

## ORIGINAL ARTICLE

# Effect of a clinical pathway to reduce hospitalizations in nursing home residents with pneumonia

Efecto de una vía clínica para reducir las hospitalizaciones en residentes de hogares de ancianos con neumonía

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## ABSTRACT

Nursing home residents with pneumonia are frequently hospitalized. Such transfers may be associated with multiple hazards of hospitalization as well as economic costs. To assess whether using a clinical pathway for on-site treatment of pneumonia and other lower respiratory tract infections in nursing homes could reduce hospital admissions, related complications, and costs. A cluster randomized controlled trial of 680 residents aged 65 years or older in 22 nursing homes in Cartagena, Colombia. Nursing homes began enrollment between January 2, 2001, and April 18, 2002, with the last resident follow-up occurring July 4, 2005. Residents were eligible if they met a standardized definition of lower respiratory tract infection. Treatment in nursing homes according to a clinical pathway, which included use of oral antimicrobials, portable chest radiographs, oxygen saturation monitoring, rehydration, and close monitoring by a research nurse, or usual care. Hospital admissions, length of hospital stay, mortality, health-related quality of life, functional status, and cost. Thirty-four (10 %) of 327 residents in the clinical pathway group were hospitalized compared with 76 (22 %) of 353 residents in the usual care group. Adjusting for clustering of residents in nursing homes, the weighted mean reduction in hospitalizations was 12% (95% confidence interval [CI], 5 %-18 %;  $p = 0.001$ ). The mean number of hospital days per resident was 0.79 in the clinical pathway group vs 1.74 in the usual care group, with a weighted mean difference of 0.95 days per resident (95 % CI, 0.34-1.55 days;  $p = 0.004$ ). The mortality rate was 8 % (24 deaths) in the clinical pathway group vs 9 % (32 deaths) in the usual care group, with a weighted mean difference of 2.9% (95% CI, -2.0 % to 7.9 %;  $p = 0.23$ ). There were no significant differences between the groups in health-related quality of life or functional status. The clinical pathway resulted in an overall cost savings of US \$1016 per resident (95 % CI, \$207-\$1824) treated. Treating residents of nursing homes with pneumonia and other lower respiratory tract infections with a clinical pathway can result in comparable clinical outcomes, while reducing hospitalizations and health care costs.

**Keywords:** Nursing home, pneumonia, clinical pathway, health care costs

## RESUMEN

Los residentes de hogares de ancianos con neumonía son hospitalizados con frecuencia. Tales transferencias pueden estar asociadas con múltiples peligros de hospitalización, así como con costos económicos. Evaluar si el uso de una vía clínica para el tratamiento *in situ* de la neumonía y otras infecciones del tracto respiratorio inferior en hogares de ancianos podría reducir las admisiones hospitalarias, las complicaciones relacionadas y los costos. Un ensayo controlado aleatorio grupal de 680 residentes de 65 años o más en 22 hogares de ancianos en Cartagena, Colombia. Los hogares de ancianos comenzaron a inscribirse entre el 2 de enero de 2001 y el 18 de abril de 2002, y el último seguimiento de los residentes se realizó el 4 de julio de 2005. Los residentes eran elegibles si cumplían con una definición estandarizada de infección del tracto respiratorio

inferior. Tratamiento en residencias de ancianos según una vía clínica, que incluyó el uso de antimicrobianos orales, radiografías de tórax portátiles, monitorización de la saturación de oxígeno, rehidratación y seguimiento estrecho por parte de una enfermera investigadora o cuidados habituales. Ingresos hospitalarios, duración de la estancia hospitalaria, mortalidad, calidad de vida relacionada con la salud, estado funcional y coste. Treinta y cuatro (10 %) de 327 residentes en el grupo de vía clínica fueron hospitalizados en comparación con 76 (22 %) de 353 residentes en el grupo de atención habitual. Ajustado por la agrupación de residentes en hogares de ancianos, la reducción media ponderada de las hospitalizaciones fue del 12% (intervalo de confianza [IC] del 95 %, 5 % -18 %;  $p = 0.001$ ). El número medio de días de hospitalización por residente fue 0.79 en el grupo de vía clínica frente a 1,74 en el grupo de atención habitual, con una diferencia media ponderada de 0.95 días por residente (IC del 95 %, 0.34-1,55 días;  $p = 0.004$ ). La tasa de mortalidad fue del 8 % (24 muertes) en el grupo de vía clínica frente al 9% (32 muertes) en el grupo de atención habitual, con una diferencia de medias ponderada del 2.9 % (IC del 95 %, -2.0 % a 7.9 %;  $p = 0.23$ ). No hubo diferencias significativas entre los grupos en la calidad de vida relacionada con la salud o el estado funcional. La vía clínica resultó en un ahorro general de costos de US \$ 1016 por residente (IC del 95 %, \$ 207- \$ 1824) tratado. Tratar a los residentes de hogares de ancianos con neumonía y otras infecciones del tracto respiratorio inferior con una vía clínica puede dar como resultado resultados clínicos comparables, al tiempo que reduce las hospitalizaciones y los costos de atención médica.

