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Effects of Low Intraoperative Pressure on Quality of Postoperative Recovery after Laparoscopic Surgery for Genital Prolapse in Elderly Patients Aged 75 Years or Older

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1

2 **Effects of low intraperitoneal pressure on quality of postoperative recovery after**
3 **laparoscopic surgery for genital prolapse in elderly patients age 75 years and older.**

4

5 **Short title: laparoscopy and elderly patients age 75 years and older**

6

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36 corresponding author (SM), on reasonable request.

37

38 Abstract**39 STUDY OBJECTIVE**

40 Previous clinical trials for laparoscopic surgery have included few elderly patients age ≥ 75
41 years. We aimed to evaluate the quality of postoperative recovery after laparoscopic surgery
42 using low intraperitoneal pressure (IPP) (6 mmHg) and warmed, humidified carbon dioxide
43 (CO₂) gas for genital prolapse in elderly patients age ≥ 75 years.

44 DESIGN

45 Prospective consecutive case series.

46 SETTING

47 University hospital

48 PATIENTS

49 Consecutive patients (n=30) age ≥ 75 years planning to undergo laparoscopic surgery for
50 genital prolapse by the same surgeon were recruited from October 2016 to December 2019.

51 INTERVENTIONS

52 Laparoscopic promontofixation for the treatment of genital prolapse was performed using low
53 IPP and warmed, humidified CO₂ gas. When a promontory could not be easily identified,
54 laparoscopic pectopexy was alternatively performed.

55

56 MEASUREMENTS

57 The primary outcome was the QoR-40 (Quality of Recovery–40) score at 24 hours
58 postoperatively. Secondary outcomes were postoperative pain using a 100-mm visual
59 analogue scale (VAS) and length of hospital stay after surgery (LHSS).

60 MAIN RESULTS

61 For the global QoR-40 score and for the four dimensions of the QoR-40, “emotional state,”
62 “physical comfort,” “psychological support,” and “pain,” no differences were observed
63 between the baseline score and at 24 hours. The score for the “physical independence”
64 dimension was significantly lower at 24 hours than the baseline score ($p < .001$). No patient
65 had VAS pain scores >30 of 100 at 12 hours or later. LHSS was <48 hours in 22 patients
66 (73.3%) and <72 hours in 8 patients (26.7%). Multivariable analysis showed that the odds of
67 a LHSS >48 hours were more than 8 times higher in patients who were discharged from the
68 operating room (OR) in the afternoon compared with those with a morning discharge.

69 **CONCLUSION**

70 The use of a low IPP is feasible, safe and has clinical benefits for elderly patients age ≥ 75
71 years who undergo laparoscopic surgery for genital prolapse.

72

73

74 **KEYWORDS:** length of hospital stay after surgery; pneumoperitoneum; Quality of
75 Recovery–40

76

77 **Introduction**

78 The chance of a woman experiencing a prolapse increases with age [1]. The lifetime
79 risk of undergoing a single operation for prolapse or incontinence by age 80 is 11.1% [1]. A
80 recent study demonstrated that the population undergoing surgery is aging at a faster rate
81 than the general population [2]. By 2030, it is estimated that one-fifth of patients ≥ 75 years
82 will undergo surgery each year in England [2]. Therefore, the number of very elderly patients
83 (age ≥ 75 years) who require surgery for genital prolapse is also expected to rise [1, 2]. The
84 elderly are often excluded from clinical trials [2, 3], particularly surgical trials [2]. Therefore,
85 the best available evidence frequently does not apply to the elderly patient [2, 3].

86 Our previous randomized 2x2 factorial trial controlled trial (RCT) showed that low
87 intraperitoneal pressure (IPP) (8 mmHg) and warmed, humidified carbon dioxide (CO₂) gas
88 independently decreased postoperative pain in patients < 75 years old who underwent
89 laparoscopic surgery for genital prolapse [4]. In the present prospective study, we attempted
90 to evaluate benefits and harms of low IPP and warmed, humidified CO₂ gas in very elderly
91 patients (age ≥ 75 years) who underwent laparoscopic surgery for genital prolapse.

92

93 **Materials and Methods**

94 ***Methods***

95 The study was designed as a prospective, single-center, observational trial.
96 Consecutive patients age ≥ 75 years who underwent laparoscopic surgery for genital
97 prolapse by the same surgeon (RB) were recruited at CHU Clermont-Ferrand from October
98 2016 through December 2019. Informed written consent was obtained from each patient
99 prior to surgery. The study protocol was approved on 29th September 2016 by the IRB
100 (00008526) of the Committee for Protection of Persons in Biomedical Research (CPP SE VI)
101 of the Auvergne (France) (2016 / CE 57) and registered on ClinicalTrials.gov
102 (NCT03095716).

