	You must able to interpret results, also if they are not standard. This is difficult for nurses	Difficult for nurses to interpret the results
Nurse: It was decided that we should use it. We didn't have any influence and we didn't know what it was. It was just another thing to do	No information gave a feeling of it as just another thing they had to do when they were already busy	Resistance because of lack of education

## Findings

In Table 3, one overarching theme was identified based on three categories, which were grounded by two subcategories. In the following text, theme and categories will be presented and supported by quotes.

<b>Theme:</b> Interprofessional collaboration encourage and impede		
<b>Category 1</b>	<b>Category 2</b>	<b>Category 3</b>
Interprofessional and professional challenges	Obtaining competences	Understanding optimal fluid treatment
<b>Subcategories</b> <i>Interprofessional collaboration in use of GDT</i>  <i>Professional difficulties</i>	<b>Subcategories</b> <i>To be involved in an implementation process</i>  <i>Lack of education and experience</i>	<b>Subcategories</b> <i>Arterial wave analysis and GDT is used for optimal fluid treatment</i>  <i>Variety in how the guidelines are used</i>

## Interprofessional and professional challenges

The physicians described the nurses as being positive towards the use of arterial wave analysis, even though they had many other tasks to complete. Physicians felt that they thought that arterial wave analysis should primarily be used after the patients were anesthetized and stabilized. However, this is usually the time when physicians leave the operating room, and where the continued use of arterial wave analysis depends on nurses' skills and knowledge. This was considered a barrier for nurses.

*"Sometimes when one thinks that they (the patients) should be monitored (with arterial wave analysis) but the nurse does not trust arterial wave analysis, then it is only when one is present as a physician that it (arterial wave analysis) is used" (Physician 1)*

*[The physician must go to see the next patient. The nurse asks if it is fluid she should begin with. The physician tells her that when she has infused 250 ml ringers-acetate, she should press the red button on the arterial wave analysis to stop the infusion. She tells the nurse to call her and says "look at the blood pressure if it gets too low, call me. Don't look at the other one (arterial wave analysis). The nurse says "but I would like to learn to use it. The physician leaves the operating room to see the next patient.] (Fieldnote)*

This barrier of using arterial wave analysis after the induction of the anesthesia was also described by the nurses. They did not feel competent in using arterial wave analysis and were thus limited to working independently when treating complicated patients. The nurses felt incompetent about interpreting arterial wave monitoring results. They felt isolated when the physician exited the operating room and described feeling uncertain about who was responsible for follow-up of measured values from arterial wave analysis. This felt demotivating and potentially resulted in arterial wave analysis not being used, which was thought of as a waste of resources. In such situations, the responsible physician was called in; arterial wave analysis was regarded as a physician responsibility.

*"That is how it is, they (physicians) have to come and help me with it if I cannot. If I think that the patient, maybe, if something doesn't fit compared to how much vasopressor is given, that is when they (the physicians) are helping" (Nurse 4)*

The use of arterial wave analysis could be facilitated if the physician took the time to review the observation, use, and plan for the arterial wave analysis with the nurse before exiting the operating room (as expressed by the nurses).

The physicians described a lack of consensus regarding the value of arterial wave analysis among themselves as a barrier for a consistent use of it. They could not see an immediate benefit for the patient and felt there were many pitfalls.

The nurses described physicians' different approaches and attitudes towards use of arterial wave analysis as confusing. They regarded the physician's attitude as crucial in the decision about using arterial wave analysis. In the ICU, these different approaches seemed to be due to heterogeneity in the patient group regarding sedation level and whether the patient was on a controlled or supportive ventilation mode. Nurses also described that if physicians had a negative attitude toward using arterial wave analysis in the ICU, it generated resistance against using arterial wave analysis among the nurses as well.

*“The physicians use it in different ways. Some are very focused on calibrating while others never calibrate. Some only want to use it if the patient is on pressure control and deeply sedated and doesn’t breathe on their own and others use it even when the patient is on pressure support. So there, you are losing a lot of understanding when it is going on like that.” (Nurse 10)*

During the induction of the anesthesia most of the tasks seemed to be clearly allocated to the respective members of the team. However, with to arterial wave analysis, there were differences between the departments and internally. In one department, it was the nurses who were responsible for the arterial wave analysis set-up, this led to an established routine and was not regarded as time-consuming or difficult. In the other departments, this task was handed over to the physicians or to a nurse assistant and the less experienced nurses were left in the field, which created a barrier in the utilization of arterial wave analysis.