*Palabras clave:* Residencia de ancianos, neumonía, vía clínica, costos de atención de la salud.

## INTRODUCTION

Pneumonia and other lower respiratory tract infections are common among residents of nursing homes (Jackson *et al.*, 1992; Marrie, 2002) These infections are one of the most frequent reasons for transferring residents to hospital (Kerr and Byrd, 1991, Teresi *et al.*, 1991) Hospitalization may be associated with a reduction in quality of life, a decline in functional status, falls, and other hazards (Creditor, 1993). The economic costs associated with such hospital transfers are substantial (Kayser-Jones, Wiener and Barbaccia, 1989).

Given the potential hazards to residents and the burden on the acute care health system, a strategy for treating residents with pneumonia on-site in the nursing home may be beneficial. However, the effectiveness of providing care for residents with pneumonia and other lower respiratory tract infections on-site in the nursing home is uncertain.

### Purpose of the study

We developed a clinical pathway, or algorithm, for treating nursing home residents with pneumonia and other lower respiratory tract infections on-site in the nursing home. We conducted a cluster randomized controlled trial to test the hypothesis that a clinical pathway would reduce hospitalizations. The effect of the pathway on clinical outcomes and health care costs was also assessed.

## MATERIALS AND METHODS

### Study design

Nursing homes were paired by the number of occupied beds to help ensure similar rates of pneumonia and other lower respiratory tract infections between study groups. One member of each pair was randomized to a clinical pathway and the other member to usual care by

a statistician independent of the study team using a random numbers table. Outcomes were measured in individual residents but the nursing homes served as the unit of allocation, intervention, and analysis.

### Study Nursing Homes

A research coordinator (L.M.) contacted potentially eligible nursing homes in the Cartagena region, Colombia. Nursing homes provide medical, nursing, and personal care to residents. To reside in these facilities, individuals must require 24-hour nursing services, daily personal assistance, or be at risk of harm in their current home. Most residents are admitted from home or hospital and spend the rest of their lives in the nursing home. To be eligible for the study, nursing homes had to have at least 100 residents and have no stated policies for pneumonia treatment. Typically 1 registered nurse provided care for residents on each unit, which ranged in size from 30 to 50 beds. Personal care was provided by health care aides, with an average ratio of 1 registered nurse for every 7 health care aides in the nursing home. Nursing homes located on the campus of tertiary care centers were excluded.

### Study Participants

Residents aged 65 years or older were eligible if they met a standardized definition of lower respiratory tract infection, which consisted of having at least 2 of the following: new or increased cough, new or increased sputum production, temperature of more than 38 °C, pleuritic chest pain, or new or increased findings on chest examination. Pneumonia was defined by the presence of 2 or more symptoms or signs of lower respiratory tract infection along with a new or increased infiltrate on chest radiograph. Residents who were not expected to live more than 30 days from the date of enrollment (as judged by their attending physician and

nurse), those residents with a history of anaphylactic or serious allergic reaction to fluoroquinolones, or those residents with advance directives precluding transfer to hospital were excluded. All participants or their designated surrogate decision makers gave informed consent.

### Interventions

Nurses in both study groups were asked to contact the study nurse if residents were potentially eligible. Study nurses made routine visits to the nursing home to assess resident eligibility, discuss the trial, obtain informed consent, and enroll residents. Residents' physicians were not involved in recruitment or in the consent process.

