Acknowledgements

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Key Points

- CAEP prepared nurses for as experiences as close to real life as possible.
- Repeated learning from mistakes and constructive feedback strongly supported the development and of increased perceived confidence and retention of HF knowledge.
- CAEP utilizing simulation helped increase knowledge and confidence of the bedside nurse caring for HF patients.
Comprehensive Aquapheresis Education to Enhance Nursing Knowledge and Confidence in Caring for the Heart Failure Patient

Abstract

**Background:** Because aquapheresis is a new and highly specialized treatment modality, many nursing curricula do not teach students how to operate and trouble-shoot its equipment. In order to bridge the gap between classroom and practice, simulation-based education is now being used to increase knowledge. Therefore, the purpose of this project was to implement and evaluate a comprehensive educational program (CAEP) to improve HF knowledge and self-confidence of registered nurses (RNs) working in critical care units who provide care to patients receiving aquapheresis in a rural setting. The research questions were:

1). Does the CAEP improve RNs’ knowledge and perceived confidence in caring for HF patients receiving aquapheresis from baseline to 4 weeks and baseline to 8 weeks post-intervention?
2.) Does the score on the Creighton Simulation Evaluation Instrument (C-SEI) reflect nurse competence on the CAEP performance?

**Methods:** A pre-posttest design was used with a convenience sample of RNs (N = 20). Each nurse completed a pre-CAEP and post-CAEP clinical knowledge and confidence questionnaire. Repeat tests were completed at 4 weeks and at 8 weeks post-simulation. CSEI was used to evaluate nurse competence and knowledge retention. All nurses received the highest score of 1 on 14 possible items achieving (>75%) immediately following simulation.

**Results:** The majority of the sample was female (n=13), 65% (n=13) had bachelor’s degrees, and nearly 60% (n=12) reported running aquapheresis therapy between 0-10 times. No CAEP knowledge results were found to be statistically significant. Statistically significant results were reported in nurses’ confidence level in both troubleshooting aquapheresis equipment (p=0.0032)
with improvement of 95% (n=19) at 4 weeks and 100% (n=20) at 8 weeks and overall HF aquapheresis decision making (p=0.0036) of 85% (n=17) at 4 weeks and 100% (n=20) at 8 weeks.

The Creighton Simulation Education Tool (CSEI) found all nurses (n=20) within the sample received a one on each of 14 possible items indicating competency and knowledge retention.

**Conclusions:** Utilizing simulation to augment continuing nursing education programs for aquapheresis may strengthen perceived nurse knowledge and confidence caring for HF patients. Further research should aim to use larger sample sizes and direct assessments of nurses’ clinical performance.
Heart failure (HF) is the leading cause of hospitalizations in patients older than 65 years. Approximately 90% of HF hospitalizations result from volume overload, which also contributes to longer length of stays (LOS) (Hines, Yu & Randall, 2010). These increased LOS as well as increased hospital readmissions are directly related to increased overall healthcare costs. With an estimated 670,000 new cases each year, HF has also been directly linked to increased patient morbidity and mortality nationwide (Centers for Disease Control [CDC], 2010). The CDC reported an estimated $39.2 billion was spent on HF services, medications and lost productivity in 2010.

The Centers for Medicare and Medicaid Services (CMS) have recently focused on revising the Diagnosis –Related Group (DRG) for provider reimbursement (Meadow & Sangl, 2010). Efforts are therefore specifically aimed at identifying HF exacerbations prior to discharge to decrease readmission costs (Simulationzo, Saltzberg, Jessup, Teerlink, & Sobotka, 2010). Despite many strategies designed to improve HF management, there has been no effective strategy for 20-30% of diuretic-resistant HF patients. This resistance poses a threat to overall HF morbidity and mortality nationwide (Brandimarte et al., 2010).

Therefore, the need for advances in technology has led to the development of aquapheresis, a therapy targeted directly at diuretic resistant patients (Andrade, Stadnick & Virani, 2010). Aquapheresis removes approximately two to three times more sodium per liter of fluid than standard diuretics and reduces the incidence of electrolyte abnormalities, which often correlate to poor patient outcomes and increased LOS. In addition, reduction in readmission rates, emergency room (ER) and office visits were found compared to standard fluid removal therapies. Therefore, aquapheresis aids to decrease overall HF related costs while preserving renal function (Capodilupo, 2009).
Because aquapheresis is a relatively new bedside therapy, many registered nurses (RN) lack comprehensive disease and equipment education (Pittman, 2012). Therefore, aquapheresis continuing education could be used to help improve RNs foundational HF knowledge and self-confidence in providing care to this patient population. This type of education is essential in rural areas where nurses are in demand and there is less of an emphasis on hiring those with experience (Broussard, Myers, & Lemoine, 2009). Inadequate nurse preparation has led to self-doubt and a lack of confidence while managing these patients (Bricker & Pardee, 2011). Therefore, the importance of educating nurses in specialized therapies is essential for patient safety and successful outcomes (Esposito, Bagchi, Verdier, Bencio, & Kim, 2009).