*[A hospital porter comes in to help with the positioning of the patient. The nurse says: “it’s too soon, I have to gather all this equipment” (arterial wave analysis). She gives up and calls a nurse outside the operating theatre. She talks to herself “I don’t have time for this”. She says: “normally the physician should stay and help us”. Another nurse comes in to the room. The first nurse tells her that she is too busy to do this (gather and connect the equipment for arterial wave analysis)] (Fieldnote)*

In the beginning of the anesthesia, it is mainly the physician who is inducing a fluid bolus with arterial wave analysis. According to some nurses, one had to be inquiring and investigative before the physicians let them be a part of the process.

*“I think I am a part of it. It also has to do with how much interest you show, but it is also okay if a senior physician shows up and controls the procedure and kind of leads it and says, “now we are making a test to see where we are” okay fine. Then we share the task.” (Nurse 6)*

Arterial wave analysis was used in various ways, which sometimes confused both nurses and physicians; they described it as decreasing their understanding of how to use it. On other occasions, arterial wave analysis was connected before the patient was sedated and a fluid bolus was given to assess the patient’s baseline data. On other occasions arterial wave analysis was not applied until after the patient was anesthetized and under controlled ventilation. Type and amount of fluid given also differed. Some used colloids, while others used crystalloid solutions when they gave fluid boluses.

*“Normally I would begin by making an event to see if the patient needs fluid or not. They do not do that here, they just start it” (Physician 12)*

Nurses and physicians described different situations they found conflicting when using arterial wave analysis to guide fluid administration. Some physicians described feeling conflicted if arterial wave analysis showed a need for extra fluid, due to evidence supporting better outcomes related to fluid restriction. They also described a dilemma because patients in OR are artificially dilated on the venous side due to anesthesia, despite the evidence for GDT.

The physicians expressed concern about risk of fluid overload when applying arterial wave analysis in the ICU. They did not believe that one could just use the same guideline for OR and ICU. Patients in the OR are

more homogeneous due to anesthesia and controlled ventilation compared to ICU patients, who often have multi organ failure, are occasionally awake, and breathing spontaneously.

*“In intensive care, the patients are very different from each other and different in the organ systems that are affected and the things that we do to the patients in form of the situation and ventilator strategy. That is also applicated in very different ways than in the operating room” (Physician 3)*

Some felt insecure when deciding to administer a fluid bolus, others only in more complex situations. For example, a complex situation would be if the patient was not responding to a fluid bolus and continued to present with divergent parameters such as hypotension or low SV, or if one of the parameters was sufficiently corrected while others were not.

*“Sometimes we choose to administer fluid even though it (arterial wave analysis) indicates that there is no need for it, but you give it anyway because ahh..., maybe they do need it” (Nurse 3)*

Cardiovascular symptoms, particularly atrial fibrillation, were considered problematic among both nurses and physicians. They described insecurities about if and how they could use the arterial wave analysis in these situations.

*“What’s about it is, that with atrial fibrillation, unfortunately, it is often the unstable (patients) and then we are back to square one right, because then it (arteria wave analysis) varies a lot.” (Nurse 18)*

### **Obtaining competencies**

There were differences in the introduction to the use of arterial wave analysis among physicians and nurses. Arterial wave analysis had suddenly been introduced into the department with little to no information according to the nurses. Many, including physicians, did not know how to gather and use the equipment. This made the use of it coincidental, decreased motivation, and created resistance among the nurses who described they were set to do extra work without knowing why. The description below demonstrated how the nurses felt unimportant in the implementation of arterial wave analysis for GDT.

*[We talk about the way arterial wave analysis has been introduced in the department. The nurse thinks they (physicians) have been late to involve the nurses. She says that after a while with arterial wave analysis in the department, the leading physician sends out an email offering the physicians education in how to use arterial wave analysis if they have the need. She was happy that some nurses had responded that they would like to participate as well.] (Fieldnote)*

When it came to attending formal lessons provided by an experienced physician, some nurses were encouraged to participate by their ward manager, who, in return arranged for them to attend. Others had to come in on their day off, which not all nurses had the ability to do. Nurses in ICU found it impossible to participate in these formal lessons due to the way their work was organized. Instead, they used peer-to-peer training.