103 Anesthetic management was performed by staff anesthesiologists and
104 anesthesiology residents or nurse anesthetists under their supervision. Standard ASA
105 anesthetic monitors were placed in the operating room. All patients received the
106 same general technique, as we previously reported [4]. After induction of anesthesia, all
107 patients received forced-air warming blanket, which was maintained until the end of the
108 operation. Intraoperative core temperatures were recorded at 15-minute intervals by a probe
109 inserted into the distal esophagus throughout surgery. Paracetamol (1g) and ketoprofene
110 (50mg) were injected 30-minutes before the end of the operation to prevent postoperative
111 pain.

112 All operations were performed by the same surgeon (RB) with the assistance of a
113 gynecological surgical resident. Insufflation of CO₂ gas was performed using a Storz
114 electronic endoflator (KARL STORZ SE & Co. KG, Tuttlingen, Germany). All patients
115 received warm (37 °C), humidified (98% relative humidity) CO₂ insufflation gas delivered
116 by the Fisher & Paykel MR860 Laparoscopic Humidification System (HumiGard, Fisher &
117 Paykel Healthcare, Auckland, New Zealand) [4]. When the IPP reached 15 mmHg, four
118 trocars were inserted. Then, the IPP was immediately decreased to 6 mmHg, at which it was
119 maintained for the duration of surgery. We used 6 mmHg instead of 8 mmHg for low IPP in
120 the present study, according to the European Association for Endoscopic Surgery clinical
121 practice guideline on pneumoperitoneum for laparoscopic surgery, which recommends using
122 the lowest IPP possible that allows adequate exposure of the operative field rather than
123 using a routine pressure [5].

124 For all patients, 5 mL ropivacaine hydrochloride solution (2 mg/mL) were infiltrated
125 around the trocar wounds before incisions [1]. In addition, 20 mL ropivacaine solution (2
126 mg/mL) were infused under the right hemidiaphragm just after insertion of the four trocars [4].
127 We have been systematically performing infusion of ropivacaine solution under the right
128 hemidiaphragm for over 10 years [6]. During this time, we have had no or few complaints
129 about shoulder pain after laparoscopic surgery [1]. Laparoscopic promontofixation with or
130 without (for patients who have already undergone hysterectomy) sub-total hysterectomy

131 using the same surgical technique as we previously described [7]. When a promontory as
132 well as surrounding blood vessels and/or nerves could not be very easily identified,
133 laparoscopic pectopexy (the iliopectineal ligament on both sides is used for the mesh
134 fixation) [8] was alternatively performed to avoid potential surgical complications such as
135 blood vessels and/or nerves injuries. A RCT showed that both surgical
136 techniques are equally effective in treatment for genital prolapse [8]. We did not attempt to
137 increase IPP prior to making the decision to proceed to pectopexy, because we know from
138 our experiences that increased IPP does not enable us to identify a promontory and
139 surrounding vessels and nerves more easily [4].

140 All patients were treated according to our standardised postoperative pain
141 management as we previously reported [4]. After arrival of patients in the postanesthesia
142 care unit (PACU), they were asked to rate intensity of their pain at rest using a 100-mm
143 visual analogue scale (VAS) every 20 minutes. When the VAS pain score was >30 of 100
144 (clinically relevant moderate to severe pain), patients received an IV bolus of 2 to 3 mg
145 morphine, and then 1 to 2 mg IV every 10 minutes to achieve a VAS pain score \leq 30 of 100
146 (no or mild pain). After arrival of patients in the ward, they were asked to rate intensity of their
147 pain at rest using a VAS, every 4 hours for the first 24 hours postoperatively, and then 3
148 times daily until discharge. The patients received intravenous paracetamol (1g) and
149 ketoprofene (50 mg) every 6 hours for the first 24 hours postoperatively.

150 The quality of postoperative functional recovery was evaluated using the Quality of
151 Recovery-40 questionnaire (QoR-40) [4, 9]. The QoR-40 the quality of postoperative
152 recovery through five dimensions (emotional state, physical comfort, psychological support,
153 physical independence, and pain) [9]. This tool has been confirmed as the most suitable one
154 for perioperative clinical studies [10].

155 The day before surgery (between 7:00 and 8:00 pm), patients were asked to
156 complete QoR-40 questionnaire as a measure of baseline score. The QoR-40 was then

157 administered three times, 24 hours and 48 hours postoperatively. Surgical complications
158 were categorized according to the Clavien-Dindo classification [11].

159 The quality of the surgical conditions (the operative technical difficulty, working space,
160 visibility, and pain experienced by the surgeon during surgery) was rated by the operating
161 surgeon at the end of surgery using a 100-mm VAS [4].

162

163 ***Statistical analysis***

164 Statistical analysis was performed using the STATA program version 13.1
165 (StataCorp, College Station, TX, USA). The power calculation of the present trial was based
166 on our previous RCT [4].