Nurses within this rural hospital expressed concern and hesitation with initiating and managing aquapheresis patients. Further doubt was attributed to reduced frequency of caring for patients needing aquapheresis and high nursing turnover rates. Once a comprehensive aquapheresis educational program (CAEP) is incorporated into hospitals continued education programs, a more consistent and efficient approach to aquapheresis management can be attained. This in turn will lead to improved nurse knowledge and confidence which should subsequently impact patient outcomes (Pittman, 2012).

**Methods**

**Sample and Setting**

The population for this study included 20 nurses working in intensive care units (ICU) and progressive care units (PCU) where aquapheresis is initiated and managed. The sample of nurses was recruited from a rural Midwestern, 287-bed regional referral center.

**Methods**

The CAEP, involving classroom lecture, hands-on skills with simulated patients, and
personalized interaction with the instructors, was developed to determine if it improves nurse’s knowledge and confidence in providing aquapheresis to HF patients. Retention of knowledge and retention of confidence in their abilities was also evaluated. The research questions for this educational project were:

1) Does the CAEP improve RNs’ knowledge and confidence caring for HF patients receiving aquapheresis from baseline to 4 weeks and baseline to 8 weeks post-intervention?

2.) Does the score on the Creighton Simulation Evaluation Instrument (C-SEI) reflect nurse competence on the CAEP performance?

**Recruitment**

The nursing manager of the ICU and PCU selected 20 nurses to participate in the new CAEP based on prior exposure or lack of experience caring for HF patients. Each RN was notified of the mandatory education through their work email address. The sessions took place in the simulation laboratory from January 14, 2014 to January 28, 2014 at a rural academic medical center. Prior to initiation of the CAEP, a request was submitted for approval by the Institutional Review Board (IRB). It was deemed an educational project and IRB approval was not necessary.

**Procedure for Data Collection**

Each nurse was gathered for an initial proctored session during which they completed a Demographic Survey, The Comprehensive Heart Failure Education Knowledge Questionnaire, The Heart Failure and Aquapheresis Knowledge Test, and A Self-Confidence in Aquapheresis Management Survey which served as baseline assessments. Each nurse was assigned a number
that was placed on each instrument to allow for form completion tracking and to ensure confidentiality of responses. This information was stored in an electronic file.

Each nurse then individually registered and completed a mandatory, 60-minute online training and certification program for the Aquadex FlexFlow (aquapheresis) fluid removal system (Gambro, 2012). Gambro, a company that specializes in the development of renal therapies and improved treatment quality and efficiency, developed this comprehensive, interactive, computer-based training program (Gambro, 2012). The online training and certification program focused on providing early recognition of worsening HF symptoms, prompt intervention, and adherence to established protocols and a training foundation for all nurses. Specifically, it provided the following information: 1) the ultrafiltration/aquapheresis therapy system, 2) the steps required to set up and prime the system, 3) the treatment steps for aquapheresis therapy, and 4) equipment trouble-shooting. The certificate of completion was required to be admitted into the CAEP simulation. All nurses attended one scheduled simulation session during the month following the online program completion for hands-on experience in setting up, trouble-shooting, and managing “simulated” patient receiving aquapheresis. Each nurse was required to prepare for the simulated activity by reading a pre-lab packet which they received after completing the on-line education. This packet consisted of an aquapheresis equipment brochure; aquapheresis slide presentation, and an outline of evidence-based clinical trials. This information was discussed throughout the interactive portion of each simulation session. Each simulation session lasted approximately two hours including a 10-minute overview prior to starting, a 30-45 minute simulation skill testing session and a 30-45 minute debriefing session at completion of the CAEP.