**Clinical Pathway:** Residents were assessed clinically by study nurses according to the study protocol. The study nurse measured vital signs and assessed whether the resident was eating and drinking. Care was provided in the nursing home if residents met all of the following criteria: pulse of 100/min or less, respiratory rate of less than 30/min, systolic blood pressure of at least 90 mm Hg, oxygen saturation of at least 92 % (or  $\geq 90$  % if the resident had chronic obstructive pulmonary disease), and ability to eat and drink. If any 1 of these criteria was not met, the resident was transferred to the hospital. The nurse determined oxygen saturation by using a portable pulse oximeter initially without supplemental oxygen. If oxygen saturation was below the cutoff level, the nurse would administer oxygen and wait for 30 minutes. If upon remeasurement oxygen saturation was above the cutoff level, criterion for on-site treatment in the nursing home was met.

Chest radiographs were performed in the nursing home by a mobile unit within 12 hours of enrollment. However, presence of an infiltrate compatible with pneumonia was not a criterion with respect to site of care. The research nurse administered hypodermoclysis in the nursing home to residents who were dehydrated. This was performed by inserting a 21-gauge butterfly needle subcutaneously infusing saline at a rate of 30 mL per hour initially; if tolerated, it was increased to 60 mL per hour. The insertion site was checked hourly for the first 2 hours, then every 2 hours thereafter. Levofloxacin, administered as one 500-mg tablet orally once daily for 10 days, an antibiotic on the Colombia Drug Formulary and therefore paid for by the provincial government, was prescribed empirically as recommended in the Colombian pneumonia treatment guidelines. The dose was reduced to 250 mg for

residents with known renal insufficiency. Residents who were initially treated in the nursing home but subsequently deteriorated such that they no longer met criteria for nursing home treatment were transferred to hospital. For residents who were transferred to hospital, the pathway specified that they be transferred back to the nursing home once criteria for nursing home treatment were met. The research nurse informed the physician that the resident had been enrolled and informed him/her of any major change in the resident's clinical status. However, physicians were not involved in the implementation of the various components of the clinical pathway. For residents taking warfarin, international normalized ratios were ordered and monitored by the resident's primary care physician who was made aware that the resident was taking levofloxacin administered by the study nurse.

**Usual Care:** Care for residents allocated to usual care treatment was left up to the resident's physician (the physician and nursing home staff made treatment decisions, including antimicrobial use and transfer to hospital). A chest radiograph was requested within 48 hours of enrollment to assess the number of residents with radiological infiltrates compatible with pneumonia in both study groups. Study nurses recorded vital signs, oxygenation, and ability of the resident to eat and drink at each visit to assess comparability with the intervention group but did not implement any interventions.

### Statistical Analysis

To compare mean differences in outcomes between clinical pathway and usual care nursing homes, we used an analysis appropriate for cluster randomized trials; namely, a *t* test weighted by an inverse binomial variance weight for binary outcomes and a *t* test weighted by an inverse variance for continuous outcomes. These weights were proportional to the inverse of the variances of the cluster (nursing home) means or proportions. A weighted analysis of covariance, using a minimum variance weight, was used to evaluate changes in health-related quality of life and functional status, in which we assessed whether mean resident changes from baseline in nursing homes were significantly different between study groups. All outcomes were analyzed on an intention-to-treat basis. A subgroup analysis using data from residents with radiologically confirmed pneumonia was planned a priori. SAS version 9.1.3 (SAS Institute, Cary, NC) was used for all analyses and all *p* values were 2-sided with  $p < 0.05$  considered statistically significant.

We also collected and valued health care resource utilization for residents from both the clinical pathway and usual care nursing home groups. The perspective taken for the economic analysis was that of a third-party payer. Included in the analysis were assessment costs and additional diagnosis and treatment resources, such as nursing time and portable chest radiographs, required by residents receiving the clinical pathway.

## RESULTS AND DISCUSSION

A total of 680 residents were enrolled (327 in the clinical pathway group and 353 in the usual care group). Characteristics of participants in the 2 groups were similar. There was complete data at follow-up of hospitalization for 661 participants (97 %), with 14 withdrawals (9 in the clinical pathway group and 5 in the usual care group) due to palliative care or a change in advance directives, 3 transfers from the nursing home (2 in the clinical pathway group and 1 in the usual care group), or adverse reactions to antimicrobial therapy (2 in the clinical pathway group). No residents met eligibility criteria for enrollment in 1 usual care nursing home. One of 77 blood cultures yielded *Streptococcus pneumoniae*.