167 VAS pain scores were categorized as either ≤ 30 of 100 or >30 of 100, providing a
168 binary variable, as previously reported [4, 12]. Comparisons of the global QoR-40 scores and
169 the dimensions of the QoR-40 questionnaire between the day before surgery (baseline) and
170 at 24 hours were made using Wilcoxon's matched pairs test. To identify factors that influence
171 the length of hospital stay after surgery (LHSS), the first set of analyses compared the
172 characteristics of patients in the two length of stay groups (<48 hours versus <72 hours).
173 Continuous variables were compared between groups using either the unpaired t-test, if
174 found to be normally distributed, or the Mann-Whitney test or one-way analysis of variance
175 (ANOVA) otherwise. Categorical variables were compared between groups using Fisher's
176 exact test. The second stage examined the joint association between patient factors and
177 LHSS in a multivariable analysis. As there were only two different lengths of stay (<48 hours
178 versus <72 hours), the analysis was performed using logistic regression. Due to the relatively
179 small sample size, only variables showing some association with LHSS from the initial
180 analyses ($p < .1$) were included in this stage of the analysis. A backwards selection procedure
181 was used to retain only the statistically significant variables in the final model. This involved
182 omitting non-significant variables, one at a time, until only significant variables remain.

183 Statistical significance was accepted at the .05 level.

184

185 Results

186 A total of 32 consecutive patients age ≥ 75 years underwent surgical treatment for
187 genital prolapse by the same surgeon (RB) during the study period. Among them, 2 patients
188 declined participation in completing the QoR-40 questionnaire. The present analysis
189 therefore included 30 patients. Patient and surgical characteristics are presented in Table 1.
190 A total of 27 patients underwent laparoscopic promontofixation and the remaining 3 patients
191 underwent pectopexy. A total of 6 patients had previously undergone total hysterectomy. The
192 surgery could be performed with 6 mmHg and the IPP was maintained for the duration of
193 surgery in all the patients.

194

195 Quality of Recovery–40 score

196 Results are shown in Table 2. For the global QoR-40 score and for the four
197 dimensions of the QoR-40, “emotional state,” “physical comfort,” “psychological support,” and
198 “pain,” no differences were observed between the basal score (the day before surgery,
199 between 7:00 and 8:00 pm) and at 24 hours (Table 2). The score for the “physical
200 independence” dimension was significantly lower at 24 hours than the basal score (Table 2).

201 For further evaluation of the effects of a low IPP in elderly patients, we compared the
202 present results with those of our previous RCT in elderly patients age ≥ 65 years [4]
203 (Supplementary Table 1). In our previous RCT [4], we included only patients who underwent
204 laparoscopic sub-total hysterectomy with promontofixation. Thus, we performed a subgroup
205 analysis of patients underwent the same surgical procedure (n=21) for comparison
206 (Supplementary Table 1). The operating time was significantly longer in our previous RCT
207 compared with those of the present study (Supplementary Table 1). The results of the
208 QoR40 scores (Supplementary Table 2) in these patients (n=21) were nearly identical to
209 those in the full cohort of patients (Table 2). In the low IPP group (8 mmHg, n=17) of our

210 previous RCT study [4], the scores for the two dimensions of the QoR-40, “physical comfort,”
211 and “physical independence,” were significantly lower at 24 hours than the basal score
212 (Supplementary Table 2). In the standard IPP group (12 mmHg, n=20) of our previous RCT
213 [4], the scores for the global QoR-40, and for the three dimensions of the QoR-40, “physical
214 comfort,” “physical independence,” and “pain,” were significantly lower at 24 hours than the
215 basal score (Supplementary Table 2).

216 To evaluate the effects of additional surgical procedures (Burch colposuspension
217 [Burch] or tension-free vaginal tape procedure [TVT]), we compared the QoR40 scores
218 between patients with (n=18) versus without (n=12) additional surgical procedures
219 (Supplementary Table 3). The operating time was significantly longer in patients with
220 additional surgical procedures (Supplementary Table 3). There was no significant difference
221 in the QoR40 scores between patients with versus without additional surgical procedures
222 (Supplementary Table 4)

223

224 ***VAS pain score***

225 No patients had a VAS pain score >30 the day before surgery. No patients had post-
226 operative shoulder pain. In the PACU, 7 (23%) patients had VAS pain scores >30. Upon
227 arrival in the ward, 4 patients (13%) had VAS pain scores >30. No patient had VAS pain
228 scores >30 at 12 hours or later (Supplementary Table 5).

229

230 ***Intraoperative core temperature***

231 Results are shown in Table 1. We observed that 15 of 30 (50.0%) patients were
232 already hypothermic just before starting the surgical procedure. Of these, 10 patients
233 remained hypothermic at the end of surgery. A total of 15 patients (50.0%) were hypothermic
234 at the end of surgery.