*“I have not received any formal education in how to use it (arterial wave analysis), so it is bedside with hands on what I have learned about it// it can create some challenges because of who are you learning from and where do they have their knowledge from” (Nurse 13)*

Some described that maybe they should have taken the initiative to learn about arterial wave analysis, but found it difficult to find the time. Others stated that it was the department's responsibility to plan it into their normal working schedule.

*"As so many times before, they prioritize to arrange education, so it is either outside our working hours or we must leave the department to participate. They have not chosen to say that, if you want to optimize the use of it here (ICU) then you have to be here and teach us here, because we cannot go to the conference room or PACU, that just does not work for this department" (Nurse 12)*

The initial education was primarily physician-oriented and even then, not all physicians were trained. Physicians believed that formal education followed by bedside demonstration was important to standardize the use of GDT by arterial wave analysis. However, one needed to take responsibility for his or her own learning as well as be inquiring when there was opportunity for bedside education/training.

*"I think of it as my lack of knowledge depends on me" (Physician 11)*

Continuous bedside training by an experienced colleague was an essential factor for a successful facilitation of arterial wave analysis, for both nurses and physicians. However, opportunities to have this kind of training was rare, often due to lack of patients who were ill enough to justify an arterial needle. Also, CRNA students were often prioritized to be with these patients which created a barrier for educated CRNAs to practice their use of arterial wave analysis.

*"It makes it difficult for the nurses to get to it (arterial wave analysis). And then they are standing with it in the night shifts and are not comfortable with it. So, you can say it is our organization, it's not quite good. It's simply not enough what we have done, and people don't feel safe to use it at all" (Nurse 20)*

Sometimes organization and working routines were a barrier for the nurses to be a part of bedside education. The nurses are bound to be with their patients while physicians' work is spread throughout several patients and departments. This gives physicians the opportunity to move around and be present during bedside education. At the beginning of surgery, younger physicians were often present in the OR and received bedside education in arterial wave analysis. The physicians, particularly the younger ones, described their need to be inquisitive toward these situations in order to learn how to use it. During this education, the nurses were often doing practical tasks. Tasks that were necessary to move on and get the patient ready, so the surgery could start. This could have led to misunderstandings where physicians expected the nurse to be more confident with the use of arterial wave analysis.

*[The physician responsible for the anesthesia is asking for the dopamine to be increased from 2 to 3 milliliters. He discusses the low blood pressure with another physician who has entered the operating room. He says "she (the patient) has the same stroke volume". The responsible physician asks about blood pressure and SV. Then he teaches two younger physicians in how to use arterial wave analysis. The nurse is busy with gastro intestinal tube placement] (Fieldnote)*

## Understanding of optimal fluid treatment

Even though managing arterial wave analysis for GDT in everyday practice was an extra workload in a busy situation, the nurses and physicians' overall positive attitude towards the use of GDT made it a priority in the clinical setting.

*[The nurse under observation is interrupted by another nurse but says "I want to give a fluid bolus now. I am ten minutes late with that". The nurse administers 200 ml ringer-acetate to the patient with a syringe. The nurse says, "she isn't responding. She is not a fluid responder". The physician: "but she still has a basic need, 3 ml/kg/h". The nurse and physician talk about fluid and how to control the patients' blood pressure. The physician says, "we hold the blood pressure around 70". The nurse: "if the blood pressure is deteriorating, I will try to give her another fluid bolus.] (Fieldnote)*

The physicians described GDT as one way to optimize patient perfusion through optimizing hemodynamic parameters, a future way to hemodynamic optimization and a new possibility to control "if we are giving the right amount of fluid compared to not knowing what we were doing". They also described that it was important to see it as trend monitoring and not just one measurement.

It was important for nurses and physicians to note measurements from arterial wave analysis was compared to clinical observation of the patient. Some described there was a risk to get blocked on too much monitoring equipment and that one could have too much confidence in the results from the monitor. Another important facilitator in using the arterial wave analysis included situations when analysis demonstrated clinical assessment was not always correct. A patient responded on a fluid bolus despite the initial estimate. This led to an increased confidence in arterial wave analysis. On the other hand, if clinical signs from the patient differed from the measurements, they relied on the clinical signs.