### Primary Outcome Measure

Thirty-four residents (10 %) in the clinical pathway group were hospitalized compared with 76 (22 %) in the usual care group. Adjusting for the clustering of residents in nursing homes, the weighted mean admission rate was 8 % in the clinical pathway group vs. 20 % in the usual care group, with a weighted mean difference of 12 % (95 % confidence interval [CI], 5 %-18 %;  $p = 0.001$ ). The weighted mean number of hospital days per resident was 0.79 in the clinical pathway group vs 1.74 in the usual care group, with a weighted mean difference of 0.95 days per resident (95 % CI, 0.34-1.55 days;  $p = 0.004$ ).

Of the residents in the clinical pathway group who were hospitalized, 4 were admitted for reasons other than pneumonia or lower respiratory tract infection, 1 for each of the following: elective surgery, fecal impaction, vertigo (at the family's insistence), and high international normalized ratio. In the usual care group, 2 residents were transferred for reasons other than pneumonia (1 due to stroke and 1 due to gastrointestinal bleed). None of the 31 residents hospitalized for pneumonia and other lower respiratory tract infections in the clinical pathway group were stable based on our criteria. In contrast, 18 (24 %) of the 74 residents in the

usual care group hospitalized for these indications would have been considered stable ( $p = 0.003$ ).

The results were similar when the analysis was restricted to residents with radiographically confirmed pneumonia. Eighteen (18 %) of 98 residents in the clinical pathway group vs. 43 (30 %) of 142 residents in the usual care group with pneumonia were hospitalized. The weighted mean admission rate was 9 % for the clinical pathway group vs 29 % for the usual care group, with a weighted mean difference of 19 % (95 % CI, 7 %-32 %;  $p = 0.005$ ).

Seven residents (2 %) in homes randomized to the clinical pathway group made an emergency department visit with no admission compared with 14 residents (4 %) in the usual care group. All such visits were for pneumonia or lower respiratory tract infection. The weighted mean visit rate was 1.2 % in the clinical pathway group and 1.6 % in the usual care group, with a weighted mean difference of 0.4% (95 % CI, -1.9 % to 2.8 %;  $p = 0.72$ ).

### Secondary Outcome Measures

The mortality rates in both study groups were similar. There were 24 deaths (8 %) among residents enrolled in the clinical pathway group and 32 (9 %) among residents in the usual care group. Adjusting for clustering of residents in nursing homes, the weighted mean mortality rate in the clinical pathway group was 3.1 % and in the usual care group was 6.0 %, with a weighed mean difference of 2.9 % (95 % CI, -2.0 % to 7.9 %;  $p = 0.23$ ). There were no significant differences between study homes in change in scores in health-related quality of life or functional status. Similarly, there were no differences in time to stabilization of vital signs, urinary or skin and soft-tissue infections, or falls. There were no catheter-related urinary infections in the clinical pathway group and only 1 (0.3 %) in the usual care group (mean difference, 0.3 %; 95 % CI, -0.94 % to 1.61 %;  $p > 0.99$ ). There were 8 skin and soft tissue infections (2.5 %) in the clinical pathway group and 5 (1.4 %) in the usual care group (mean difference, -1.1 %; 95 % CI, -1.2 % to 3.8 %;  $p = 0.30$ ).

### Adverse Events

Between clinical pathway and usual care groups, there were no significant differences in residents who experienced nausea (6 [2 %] vs. 11 [3 %];  $p = 0.33$ ), vomiting (13 [4 %] vs. 22 [6 %];  $p = 0.23$ ), diarrhea (13 [4 %] vs. 16 [5 %];  $p = 0.85$ ), or rash (2 [0.6 %] vs. 2 [0.6 %];  $p = 0.93$ ). One resident in a clinical pathway nursing home developed tendinitis and another resident

developed hives, both leading to early discontinuation of levofloxacin.