Simulated Educational Intervention
Simulation sessions used a high-fidelity mannequin (Laerdal SimMan) to represent a real-life patient receiving aquapheresis. The lead investigator who was trained on the simulation equipment by a simulation nursing instructor controlled the SimMan during each session. Nurses were dressed in scrubs to mimic the natural work environment and were expected to use equipment and supplies normally used within their critical care area. Gambro provided a senior aquapheresis consultant to perform equipment setup prior to each session and lead each CAEP session with the primary investigator. Each simulation scenario consisted of a patient with either an episode of acute, decompensated HF or congestive HF with renal insufficiency. The expectation was that the nurse functioned as in a real life situation.

Simulation sessions were limited to four nurses per session. Each nurse was randomly assigned to a role throughout simulation scenario. Roles included that of the nurse (learner role) and patient (instructor role). The first pair worked together as active learners to complete the first scenario while the opposite pair observed and gained feedback. Upon completion of the first scenario, the pairs reversed roles for the remainder three scenarios. All four scenarios were completed prior to starting the debriefing session.

Each pair of nurses attended a debriefing session at the end of each CAEP to allow for open dialogue between the lead investigator and the nurses. Debriefing followed a structured guide and allowed each nurse to receive feedback from the lead investigator, aquapheresis consultant and fellow nurses.

Following debriefing, each nurse completed the post-assessments including the Comprehensive Heart Failure Education Knowledge Questionnaire, the Heart Failure and Aquapheresis Knowledge Test, and the Self-Confidence in Aquapheresis Management Survey. The lead investigator completed the C-SEI as a post-simulation evaluation of each nurses
performance. The nurses were then scheduled a time to return to a controlled environment 4 weeks and 8 weeks after the completion of the initial simulation session for completion of the questionnaires and tests to evaluate knowledge and confidence retention.

**Evaluation Tools**

The demographic data collection tool was developed to collect baseline information about each RN. Age, gender, education, and experience were used to describe the sample and to determine if differences in outcomes existed between demographic variables.

The Heart Failure and Aquapheresis Knowledge Test is a 12-item, multiple-choice and true-false test provided by the aquapheresis consultant and used routinely in evaluation of students attending their classroom education on aquapheresis management. No reliability or validity studies have been done on this tool since the tool was designed to test educational knowledge on this specific therapy. Prior to the CAEP, the score obtained on the knowledge test was expected to be less than 60% with scores improving to greater than or equal to 80% (minimum of 10/12) for certification. If scores were less than this 80% requirement, repeating the CAEP intervention was required. A baseline pre-test was given prior to the online session, immediately following the debriefing session, and then 4 and 8 weeks after CAEP completion. These time intervals have been shown to be the most appropriate for true evaluation of knowledge and confidence after undergoing an active learning session (Smith & Barry, 2011).

The Comprehensive Heart Failure Education Knowledge Questionnaire was designed for use in this study and allowed each nurse to self-report his/her level of knowledge of HF patients and treatments including aquaphereses. This tool is based on a 3-point likert scale from low level of knowledge to high level of knowledge with a total score of zero to 15 possible. A pre-test was
given prior to the online session, immediately following the simulation, and then 4 and 8 weeks after CAEP completion.

The Self-Confidence in Aquapheresis Management Survey is a survey designed for use in this study to evaluate RN self-reported perceived confidence in providing aquapheresis to HF patients. This tool is based on a 3-point likert scale from low level of confidence to high level of confidence with a total score from zero to 15 possible. A pre-test was given prior to the online session, immediately following the debriefing session, and then 4 and 8 weeks after CAEP completion.

The Creighton Simulation Evaluation Instrument (C-SEI) is an evaluation tool designed to evaluate the nurse’s ability to perform adequate assessment, effective communication, clinical judgment and maintenance of patient safety throughout simulation. This tool was adapted to reflect 14 outcomes essential for this simulation. Reliability and validity of the tool has been established through prior studies (Adamson & Kardong-Edgren, 2012; Adamson et. al. 2011; Hawkins, Todd & Manz, 2008; Manz, Hercinger, Todd, Hawkins & Parsons, 2013; Todd, Manz, Hawkins, Parsons & Hercinger, 2008). Each nurse was given either a zero (does not demonstrate competency) or one (demonstrates competency) with completion of each section (n=14) of the C-SEI. This was completed by the lead investigator immediately after the CAEP and was based on simulation performance.

Results

The demographics of the 20 nurses taking part in the CAEP were summarized using descriptive statistics. Quantitative comparisons were made using a paired cumulative logistic ANOVA to explore whether the CAEP had an effect on nurse knowledge, confidence, and
retention of knowledge and confidence over time. Analyses were performed in SAS 9.3 (SAS Institute, Cary, N.C.).