*"If the perfusion is deteriorating and the patient gets cold and serum lactate is increasing but SV is increasing, then it is possible that fluid is not necessary even though SV is increasing" (Physician 1)*

When talking about GDT, the nurses focused on the ability to administer the right amount of fluid and the possibility to analyze whether the patient needed fluid or vasopressor. However, they described this as being complex and when they did not see any effect of fluid bolus, they expected the physicians to decide what they should do.

Nurses in the ICU described that it was not clear for them which patients would benefit from the use of arterial wave analysis and that they doubted if it benefited patients in the ICU at all. This doubt occurred when they heard different opinions about the benefit of arterial wave analysis from different physicians. The ICU nurses felt there was a lack of clear guidelines for which patients they should use it for. This resulted in coincidental use of arterial wave analysis in the ICU.

*"It is not because I don't think it is relevant to use it. I just think there is no clear instructions for when we should use it. I think that it is one of the obstacles to learn it properly" (Nurse 12)*

## Discussion

An important finding in this study was the degree of interprofessional collaboration that could either encourage or impede nurses and physicians' use arterial wave analysis for GDT. The finding is based on an interdependence between these two professional groups: nurses are depending on help and support from physicians; physicians are depending on nurses' ability to use arterial wave analysis unassisted. It is also based on nurses' experience of being regarded as an important co-player in the use of arterial wave analysis.

Interprofessional collaboration is the process in which different professional groups work together to positively impact healthcare.<sup>23</sup> It has been regarded as a cornerstone for the delivery of safe, high quality patient-centered care for the past 30 years.<sup>24</sup> In a framework "Interprofessional Activity Classification Tool" (InterPACT) developed by Xyrichis et. al.<sup>25</sup> team interdependence is described as a core element in teamwork and defined as the extent to which the outcome of an interprofessional collaboration depends on decisions and choices of all team members.<sup>25</sup> However, findings in this study, like "to be involved in the implementation process" indicates that nurses have low influence on decisions regarding arterial wave analysis. When nurse-physician communication is limited and physicians do not involve nurses in decisions involving them, it leaves nurses dissatisfied.<sup>26</sup> This may decrease nurses' motivation to be involved in the implementation and use of arterial wave analysis and regard it as the physicians' project and responsibility to make it work. Furthermore, frustration among nurses of differentials in power and status, which provides the physicians with the right to implement new interventions, can lead to an "us and them" effect, hindering optimal interprofessional collaboration.<sup>27</sup>

Unclear roles and responsibility were also a barrier against successful use of arterial wave analysis. Nurses described it as unclear who was responsible for following up on measured values from arterial wave analysis and they were unsure about which patients would benefit from it (ICU). Team roles and responsibilities is also described as a core element in teamwork.<sup>25</sup> It refers to the differentiation of healthcare professionals' jurisdiction among the interprofessional team members and signifies the extent to which a profession holds authority over a bundle of tasks.<sup>25</sup> It is possible that nurses' insecurity is grounded in lack of knowledge, but it could also indicate that there are areas of unclear responsibility in connection with the use of arterial wave analysis.

Facilitators, as described by nurses, were physicians who took time to discuss the plan, use, and observation of arterial wave analysis. In these situations, nurses felt their work with arterial wave analysis was important and physicians took them and their work seriously. It is possible that this form of communication gave nurses a feeling of being a part of the decision-making process regarding their patient. It also met other key dimensions in team work, like clear goals, roles and responsibility.<sup>25</sup> This was supported by a review on nurse-physician communication finding that physicians proactive communication with nurses encouraged nurse-physician communication.<sup>26</sup> This suggested that nurses' motivation was not increased by just receiving new work assignments; rather motivation was affected by an increase in a good working relationship with physicians.

Nurses and physicians described lack of training possibilities as a barrier toward the use of arterial wave analysis. However, physicians saw it as their own responsibility to learn it and attended cases where arterial wave analysis was used. This was possible because of their opportunity to move around between patients.