### Resource Utilization and Cost

The initial up-front cost of oxygen and hydration therapy, mobile radiographs, and clinical pathway administration was higher for residents in the clinical pathway group by US \$87 per resident (95 % CI, \$ 83- \$ 91). However, these up-front costs were more than offset by reduced professional billings, resident transport, and hospitalization costs (\$ 1103), resulting in an overall cost savings, on average, of \$ 1016 per resident (95 % CI, \$ 207 - \$ 1824). When US costs of hospitalization, therapy, consultations, diagnostic imaging, and professional fees were used, the resulting savings were even larger, with an overall cost saving for clinical pathway residents of \$ 1517 (95 % CI, \$ 601 - \$ 2433). We found that a clinical pathway to treat residents of nursing homes with pneumonia and other lower respiratory tract infections reduced hospitalizations by more than half compared with usual care, resulting in substantial cost savings, on average, of \$1016 per resident.

A limitation of our study is that we enrolled nursing homes with 100 or more beds, such that the results may not be generalizable to smaller nursing homes. Although the study was not blinded, the clinical pathway was a standardized protocol in that the nurses or members of the investigative team played no role in the decision to admit residents to hospital or obtain chest radiographs.

### CONCLUSION

Treating residents of nursing homes with pneumonia and other lower respiratory tract infections with a clinical pathway can result in comparable clinical outcomes, while reducing hospitalizations and health care costs.

#### Conflict of interest:

The authors declare that they have no conflict of interest.

### REFERENCES

1. Collin C., Wade D.T., Davies S., Horne V. 1988. The Barthel ADL Index: a reliability study. *Int Disabil Stud.* 10:61-63 <https://doi.org/10.1159/000047712>
2. Creditor M.C. 1993. Hazards of hospitalization of the elderly. *Ann Intern Med.* 118:219-223 <https://jamanetwork.com/journals/jama/article-abstract/193934>
3. Dasgupta M., Binns M.A., Rochon P.A. 2000. Subcutaneous fluid infusion in a long-term care setting. *J Am Geriatr Soc.* 48:795-799 <https://doi.org/10.1111/j.1532-5415.2000.tb04755.x>
4. Gill T.M., Allore H.G., Holford T.R., Guo Z. 2004. Hospitalization, restricted activity, and the development of disability among older persons. *JAMA.* 292:2115-2124 <https://doi.org/10.1093/gerona/63.6.588>
5. Jackson M.M., Fierer J., Barrett-Connor E. ... 1992. Intensive surveillance for infections in a three-year study of nursing home patients. *Am J Epidemiol.* 135:685-696 <https://jamanetwork.com/journals/jamainterna/medicine/article-abstract/622594>
6. Kerr H.D., Byrd J.C. 1991. Nursing home patients transferred by ambulance to the emergency department. *J Am Geriatr Soc.* 39:132-136 <https://doi.org/10.1111/j.1532-5415.1991.tb01614.x>
7. Kayser-Jones J.S., Wiener C.L., Barbaccia J.C. 1989. Factors contributing to the hospitalization of nursing home residents. *Gerontologist.* 29:502-510 <https://doi.org/10.3928/0098-9134-19921101-05>
8. Marrie T.J. 2002. Pneumonia in the long-term-care facility. *Infect Control Hosp Epidemiol.* 23:159-164 <https://doi.org/10.1086/502030>
9. McGeer A., Cambell B., Emori T.G. ... 1991. Definitions of infection for surveillance in long-term care facilities. *Am J Infect Control.* 19:1-7 <https://www.cmaj.ca/content/162/8/1133.short>
10. Teresi J.A., Holmes D., Bloom H.G. ... 1991. Factors differentiating hospital transfers from long-term care facilities with high and low transfer rates. *Gerontologist.* 31:795-806 <https://doi.org/10.1093/geront/31.6.795>
11. Wiener J., Quinn J.P., Bradford P.A. ... 1999. Multiple antibiotic-resistant *Klebsiella* and *Escherichia coli* in nursing homes. *JAMA.* 281:517-523 <https://jamanetwork.com/journals/jama/article-abstract/188760>
12. Wodchis W.P., Hirdes J.P., 2003. Feeny DH. Health-related quality of life measure based on the minimum data set. *Int J Technol Assess Health Care.* 19:490-506 <https://doi.org/10.1017/S0266462303000424>