235

236 ***Intraoperative and postoperative complications***

237 One patient who had previously undergone laparoscopic total hysterectomy following
238 radiation therapy and chemotherapy due to uterine adenocarcinoma experienced an
239 intraoperative complication (bladder perforation). This was not related to low IPP, but rather
240 due to postsurgical and/or radiation-related adhesion. The patient was discharged on
241 postoperative day 2 with an indwelling urinary catheter after an uneventful postoperative
242 recovery. No patients experienced postoperative complications. No patients required re-
243 admission.

244

245 ***Quality of surgical conditions***

246 Scores rated by the surgeon for operative technical difficulty and working space for
247 dissection and suturing, surgical field visibility, pain experienced by the surgeon, are shown
248 in Supplementary Table 6.

249

250 ***Factors influencing length of hospital stay after surgery***

251 LHSS was <48 hours in 22 patients (73.3%) and <72 hours in 8 patients (26.7%). The
252 results of analyses comparing the characteristics of patients with a LHSS <48 hours versus
253 those >48 hours are summarized in Table 3. Only operating room (OR) exit time significantly
254 differed between patients with a LHSS <48 hours versus those >48 hours (Table 3). The
255 majority (n=7, 88%) of patients with a LHSS >48 hours were discharged from the OR in the
256 afternoon, whilst only one third of those (n=7, 32%) with a LHSS <48 hours were discharged
257 in the afternoon (Table 3). In addition to this significant factor, some evidence suggested that
258 operating time and QoR-40 scores at both baseline and 24 hours varied between the two
259 discharge time groups (Table 3). However, the results for all these variables did not quite
260 reach statistical significance.

261 Next, we examined the joint association between select factors and LHSS. A
262 backwards selection procedure was used to retain only the significant variables in the final

263 analysis (Table 4). The results of the multivariable analysis showed that both OR exit time
264 and QoR-40 score at baseline were associated with LHSS (Table 4). After adjusting for these
265 two variables, no additional effects of either operating time or QoR-40 score at 24 hours were
266 observed, both of which showed some association with LHSS in the initial analyses. OR exit
267 time was again associated with an increased chance of a LHSS >48 hours. The odds of a
268 LHSS >48 hours were more than 8 times higher in those with an afternoon discharge from
269 the OR compared with those with a morning discharge (Table 4). Higher baseline QoR-40
270 scores were associated with a lower chance of a LHSS >48 hours (Table 4). A one-unit
271 increase in this score was associated with a 20% reduction in the odds of a LHSS >48 hours
272 (Table 4).

273

274 **Discussion**

275 The present study showed the feasibility, safety, and clinical benefits of use of a low
276 IPP in very elderly patients who undergo laparoscopic surgery for genital prolapse, in
277 agreement with the results of our previous RCT [4]. Laparoscopic surgery confers several
278 benefits, including decreased postoperative pain, shorter LHSS, and a more rapid return to
279 regular daily activities [13, 14]. However, previous clinical trials for laparoscopic surgery have
280 included few very elderly patients age ≥ 75 years [15,16], who may benefit the most from
281 laparoscopic surgery [13, 14]. The present clinical trial could provide useful information for
282 very elderly population who require surgical treatment for genital prolapse.

283 Several limitations of the present study should be considered, and thus, the present
284 findings may not be generalized. First, the present study included only a small number of
285 patients and the same surgeon performed all procedures. Second, there were no age-
286 matched controls. Because our previous RCT [4] has already showed that a low IPP could
287 result in better clinical outcomes, it was not ethically possible to include age-matched elderly
288 patients who undergo laparoscopic surgery under a standard IPP (12mmHg). However,

289 compared with those of our previous RCT in elderly patients age ≥ 65 years, the present
290 findings suggested that the use of a low IPP could result in better quality of postoperative
291 recovery in elderly patients. Third, there may be biases associated with the heterogeneity of
292 the present study population. However, we found no significant differences in the QoR 40
293 scores between patients with versus without additional surgical procedures. In a subgroup
294 analysis of patients who underwent laparoscopic sub-total hysterectomy with
295 promontofixation, results of the QoR40 scores were nearly identical to those in the full cohort
296 of patients. Furthermore, the objective of the present study was not to identify factors that
297 influence LHSS; thus, we did not calculate the required number of patients for this. A large,
298 prospective, multicenter study is required to confirm the external validity of the present
299 results.

300 Aging is associated with impaired thermoregulatory function [17-19]; thus, elderly
301 people are at greater risk of perioperative hypothermia [17-19]. The present study showed no
302 significant effect of warmed CO₂ gas on the prevention of intraoperative hypothermia, also
303 consistent with our previous RCT [4]. Studies have suggested that extending systemic
304 warming into the preoperative period could be more beneficial than limiting it to surgery alone
305 [20-22]. Further studies are required to investigate whether the preoperative plus
306 intraoperative systemic warming could be more effective for prevention of hypothermia in
307 elderly patients.