Demographic information for gender, age, education level, years of nursing experience, years of critical care experience, and number of aquapheresis runs are summarized in Table 1. The sample was predominately female, had obtained a bachelor’s degree and had completed an average of 0-10 aquapheresis runs.

Baseline to post CAEP comparisons between self-reported treatment knowledge and confidence were conducted using paired cumulative logistic ANOVA. Due to the small sample size and scores distribution, only four of the nine questions could be compared utilizing this method and thus there are only four p-values to report. In one instance (HF Knowledge), the model yielded a negative estimate for variance. There were four instances in which the iterative solution did not converge.

None of the knowledge results were found to be statistically significant; however, an improvement in HF knowledge was reported (100%) from baseline to 4 weeks and baseline to 8 weeks (Table 2). Nurses reported that equipment availability impacted their scores.

Statistically significant results were reported in nurses’ confidence level in both troubleshooting aquapheresis equipment (p=0.0032) and aquapheresis decision making (p=0.0036). An improvement of 95% (n=19) was reported at 4 weeks and 100% (n=20) at 8 weeks whereas overall HF aquapheresis decision making improved of 85% (n=17) at 4 weeks and 100% (n=20) at 8 weeks (Table 3).

The Creighton Simulation Education Tool (CSEI) revealed that nurses (n=20) within the sample received a one on each of 14 possible items indicating competency. This supports knowledge retention.
Discussion

Findings from this study illustrate an improvement in nurse knowledge and confidence levels, thereby providing support for the importance of simulation-based continuing education to enhance nurse knowledge and confidence among nurses with a range of clinical expertise (Ford, et al. 2010). According to Kane, Pye & Jones, (2011), simulation-based education was also supported in the continued education of nursing staff as an effective method to improve knowledge required to function in a high acuity area. Not only does simulation offer an in depth avenue to improving knowledge and confidence, it is critical to maintaining competence levels for patient safety (Yoder-Wise, 2013).

According to Dunbar-Reid, Sinclair & Hudson (2011), simulation-based education was supported by providing a positive solution to continued nursing education within a similar specialty, hemodialysis. Findings were also supported in a study by Nickerson, Morrison & Pollard (2011), where many ways to gain expertise in specialty therapies were noted. One way is to bridge the gap between knowledge gained in the classroom and real life experiences with patients at the bedside. Simulation-based education facilitates this through provision of a safe environment through knowledge facilitation as well as development of skills and independence (Harrington, Duncan, Walter, & Adamson, 2011). Therefore, further support is provided in that simulation provides an interactive and immersive learning atmosphere through recreating work environments with limited to no patient exposure. These findings however, were contradicted in a systematic review of 141 studies by Jansson, Kääriäinen & Kyngäs (2013) where the effectiveness of simulation was deemed uncertain.

Knowledge gained is difficult to assess due to a lack of robust evidence of simulation-based education within a CAEP. Few randomized control trials have been reported within
specialty therapies due to limitations in sample size, recruitment and randomization (Lapkin et al. 2010; Zigmont, Kappus, & Sudikoff, 2011). Although the evidence is not conclusive for the impact knowledge and confidence will have on comprehensive education, the foundation for simulation-based education continues to develop.

**Limitations**

The CAEP has limitations in that nurses were informed of mandatory participation before completing it. In retrospect, this may have biased the results as how an educational program is introduced may impact nurses’ perceptions of their own skills. Secondly, the sample size was small due to clinical priorities and staffing needs, thereby limiting the generalizability of the findings. Lastly, it could also be argued that any educational interventional will impact knowledge and confidence levels and improvement will be apparent.

**Implications for Future**

Future work can replicate these findings in the context of a larger and more diverse sample size and extend the concept of educational approaches within other nursing specialties. Because of the invasive nature of aquapheresis therapy, a more comprehensive education is essential to enhance nurse knowledge and skills to directly impact patient outcomes.

Future research priorities in HF therapies should also move beyond evaluating nurses’ experience and identify the direct impact on patient outcomes associated with aquapheresis. The role of simulation should also be validated in terms of cost-effectiveness especially in areas where access to care may be limited.

**Conclusions**

Nurses may go through their entire nursing career gaining little clinical experience managing critically ill HF patients. Simulation makes it possible for nurses to get experience and
insight that is as close to real life as possible with populations and technologies that they may not normally experience. As demonstrated in this small scale educational program, simulation offered a viable alternative for an affordable and feasible option when real life experiences were limited. This CAEP has helped support the benefit of regular continued nursing education to improve knowledge and confidence enhances RNs ability to respond appropriately to stressful situations as it pertains to aquapheresis management. Simulation-based education plays an important role in enhancing knowledge and confidence when real-life experiences are limited.