Nurses were not always a part of this bedside education, because they were doing other patient-related tasks. This division of labor seemed to be contrasting with the fact, that when the physicians have left the OR the responsibility for using arterial wave analysis was placed at the nurse. In another study concerning nurse-physician collaboration, division of labor was found to make the collaboration less engaging for physicians,<sup>28</sup> which may have affected their overall team commitment.

In this study, it was found that there were great variations in if and how the guideline was used. Barriers described in relation to guideline use were: lack of time, not aware of the existence of the guideline, lack of time to read and understand it, lack of clarity about when to use it, high complexity, and lacking agreement about the evidence. These findings were in line with frequently described findings from a systematic meta-review of factors influencing implementation of guidelines for health-care professionals.<sup>29</sup> Guideline implementation may be hindered if nurses and physicians are not aware that they exist or are not familiar with the content. Therefore targeted implementation strategies are needed.<sup>29</sup> It is important, to take the complexity of the guideline into account, particularly multi-disciplinary guidelines directed at groups with varying educational levels.<sup>29</sup> Involving all targeted professionals in the development phase might increase the chance of successful implementation. This is also recommended by the AGREE Collaboration.<sup>30</sup>

#### *Strengths and limitations*

This study was based on participant observation over a 4-month period and 34 interviews. This relatively long data collection period increased the risk of inconsistency because the investigator received ongoing insight into the phenomenon under investigation. This may have affected the study's dependability because of the risk related to follow-up questions or narrow observations.<sup>21</sup> Data collection was performed by the first author who had little experience in the used methods. However, the research team met several times during the data collection period to discuss the process. The observation and interview guide were made in cooperation with the research team and two pilot interviews were conducted and discussed. To increase the study's dependability, an interview was conducted to make the first author aware of her preunderstandings. A co-researcher was included in the analysis of the data to optimize the categorization and provide more reliable results.<sup>21</sup>

A purposive sampling strategy was chosen to increase the study's' credibility by increasing the possibility of shedding light on the research question from a variety of aspects.<sup>21</sup> Ward managers helped identify suitable participants they believed were familiar with the use of arterial wave analysis and capable of expressing their opinions. It was possible that they chose participants who they believed to be more skilled in using arterial wave analysis. Investigator triangulation was also used to enhance credibility of our findings.<sup>20</sup> Through discussions between the first and last author, it was possible to achieve agreement and optimize the categorization of data.

The use of data triangulation is considered a strength. The methodology of non-participating observations and semi structured interviews complemented one another by combining data on actual behavior with participants meaning and experience.

The comprehensive description of the setting, data collection, analysis, and inclusion of participants with knowledge and experience with the use of arterial wave analysis facilitates transferability of the study.

## Conclusion

Interprofessional collaboration was found to be both a barrier and a facilitator for implementation of arterial wave analysis and GDT. Obtaining competencies in using this approach for monitoring patients entailed a feeling of being or not being involved and regarded as an important co-player. Nurses and physicians shared an overall positive attitude toward implementation of arterial wave analysis for GDT. However, they had different experiences and expectations regarding being introduced to and involved in the implementation of arterial wave analysis. These differences were grounded in different working conditions with different opportunities to seek both scheduled and bedside education. Working conditions made it easier for physicians to be investigative and attend situations with bedside education. Physicians also expressed that it was their own responsibility to obtain competencies in the use of arterial wave analysis; whereas, nurses were expected to be offered more formal education. Mutual dependency was an important dimension of the interprofessional collaboration. To nurses it meant that they needed the physicians' approval of their work with arterial wave analysis. Nurses were not always clear on physicians' expectation and found physicians' different approaches toward arterial wave analysis confusing. Physicians were depending on the nurses to use it otherwise, it was practically impossible to make it work since nurses were the continuous caregiver for the individual patient.

In this study, use of guidelines varied due to high complexity and lack of clarity. Involvement of all professionals in the development phase was vital. Education both theoretical and bedside, should have been provided for all the involved professionals. Considering the education level among the professionals, when planning and performing the education is important.

Therefore, the roles and division of responsibility between nurses and physicians need to be clearer when working with arterial wave analysis for GDT and both groups need planned bedside education to strengthen their practical and analytical competencies. Clarity about how to identify which patients would benefit of GDT is needed, especially in intensive care.

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