308 LHSS after surgery can be influenced by many different factors, including medical
309 and social factors [23-32]. The presence of comorbidity has been a well-known risk factor
310 [28-30]. In the present study, no patients had ASA III-IV. Because genital prolapse is not a
311 life-threatening disease, only selected elderly patients who are in relatively good condition
312 might be referred to our hospital for surgical treatment. In the present study as well as in our
313 previous RCT [4], all patients were informed of expected discharge on postoperative day 3.
314 Social reasons requiring a longer hospital stay are more common in elderly patients [23, 24,
315 26, 27, 31]. Furthermore, studies have shown that older age can influence LHSS after

316 surgery [26, 31, 32]. Nevertheless, in the present study, 77.3% (22 of 30) patients were
317 discharged within 48 hours after surgery, whereas among elderly patients age ≥ 65 years of
318 our previous RCT [4], only 25.0% (5 of 20) patients in the 12-mmHg group and 23.5 % (4 of
319 17) in the 8 mmHg group were discharged within 48 hours (Supplementary Table 1).

320 Shortening LHSS after surgery benefits patients who prefer to be at home [33]. Furthermore,
321 in two 10-year age groups (68–77 years and 78–87 years), better functional outcomes were
322 associated with short admissions [34]. Finally, shortening LHSS benefits the healthcare
323 system in terms of cost and resource utilization [35, 36]. Hospital health care resource
324 utilization and costs are disproportionately incurred within the first 3 days of hospitalization
325 [35, 36]. It is therefore clinically important for both elderly patients and the healthcare system
326 to identify factors influencing LHSS. In the present study population, the odds of a LHSS >48
327 hours were more than 8 times higher in patients with an afternoon discharge from the OR
328 compared with those with a morning discharge. Furthermore, we observed approximately a
329 40-minute decrease both operation time and CO₂ pneumoperitoneum in the present study
330 compared to those in our previous RCT [4]. Previous studies suggested operation time [26,
331 32, 37, 38] and postoperative pain [28, 38, 39] as factors that influence LHSS. Thus, at least
332 three modifiable factors exist at an institutional and/or individual surgeon level—
333 postoperative pain, operative time, and OR exit time—that may potentially influence LHSS in
334 very elderly patients after laparoscopic surgical treatment for genital prolapse. To reduce
335 postoperative pain, a lower IPP [4, 28, 40] could be used. To reduce operative time,
336 improving surgeon efficiency is required: at an institutional level by improving coordination of
337 the surgical team and limiting unnecessary delays [41-45]. At the individual surgeon level,
338 this could be achieved by improving technical skill and operative efficiency [46, 47].

339 Achievement of a morning discharge from the OR is accomplished by a shorter operation
340 time and by scheduling the procedure as the first case in the morning [45]. Because the
341 number of very elderly patients who require surgical treatment is expected to rise [2],
342 improving the operating schedule and OR efficiency are worthy of careful consideration for
343 both patients and healthcare systems.

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353 **References**

- 354 1. Olsen AL, Smith VJ, Bergstrom JO, Colling JC, Clark AL. Epidemiology of surgically
355 managed pelvic organ prolapse and urinary incontinence. *Obstet Gynecol.* 1997;89:501–
356 506.
- 357 2. Søreide K, Wijnhoven BP. Surgery for an ageing population. *Br J Surg.* 2016;103:e7-9.
- 358 3. Cherubini A, Oristrell J, Pla X, et al. The persistent exclusion of older patients from
359 ongoing clinical trials regarding heart failure. *Arch Intern Med.* 2011;171:550-556.
- 360 4. Matsuzaki S, Vernis L, Bonnin M, et al. Effects of low intraperitoneal pressure and a
361 warmed, humidified carbon dioxide gas in laparoscopic surgery: a randomized clinical
362 trial. *Sci Rep.* 2017;7:11287.
- 363 5. Neudecker J, Sauerland S, Neugebauer E, et al. The European Association for
364 Endoscopic Surgery clinical practice guideline on the pneumoperitoneum for laparoscopic
365 surgery. *Surg Endosc.* 2002;16:1121-1143.
- 366 6. Chou R, Gordon DB, de Leon-Casasola OA, et al. Management of Postoperative Pain: A
367 Clinical Practice Guideline From the American Pain Society, the American Society of
368 Regional Anesthesia and Pain Medicine, and the American Society of Anesthesiologists'
369 Committee on Regional Anesthesia, Executive Committee, and Administrative Council. *J*
370 *Pain.* 2016;17:131-157.
- 371 7. Rivoire C, Botchorishvili R, Canis M, et al. Complete laparoscopic treatment of genital
372 prolapse with meshes including vaginal promontofixation and anterior repair: a series of
373 138 patients. *J Minim. Invasive Gynecol.* 2007;14:712-718.
- 374 8. Noé KG, Schiermeier S, Alkatout, Anapolski M. Laparoscopic pectopexy: a prospective,
375 randomized, comparative clinical trial of standard laparoscopic sacral colpopocervicopexy
376 with the new laparoscopic pectopexy-postoperative results and intermediate-term follow-
377 up in a pilot study. *J Endourol.* 2015;29:210-215.
- 378 9. Myles PS, Weitkamp B, Jones K, Melick J, Hensen, S. Validity and reliability of a
379 postoperative quality of recovery score: the QoR-40. *Br J Anaesth.* 2000;84:11-15.