Lapkin, S., Levett-Jones, T., Bellchambers, H., & Fernandez, R. (2010). Effectiveness of patient simulation manikins in teaching clinical reasoning skills to undergraduate nursing students:
A systematic review. *Clinical Simulation in Nursing, 6*(6), e207-e222.

http://dx.doi.org/10.1016/j.ecns.2010.05.005.


doi:10.1097/NND.0b013e3181a68abd


Table 1: Demographic Summary of Nursing Sample

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<th>Education Level</th>
<th>Total n (%)</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor's</td>
<td>13 (65%)</td>
<td>9 (45%)</td>
<td>4 (20%)</td>
</tr>
<tr>
<td>Diploma</td>
<td>5 (25%)</td>
<td>3 (15%)</td>
<td>2 (10%)</td>
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<tr>
<td>Associate’s</td>
<td>2 (10%)</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
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<table>
<thead>
<tr>
<th>Years of Nursing Experience</th>
<th>Total n (%)</th>
<th>Female</th>
<th>Male</th>
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</thead>
<tbody>
<tr>
<td>0-5 years</td>
<td>9 (45%)</td>
<td>7 (35%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>6-10 years</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>11-15 years</td>
<td>5 (25%)</td>
<td>2 (10%)</td>
<td>3 (15%)</td>
</tr>
<tr>
<td>&gt;15 years</td>
<td>6 (30%)</td>
<td>4 (20%)</td>
<td>2 (10%)</td>
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<table>
<thead>
<tr>
<th>Number of Years Critical Care</th>
<th>Total n (%)</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-5 years</td>
<td>11 (55%)</td>
<td>8 (40%)</td>
<td>3 (15%)</td>
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<tr>
<td>6-10 years</td>
<td>2 (10%)</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>11-15 years</td>
<td>5 (25%)</td>
<td>3 (15%)</td>
<td>2 (10%)</td>
</tr>
<tr>
<td>&gt;15 years</td>
<td>2 (10%)</td>
<td>1 (5%)</td>
<td>1 (5%)</td>
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<thead>
<tr>
<th>Number of Aquapheresis Runs</th>
<th>Total n (%)</th>
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<th>Male</th>
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<tr>
<td>0-10</td>
<td>12 (60%)</td>
<td>8 (40%)</td>
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<tr>
<td>11-20</td>
<td>3 (15%)</td>
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<tr>
<td>21-30</td>
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<td>&gt;30</td>
<td>4 (20%)</td>
<td>4 (20%)</td>
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Table 2: Overall Knowledge Improvement

<table>
<thead>
<tr>
<th></th>
<th>P-Value</th>
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<th>Post</th>
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<th>8 week</th>
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<td>HF Knowledge</td>
<td></td>
<td>-</td>
<td>50</td>
<td>85</td>
<td>100</td>
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<tr>
<td>HF Treatment Knowledge</td>
<td></td>
<td>-</td>
<td>55</td>
<td>85</td>
<td>90</td>
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<tr>
<td>Aquapheresis Knowledge</td>
<td>0.2587</td>
<td>40</td>
<td>80</td>
<td>95</td>
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<td>Trouble Shooting Aquapheresis Knowledge</td>
<td>0.1065</td>
<td>45</td>
<td>85</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>P-value</td>
<td>% Improved</td>
<td></td>
<td></td>
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<td>-----------------------------</td>
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<td>------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Baseline</td>
<td>Post</td>
<td>4 week</td>
<td>8 week</td>
</tr>
<tr>
<td>HF Confidence</td>
<td>-</td>
<td>70</td>
<td>95</td>
<td>100</td>
<td>95</td>
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<tr>
<td>Aquapheresis Confidence</td>
<td>-</td>
<td>65</td>
<td>100</td>
<td>95</td>
<td>100</td>
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<tr>
<td>Confidence in Trouble Shooting</td>
<td>*0.0032</td>
<td>75</td>
<td>95</td>
<td>95</td>
<td>100</td>
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<tr>
<td>Confidence in Patient Management</td>
<td>-</td>
<td>90</td>
<td>100</td>
<td>85</td>
<td>100</td>
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<tr>
<td>Confidence in Decision Making</td>
<td>*0.0036</td>
<td>90</td>
<td>100</td>
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*indicates statistically significant results (p<0.05)