- 380 10. Herrera FJ, Wong J, Chung F. A systematic review of postoperative recovery outcomes
381 measurements after ambulatory surgery. *Anesth Analg.* 2007;105:63-69.
- 382 11. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new
383 proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.*
384 *2004;240:205-213.*
- 385 12. Bodian CA, Freedman G, Hossain S, Eisenkraft, JB, Beilin Y. The visual analog scale for
386 pain: clinical significance in postoperative patients. *Anesthesiology.* 2001;95:1356-1361.
- 387 13. Bates AT, Divino C. Laparoscopic surgery in the elderly: a review of the literature. *Aging*
388 *Dis.* 2015;6:149-155.
- 389 14. Manceau G, Karoui M, Werner A, Mortensen NJ, Hannoun L. Comparative outcomes of
390 rectal cancer surgery between elderly and non-elderly patients: a systematic review.
391 *Lancet Oncol.* 2012;13:e525-36.
- 392 15. Schiphorst AH, Pronk A, Borel Rinkes IH, Hamaker ME. Representation of the elderly in
393 trials of laparoscopic surgery for colorectal cancer. *Colorectal Dis.* 2014;16:976-983.
- 394 16. Weber DM. Laparoscopic surgery: an excellent approach in elderly patients. *Arch Surg*
395 *2003;138:1083-8.* Blatteis CM. Age-dependent changes in temperature regulation - a
396 mini review. *Gerontology.* 2012;58:289-295.
- 397 17. Blatteis CM. Age-dependent changes in temperature regulation - a mini review.
398 *Gerontology.* 2012;58:289-295.
- 399 18. Baquero GA, Rich MW. Perioperative care in older adults. *J Geriatr Cardiol.* 2015;12:465-
400 469.
- 401 19. Jin F, Chung F. Minimizing perioperative adverse events in the elderly. *Br J Anaesth.*
402 *2001;87:608-624.*
- 403 20. Wong PF, Kumar S, Bohra A, Whetter D, Leaper DJ. Randomized clinical trial of
404 perioperative systemic warming in major elective abdominal surgery. *Br J Surg.*
405 *2007;94:421-426.*
- 406 21. Lau A, Lowlaavar N, Cooke EM, et al. Effect of preoperative warming on intraoperative
407 hypothermia: a randomized-controlled trial. *Can J Anaesth.* 2018;65:1029-1040.

- 408 22. Becerra Á, Valencia L, Ferrando C, Villar J, Rodríguez-Pérez A. Prospective
409 observational study of the effectiveness of prewarming on perioperative hypothermia in
410 surgical patients submitted to spinal anesthesia. *Sci Rep.* 2019;9:16477.
- 411 23. Lim SC, Doshi V, Castasus B, Lim JK, Mamun K. Factors causing delay in discharge of
412 elderly patients in an acute care hospital. *Ann Acad Med Singapore.* 2006;35:27-32.
- 413 24. Kelly M, Sharp L, Dwane F, Kelleher T, Comber H. Factors predicting hospital length-of-
414 stay and readmission after colorectal resection: a population-based study of elective and
415 emergency admissions. *BMC Health Serv Res.* 2012;12:77.
- 416 25. Tan TW, Kalish JA, Hamburg NM, Rybin D, Doros G, Eberhardt RT, et al. Shorter
417 duration of femoral-popliteal bypass is associated with decreased surgical site infection
418 and shorter hospital length of stay. *J Am Coll Surg.* 2012;215:512-518.
- 419 26. Dickinson KJ, Taswell JB, Allen MS, et al. Factors influencing length of stay after surgery
420 for benign foregut disease. *Eur J Cardiothorac Surg.* 2016;50:124-129.
- 421 27. Toh HJ, Lim ZY, Yap P, Tang T. Factors associated with prolonged length of stay in older
422 patients. *Singapore Med J.* 2017;58:134-138.
- 423 28. Ko-lam W, Sandhu T, Paiboonworachat S, et al. Predictive Factors for a Long Hospital
424 Stay in Patients Undergoing Laparoscopic Cholecystectomy. *Int J Hepatol.*
425 2017;2017:5497936.
- 426 29. Agrawal S, Chen L, Tergas AI, Hou JY, St Clair CM, Ananth CV, et al. Characteristics
427 associated with prolonged length of stay after hysterectomy for benign gynecologic
428 conditions. *Am J Obstet Gynecol* 2018;219:89.e1-e15.
- 429 30. Stethen TW, Ghazi YA, Heidel RE, Daley BJ, Barnes L, McLoughlin JM, et al. Factors
430 Influencing Length of Stay after Elective Bowel Resection within an Enhanced Recovery
431 Protocol. *Am Surg* 2018;84:1240-5.
- 432 31. Aarts MA, Okrainec A, Glicksman A, Pearsall E, Victor JC, McLeod RS. Adoption of
433 enhanced recovery after surgery (ERAS) strategies for colorectal surgery at academic
434 teaching hospitals and impact on total length of hospital stay. *Surg Endosc.* 2012;26:442-
435 450.

- 436 32. Chong JU, Lee JH, Yoon YC, et al. Influencing factors on postoperative hospital stay
437 after laparoscopic cholecystectomy. *Korean J Hepatobiliary Pancreat Surg.* 2016;20:12-
438 16.
- 439 33. Admi H, Shadmi E, Baruch H, Zisberg A. From research to reality: minimizing the effects
440 of hospitalization on older adults. *Rambam Maimonides Med J.* 2015;6:e0017.
- 441 34. van Vliet M, Huisman M, Deeg DJH. Decreasing Hospital Length of Stay: Effects on Daily
442 Functioning in Older Adults. *J Am Geriatr Soc.* 2017;65:1214-1221.
- 443 35. Fine MJ, Pratt HM, Obrosky DS, et al. Relation between length of hospital stay and costs
444 of care for patients with community-acquired pneumonia. *Am J Med.* 2000;109:378-385.
- 445 36. Taheri PA, Butz DA, Greenfield LJ. Length of stay has minimal impact on the cost of
446 hospital admission. *J Am Coll Surg.* 2000;191:123-130.
- 447 37. Scheer A, Martel G, Moloo H, et al. Laparoscopic colon surgery: does operative time
448 matter? *Dis Colon Rectum.* 2009;52:1746-1752.
- 449 38. Hansen RN, Pham AT, Boing EA, Lovelace B, Wan GJ, Urman RD. Reduced length of
450 stay and hospitalization costs among inpatient hysterectomy patients with postoperative
451 pain management including IV versus oral acetaminophen. *PLoS One.*
452 2018;13:e0203746.
- 453 39. Butz DR, Shenaq DS, Rundell VL, et al. Postoperative Pain and Length of Stay Lowered
454 by Use of Exparel in Immediate, Implant-Based Breast Reconstruction. *Plast Reconstr*
455 *Surg Glob Open.* 2015;3:e391.
- 456 40. Radosa JC, Radosa MP, Schweitzer PA, et al. Impact of different intraoperative CO2
457 pressure levels (8 and 15 mmHg) during laparoscopic hysterectomy performed due to
458 benign uterine pathologies on postoperative pain and arterial pCO2 : a prospective
459 randomised controlled clinical trial. *BJOG.* 2019;126:1276-1285.
- 460 41. Harders M, Malangoni MA, Weight S, Sidhu T. Improving operating room efficiency
461 through process redesign. *Surgery.* 2006;140:509-514.
- 462 42. Lee BT, Tobias AM, Yueh JH, et al. Design and impact of an intraoperative pathway: a
463 new operating room model for team-based practice. *J Am Coll Surg.* 2008;207:865–873.

- 464 43. Wolf FA, Way LW, Stewart L. The efficacy of medical team training: improved team
465 performance and decreased operating room delays: a detailed analysis of 4863 cases.
466 *Ann Surg.* 2010;252:477-483.
- 467 44. Russ S, Arora S, Wharton R, et al. Measuring safety and efficiency in the operating room:
468 development and validation of a metric for evaluating task execution in the operating
469 room. *J Am Coll Surg.* 2013;216:472–481.
- 470 45. Phieffer L, Hefner JL, Rahmanian A, et al. Improving Operating Room Efficiency: First
471 Case On-Time Start Project. *J Healthc Qual.* 2017;39:e70-8.
- 472 46. Hu YY, Peyre SE, Arriaga AF, et al. Postgame analysis: using video-based coaching for
473 continuous professional development. *J Am Coll Surg.* 2012;214:115–124.
- 474 47. Hull L, Arora S, Aggarwal R, Darzi A, Vincent C, Sevdalis N. The impact of nontechnical
475 skills on technical performance in surgery: a systematic review. *J Am Coll Surg.*
476 2012;214:214-230.
- 477
- 478

Table 1. Baseline Characteristics

Variable	6 mmHg warmed, humidified CO2 gas (n=30)
Age, mean (SD), y	80.4 (3.5)
Hight, mean (SD), cm	156.7 (19.4)
Body weight, Mean (SD), kg	59.3 (12.7)
Body mass index, mean (SD)	23.4 (3.7)
ASA status, No. (%)	
ASA 1	4 (13.3)
ASA 2	26 (86.7)
ACCI	3.6 (0.50)
Basal QoR 40, median [IQR]	191 [185, 197]
Additional surgical procedure, No. (%)	

None	12 (40.0)
Burch	15 (50.0)
TVT	3 (10.0)
Operating time, mean (SD), min	
Total operating time	124.3 (21.7)
Pneumoperitoneum time	112.3 (23.2)
Volume CO2 used, median [IQR], L	160 [80, 240]
Trendelenburg position, mean (SD), degree	22.6 (3.6)
Intraoperative sufentanyl usage, mean (SD), µg	41.0 (6.8)
Core temperature, median [IQR], °C	
Start temperature	35.9 [35.2, 36.6]
Minimum temperature	35.7 [35.2, 36.2]
Maximum temperature	36.0 [35.4, 36.6]
Final temperature	35.9 [35.4, 36.4]
PACU LOS, mean (SD), min	118.6 (24.6)

Morphine requirement in the PACU	
Patients requiring morphine, No. (%)	7 (23.3)
Morphine usage, median [IQR], mg	0 (1)
Patients requiring morphine in the ward, No. (%)	0 (0)
Hospital LOS after surgery, No. (%)	
<48h	22 (73.3)
>48h <72h	8 (26.7)

Abbreviations

IPP: intraperitoneal pressure, IQR: interquartile range, ASA: American Society of Anesthesiologists

ACCI: age-adjusted Charlson comorbidity index, QoR 40: Quality of Recovery–40

LOS: length of stay , PACU: postanesthesia care unit

Burch: Burch colposuspension , TVT: tension-free vaginal tape procedure

Table 2: QoR-40 Scores

Outcome	Baseline (n=30)	24h (n=30)	P-value
Global score	191 [185, 197]	190 [181, 194]	.07
C1: Emotional State	42 [38, 43]	41.5 [38, 44]	.76
C2: Physical Comfort	57.5 [54, 59]	58 [53, 58]	.33
C3: Psychological Support	35 [35, 35]	35 [35, 35]	.34
C4: Physical independence	25 [24, 25]	23.5 [22, 25]	<.001

C5: Pain

34 [31, 35]

33 [32, 34]

0.24

Results are shown as median [inter-quartile range]

Abbreviations

QoR-40: Quality of Recovery-40

Table 3: Comparisons of patients with a LHSS <48 hours versus those >48 hours

Variable	Category	<48 hours (n=22)	>48h <72h (n=8)	P-value
Age	-	80.4 ± 3.8	80.4 ± 2.6	.98
ASA score	1 2	3 (14%) 19 (86%)	1 (12%) 7 (88%)	1.00
ACCI	-	3.5 ± 0.5	3.7 ± 0.5	.32
BMI	-	23.6 ± 3.6	24.0 ± 4.4	.80
CO2 duration (mins)	-	108 ± 19	120 ± 25	.18
Operating time (mins)	-	119 ± 20	134 ± 22	.09
Volume CO2 (L)	-	165 [115, 200]	154 [121, 198]	.98
Additional procedure	No Yes	10 (45%) 12 (55%)	1 (12%) 7 (88%)	.20
Surgical difficulty	-	35 ± 16	33 ± 16	.71
OR exit time	AM PM	15 (68%) 7 (32%)	1 (12%) 7 (88%)	.01
Weekend discharge	No Yes	14 (64%) 8 (36%)	5 (62%) 3 (38%)	1.00
LOS in PACU	-	118 ± 24	120 ± 27	.83
Pain in PACU	≤ 30 > 30	15 (68%) 7 (32%)	5 (62%) 3 (38%)	.77

Temperature start	-	36.0 [35.6, 36.3]	36.1 [35.9, 36.2]	.83
Temperature end	-	36.0 [35.5, 36.2]	35.8 [35.5, 36.2]	.96
QoR40 score baseline	-	193 [189, 197]	182 [177, 190]	.06
QoR40 score 24 hrs	-	191 [182, 196]	184 [179, 190]	.08

Results are shown as mean ± standard deviation, median [inter-quartile range], or number (percentage)

Abbreviations

LHSS; Length of hospital stay after surgery, ASA: American Society of Anesthesiologists, ACCI: age-adjusted Charlson comorbidity index,

BMI: body mass index, OR: operating room, QoR-40: Quality of Recovery–40, LOS: length of stay, PACU: postanesthesia care unit

Table 4: Multivariable analysis of factors associated with LHSS

Variable	Category	Odds Ratio (95% CI) ^(*)	P-value
OR exit time	AM	1	.03
	PM	8.6 (1.7, 44.61)	
QoR40 score baseline	-	0.80 (0.65, 0.99)	.04

(*) Odds ratios represent the odds of a LHSS >48 hours.

Abbreviations

LHSS; Length of hospital stay after surgery, OR: Operating room, QoR-40: Quality of Recovery–40